Ritual in Development:

Improving children's ability to delay gratification

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Abstract

To be accepted into social groups, individuals must internalise and reproduce appropriate group conventions, such as rituals. The high fidelity copying of such rigid and socially stipulated behavioural sequences places heavy demands on executive function abilities. Given previous research showing that challenging executive functioning also improves it, it was hypothesised that prolonged engagement in ritualistic behaviours would improve executive functioning in children, in turn improving their ability to delay gratification. A three month circle-time-games intervention with primary school children in two contrasting cultural environments (Slovakia and Vanuatu) was conducted. In both environments we found the intervention improved children's executive function and in turn their ability to delay gratification. Moreover, these effects were amplified when the intervention task was imbued with ritual, rather than instrumental, cues. The findings presented in this thesis have potentially far-reaching implications for child-rearing and educational practices, suggesting ritual participation may be necessary for the cultivation of future mindedness.

Keywords: ritual, ritual stance, social conventions, the ability to delay of gratification, executive function, cognitive development.

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0. Introduction

Advertisers constantly promise to gratify our needs on demand and to reduce waiting times. Shampoos are 2 in 1, the internet is high speed, food must be ‘fast’. Indeed, all kinds of goods and services are increasingly advertised with a promise that production, delivery, or consumption (and sometimes all three) will be instantaneous. Nevertheless, many highly desirable goals in life benefit from long-term planning: pursuing a degree, choosing a partner, planning a family, leaving a job, or buying a house. Deciding to delay gratification, defined as the ability to resist a smaller but more immediate reward in order to receive a greater but delayed reward, typically involves weighing up the relative benefits and costs of waiting (Mischel, Ebbsen, & Zeiss, 1972). This may involve predicting or anticipating the future state of the self and others, and assessing how current behaviour can influence these future states. Some developmental research suggests that children as young as three years of age are able to reason about hypothetical futures (Kuczaj & Daly, 1979) and may use future-oriented language when describing possible events that have yet to occur (e.g. what happens when you bake cookies or go to a friend’s house; Atance & O’Neil, 2005; Hudson, Fivush, & Kuebli, 1992; Nelson, 1986; O’Neil & Atance, 2000). In order to delay gratification, as well as representing their future selves (ex. being rewarded for waiting), children must also resist immediate desires.[1]

[1] A marshmallow test designed by Walter Mischel (as discussed further on) is used in this thesis, but it is argued that the persistence aspects involved in the task are also involved in multiple situations in real life (e.g. education, dieting, addictive behaviours), including social learning.

It has been more than 40 years since psychologist Walter Mischel placed a cookie in front of a group of preschool children, giving them the tempting choice to either eat the cookie immediately or wait until he came back and receive two cookies (see the series of studies on delayed gratification in the late 1960s and early 1970s led by Mischel; e.g. Mischel & Baker, 1975; Mischel & Ebsen, 1970; Mischel et al., 1972; Mischel & Grusec, 1967; Mischel & Moore, 1973; these are also discussed in detail in later chapters). Some of the children could not resist and ate the cookie either immediately or during the waiting period. However, some participants were able to control themselves and curbed their desire for immediate gratification. The experiment had an important outcome: Mischel found that children who were able to resist the cookie and wait were, ten years later, as teenagers, better able to cope with stress and frustrations and were described by their parents as more socially competent, verbally fluent, attentive, rational, and able to plan (Mischel, Shoda, & Rodriguez, 1989); these were termed as “high-delay children”. Moreover, these children performed better academically, achieving on average SAT scores 210 points higher than those of children who had experienced difficulties in delaying gratification (termed “low-delay children”). These results led to many replications and variations of the experiment, designed to understand the psychological processes that allow children to exercise control over their behaviour. It is important to note that whether or not they decide to delay gratification, all normally developing children assess the benefits and costs similarly. They are capable of discerning which choice a “clever” child would make and which choice would be made by a “stupid” child (Nisan & Koriat, 1977). Such considerations do not determine a child’s actual choice. Rather, the choice depends on different attentional and cognitive strategies employed during the waiting periods. Interestingly, recent research shows that the ability to delay gratification remains stable into adulthood. More than four decades later, children who were as four-year-olds better able to delay gratification were as adults better able to resist various immediate temptations (Casey et al., 2011).

Previous research on delayed gratification demonstrates that resisting the temptation of immediate stimuli and inhibiting impulsive decisions can have positive long-term consequences and higher pay-offs in the future: individuals who are able to wait longer for rewards have healthier relationships, are better ability to cope with stressful situations and reach higher levels of education (Godoy et al., 2004; Kirby et al., 2002; Mischel et al., 1989; Reyes-García et al., 2007; Shoda et al., 1990). In contrast, a weaker ability to delay gratification has been found to be connected with addictions, earlier sexual debuts and unwanted pregnancy, problems with regulation of emotions, and lower levels of academic performance (Ariaga & Rusbult, 1998; Ayduk et al., 2000; Ayduk & Kross, 2008; Bickel & Marsch, 2001; Diller et al., 2008; Gross, 1998; Hoerger et al., 2011; Hanoch et al., 2013; Kirby et al., 1999; 2005)[2]. The results of these studies highlight the importance of designing an intervention that would be effective in improving the ability to delay gratification in children, enabling them to enjoy the benefits of controlling their immediate impulses and go through longer waiting periods which are often necessary to endure when working toward a goal.

This thesis aims to contribute to this topic by proposing a connection between ritual and the ability to delay gratification. It examines the proposition, that through executive function improvement, ritual participation can improve the ability to delay gratification. Because research shows that the ability to delay gratification is correlated with better social competencies and avoidance of addictive behaviours, this thesis may show that ritualised

[2] The adaptive flexibility of delay of gratification in regards to these issues is discussed further in this thesis.

behaviour might have a greater impact on human actions and behaviours than has generally been assumed in previous research: namely, it is likely to enhance the ability to delay gratification – an ability that has been found to be an important predictor of children's future academic and social success.

0.1. Ritual intervention to improve the ability to delay gratification: present research and its predictions

In one of his studies Walter Mischel asks: "Can … the ability to delay gratification be taught?" (Mischel & Ayduk, 2004: 100). Considering important and consequential long-term outcomes of this ability, it is indeed an important question. On the one hand, facilitating children's delay ability would help to improve their future quality of life by controlling their desires for immediate gratification and being able to anticipate future consequences of their present behaviours. On the other hand, being able to improve an individual's ability to resist immediately available tempting stimuli in order to trade them off for more advantageous, long-term alternatives could be an avenue for treating various behavioural disorders. However, to our knowledge, there is no research program designed for improving the ability to delay gratification in typically developing populations[3]. Although there is a rich array of studies looking at the development and correlational relationships between the ability to delay gratification and various cognitive and socioeconomic variables (as reviewed in section

[3] Some clinical studies have addressed how clinical populations (such as children with ADHD) have a lower ability to delay gratification, but can improve with practice (examples include: Diamond & Lee, 2011; Gawrilow, Gollwitzer, & Oettingen, 2011; Marco et al., 2009; Muraven & Baumeister, 2000; and Sonuga-Barke, Dalen, & Remington, 2003).

1.8.1), there is no intervention program directly focused on *improving* the ability by means of specifically designed interventions. This study attempts to fill this gap by connecting an intervention designed for improving children's executive function and their ability to delay gratification. The intervention program presented in this thesis is not focused on improving the ability to delay gratification directly, rather it is argued that executive function and the ability to delay gratification are interconnected, and by improving former, the enhancement of the latter can be achieved.[4]

The present research aims to make a novel contribution to this topic by attempting to explore the role of ritualised (conventional) behaviours in the development of executive function and the ability to delay gratification. Although ritual, executive function and the ability to delay gratification are all well-researched phenomena, the present thesis provides an experimental approach to show the connections between them. It is argued that cognitive processes involved in the social learning of ritualised, group-specific conventional behaviours (themselves a relatively unexplored area) make higher demands on cognitive processing than instrumental learning, which is the learning of behaviours for which the natural causal outcome of the action is knowable – even if it is not currently known (Legare et al., 2015). A plausible reason for this is that ritual learning requires precise reproduction of modelled behaviours (at the *proper* time, in the *proper* place, in the *proper* way) in order to avoid negative feedback from a peer group (e.g. ridicule and ostracism). Although this effect of ritual has been explored in recent research (Watson-Jones, Legare, Whitehouse, & Clegg, 2014), here the focus is on how the desire to belong and avoid social threat affects the cognitive processes involved in self-control: namely attention, inhibitory control and working

[4] It was taken into account that other types of gratification – such as social gratification as experienced by satisfactorily preforming a ritual – may be experienced by a participant. However, as discussed later (in section 5.6) social gratification did not appear to affect the results of the present research.

memory – cognitive processes, united under the term *executive function* (Diamond, 2013; Hofmann et al., 2012; Cameron Ponitz, McClelland, Matthews, & Morrison, 2009; Wanless et al., 2011), which are hypothesised to be necessary for the ability to delay gratification.

Furthermore, this thesis seeks to bridge the gap between the executive function and the ability to delay gratification. It experimentally examines the prediction that by improving an individual's executive function abilities, participation in conventional behaviours leads to improvement of the ability to delay gratification: Attention is crucial for prioritising goal-relevant stimuli over cues that prompt indulgence and immediate gratification; working memory serves to maintain active representations of goal-relevant information and manipulate abstract components involved in the delay situations (future selves and the consequences of our present behaviour, delayed rewards, etc.); and inhibitory control suppresses impulsive behaviours related to more available or pleasing immediate rewards.

More specifically, this thesis aimed to assess the following predictions:

1. Rule-based intervention games will improve children's performance in the executive function tasks, with games that incorporate a *ritual stance* having the largest effect on this improvement.
2. Participants' executive function and their ability to delay gratification will be significantly positively correlated: children with better executive function abilities will be able to delay gratification for longer than children with lower executive function abilities.
3. Rule-based intervention games will improve children's ability to delay gratification, with games that incorporate a *ritual stance* having the largest effect on this improvement.

4. The effect of rule-based intervention games on children's ability to delay gratification will be significantly mediated by the executive function.
5. The effect of a *ritual stance* on children's ability to delay gratification will be significantly mediated by the executive function.

The study participants were schoolchildren attending first and second grade of primary school (M_{age} = 7.78 years, *SD* = 1.47) – the period when development of crucial cognitive abilities is essentially completed, allowing to assess individual differences between participants. Moreover, some studies suggest that before the classical milestone in the Theory of Mind at the age of four, children only understand the content of representations without a substantial understanding of different forces and directions of fit of different speech acts (e.g. Perner, 1991). This study uses two kinds of verbal priming. Therefore, a sample of children in the age that would allow the assessment of the effect of the different kinds of verbal priming was chosen. Additionally, the sample also offers a comparative sample to the previous series of studies on childrens' ability to delay gratification conducted by Mischel and his colleagues (e.g. Mischel & Baker, 1975; Mischel et al., 1972; Mischel & Metzner, 1962; Mischel & Mischel, 1983).

The thesis is structured as follows:

Chapter 0 – "Introduction" – introduced the topic of the thesis.

Chapter 1 – "Literature review" – reviewed the theoretical literature of the main elements of the investigation: ritual; executive function; and delay of gratification. It also introduced the motivation for the research, which is its application to educational settings.

Chapter 2 – “Ritual stance adoption in two contrasting cultures” – is an ethnographic chapter that introduces the two field sites. The chapter focuses on the contrasts between the two cultures that could influence participants’ ability to delay gratification.

Chapter 3 – “The impact of ritual on the executive function” – describes the empirical literature on ritual and executive function. It presents the methodology of this thesis as well as the results of statistical tests for relationships between ritual and executive function. It also includes a factor analysis, which examines the latent structure of the executive function.

Chapter 4 – “The Executive function and the ability to delay gratification” – connects executive function and the ability to delay gratification. The chapter presents the results of statistical tests examining this relationship.

Chapter 5 – “The impact of ritual on the ability to delay gratification” – examines the relationship between ritual and the ability to delay gratification. It includes a structural equation model (SEM) that investigates the effects of the ritual intervention over time as a result of a single cognitive system.

Chapter 6 – “General discussion” – discusses the results of the study and the cross-cultural similarities.

Chapter 7 – “Conclusions and future directions” – concludes the study with some final remarks, discusses limitations and offers directions for future research.

In addition, the study includes four appendices: Appendices 1 and 2 describe the executive function measure (“Appendix 1: Head-Toes-Knees-Shoulders (HTKS) task”) and the delay of gratification measure (“Appendix 2: The delay of gratification experiment”). Appendix 3 (“Appendix 3: The intervention games and experimental manipulations”) provides a description of the intervention games, together with a description of the ritual and instrumental priming. Appendix 4 (“Appendix 4: Statistical tables and additional results”) includes additional statistical tables from the analyses discussed in the text. The study includes a full list of references.

1. Literature review

1.1. Ritual as normative convention

The word ‘ritual’ has been used to refer to a rich array of diverse, arbitrary, artificial, contingent behavioural patterns. It is therefore necessary to specify the aspects of ritual that are of interest in this thesis. For the purposes of this thesis, rituals are defined as conventional, causally opaque actions (following Whitehouse, 2011; and Legare, Wen, Herrmann, & Whitehouse, 2015). These behaviours must be performed in a certain ‘done’ or ‘proper’ way, but because of their unknowable causal structure they become cognitively challenging, and cultural novices (e.g. children, immigrants) must use high fidelity means of social learning to reproduce them in the appropriate ways and contexts.

Every social group has specific social rituals that lack any causal structure (i.e. the physical-causal means by which the ritual accomplishes its goals are unknowable), such as various norms, prescriptions and proscriptions, which serve as important in-group markers. These practices are often very subtle (e.g. facial expressions, gestures, etc.), sometimes not even being accessible to the conscious awareness of their practitioners. Such conventional behaviours can be internalised early in one’s development, and the learning of these behaviours is related to the amount of time spent within a group (Heyes, 2013), These behaviours provide a reliable signal of group membership and communicate group commitment and belonging. As such, these social rituals are vital for children to learn in order to become competent members of a community. Indeed, from childhood onwards humans pick up the knowledge, skills and models of behaviour that are specific to the culture and society they live in.

Although much research has been focused on learning and copying instrumental behaviours and skills (e.g., Carpenter, Call, & Tomasello, 2005; Gleissner, Meltzoff, & Bekkering, 2000; Williamson & Markman, 2006; Woodward, 2009), relatively little is known about how ritualised actions are cognitively assessed and learnt. In addition to certain technical skills, which are undoubtedly important for survival and success in all kinds of environments, to achieve group acceptance and to flourish within a group we also need to learn behaviours that have an unknowable causal structure (rituals, values, beliefs, etc.), being performed in a certain fashion simply because that is the 'done' or 'proper' way, and to become competent at reproducing these behaviours in appropriate ways and contexts (Whitehouse, 2012). This thesis refers to this aspect of ritual as 'normative convention' and it is argued that reproducing the normative conventions in an appropriate manner is executive function demanding. In line with recent approaches to normative conventions (Sosis & Ruffle, 2003; Lanman 2012; Henrich, 2009), this research accepts that ritual can serve as an important and credible in-group marker and it is essential that cultural novices (e.g. children, immigrants) learn these conventions in order to gain social acceptance and become competent members of a community.

In this study, rituals are defined as conventional, causally opaque and goal demoted behaviours – a definition covering a wide range of socially transmitted behaviours. As such, rituals and ritualised behaviours are socially consequential acts and behaviours, serving as cultural markers, which, despite their teleological opacity and goal demotion, are successfully transmitted by specific mechanisms of cultural learning and serve as group-specific displays of affiliation, belongingness and cohesion. These behaviours are intuitively recognisable by their rigidity, normativity, and causal opacity – features that make rituals cognitively challenging because one must pay attention to arbitrary details and the requirements for proper performance of the action.

For behaviours and actions to serve as marks of group membership, they must be performed properly – in an accepted and established manner, just like various social rituals. That is to say that rituals need to be performed in *normative* fashion; there is no better or more effective way of performing a ritual sequence, there only is a prescribed, proper way, which sometimes includes creating an orderly environment - one different from everyday interaction space (e.g. people wear special clothes or make-up, delimit a particular space, dance instead of walk, build stages, etc.; Rappaport, 1979). Ritualised actions and behaviours performed in a normative fashion are socially valued, and encouraged as acts that ought to be performed even though it might not always be clear why.

Importantly, ritual sequences have a *rigid*, invariant order of actions, regarding the ways in which these actions are performed (Boyer & Liénard, 2006; Herrmann et al., 2013; Legare et al., 2015; Rappaport, 1999; Rossano, 2012; Turner, 1977; Watson-Jones et al., 2014). Performing a ritual does not allow for modifications and personal innovations: participants must defer to precise scripts without questioning the actions and techniques and must perform formal acts and utterances in more or less invariant fashion, even though they are not entirely encoded by the performers (Rappaport, 1999: 24). Unlike non-ritual actions, which are understood as expressions of the intentional states of the performer, the acts and utterances being performed during rituals do not originate from the actors themselves but are socially stipulated in advance by others (Humphrey & Laidlaw, 1994; Rappaport, 1999;

Whitehouse, 2004, 2005). Ritual participants defer to specific prescriptions and intentionality of an action thus originates from outside the actor. In other words, in rituals which are socially stipulated, actions with no intrinsic intentional meaning (as defined by Humphrey and Laidlaw, 1994), the intentionality of actors and performed actions is separated from each other (Bloch, 1974, 2004; Humphrey & Laidlaw, 1994; Whitehouse, 2004, 2005). Thus, when participants are asked about the meaning of a ritual, or why it is carried out in a certain way, they often cannot offer a clear answer (Bloch, 1974). As Humphrey and Laidlaw put it, "the peculiar fascination of rituals lies in the fact that here, as in few other human activities, the actors both are and are not the authors of their acts" (1994: 5).

Rigidity of ritual actions creates an emphasis on proper normative performance and orderly fashion in which rituals are performed, and makes rituals irreconcilable with physical causal mechanisms, i.e. direct causal connection between ritual actions and their outcomes are often missing (Bloch, 2004; Herrmann et al., 2013) – that is to say, rituals are *causally opaque*. Although rituals are believed to have a particular effect (e.g. promoting crop fertility, healing, ensuring protection, conferring a new social status, etc.), they are not expected to do so by causal mechanisms that are in principle knowable or transparent (Whitehouse, 2011). For example, ritual washing (a ritual performed to purify someone or something, e.g. immersion in a mikveh) differs from ordinary washing in that the actions are causally divorced from their goal. Although both washing and purification are manifestly goals, the set of sequences that a ritual washing is composed of are not connected to a goal in the same way as sub-actions connect to sub-goals in ordinary, everyday behaviour – using soap to wash one's hands is a causally transparent process, but how the water in mikveh purifies someone spiritually is not – instead of actual cleaning, attention is drawn to the process itself, to the precise movements and scripts. The intuition that actions are divorced from their goals is often reinforced by frequent repetition of the same actions in some rituals (e.g. kneeling repeatedly, walking around an object five times, etc.; Boyer & Liénard, 2006; Legare et al., 2015; Rappaport, 1979).

Observing normative conventions, which are rigid and causally opaque often requires an individual to coordinate with others. Emphasis is placed on precise performance, individuals must defer to the authority of others or socially stipulated rules and suspend his or her own immediate self-interest in lieu of the larger group. Despite this, people are intrinsically motivated to follow norms to fulfil the need to belong and communicate the likeness to their social partners ('we are alike' message). A strong human tendency to follow normative conventions and punish their violators, even when this brings some material disadvantage, is apparent in the ultimatum game (Henrich & Henrich, 2007). In the game, a player is given a sum of money and his or her task is to divide this money with another player however she likes. The other player can either accept or reject the offer. If the offer is accepted, both players keep the money. If it is rejected, neither player gets the money. Logically, the first player should divide the money so as to maximise his or her own gain and the second player should accept any amount of money to have at least some gain. However, it has been shown that both players have a tendency to operate using a shared perception of fairness – the first player by offering 30-40% of the money and the second player by rejecting amounts lower than this. Both players thus have a tendency to forego personal gain in order to conform to the norm of fairness (Henrich et al., 2001). Interestingly, even children as young as 21 months are sensitive to a fair and equal distribution of rewards (Sloane, Baillargeon, & Premack, 2012), reacting negatively to unequal, particularly personally disadvantageous distributions (three-year old children; LoBue, Nishida, Chiong, DeLoache, & Haidt, 2011), and taking into account individual contributions when rewards are distributed (three–four-years-old children; Baumard, Mascaro, & Chevallier, 2012).

The question then becomes how are normative conventions cognitively approached? How are the features of rituals interpreted, learnt, and transmitted? Additionally, what are the individual and social consequences of ritual learning and participation? We argue that these questions can be (at least partially) addressed by looking at how children learn rituals and how different interpretations of modelled behaviours (ritual vs. instrumental) influence the learning process. Learning normative conventions is likely supported by specific learning mechanisms. Unlike instrumental behaviours which are causally transparent and some steps can thus be omitted or replaced with alternative ones, normative conventions require higher imitative fidelity. Recent research suggests that children are able to discriminate between different learning situations and adopt different cognitive stances accordingly. This theory is discussed in the following section and argues that certain features of modelled actions lead children to believe that they are witnessing a conventional practice and as a consequence, see all elements as obligatory or necessary to perform from a normative standpoint.

1.1.1. The theory of two cognitive stances

The research in developmental psychology (Herrmann, et al., 2013; Legare et al., 2015; Watson-Jones et al., 2014) shows that children are able to flexibly navigate learning opportunities and strategies by attending to various physical and social cues, recognise that not all of the behaviours and practices they learn must be copied rigidly, and accordingly switch between different learning strategies using different interpretive modes or “cognitive stances" (Herrmann et al., 2013; Legare et al., 2015; Watson-Jones et al., 2014). These include: (1) an *instrumental stance* – a psychological system supporting the learning of instrumental skills; and (2) a *ritual stance* – a psychological system supporting the learning of conventional, ritualised behaviours. By doing so, children discriminate between learning situations allowing innovation and calculations of effectiveness, and learning situations calling for the learning of a rigid social convention[5]. When observed actions have physical/causal outcomes, learners seek the rationale for these actions based on causation. They adopt an instrumental stance, allowing the use of different or innovative ways to accomplish the goal, with unnecessary actions being cleared out. On the other hand, in the case of teleologically and causally opaque ritualised behaviours such as social norms and rules, when participants are not able to explain why particular procedures rather than any others are carried out, the rationale for actions must be looked for in social conventions. Consequently, a *ritual stance* – which promotes the employment of rigid imitation with higher levels of precision in imitating action sequences – is adopted. When the ritual stance is adopted, relying on physical and causal relationships and goal identification is abandoned. Instead, individuals learn more rigidly since, as discussed earlier, rituals do not have better or more effective ways of performing they must be executed in a certain prescribed manner. Thus, adopting a *ritual stance* is to assume that the actions are executed in a certain way simply because it is demanded by a convention – the socially stipulated, proper way of

[5] This is in accordance with Durkheim and his seminal work on religion (1915), where he concluded that one of the most fundamental distinctions in human thought is the one between *sacred* and *profane*. Whereas *profane* represents individualistic (uncommitted), utilitarian, practical and self-serving way of thinking (factual beliefs about nature, god, etc.), *sacred* includes ritualistic ways of thinking and behaviours that are valued beyond their utility (shared beliefs, ideologies, rituals, etc.) Durkheimian theory posits that social groups make individuals rather than the other way round. Groups supply *sacred* values, such as shared norms and ideologies, which help with overcoming the difficulties with finding meanings and order in the social world.

behaving – and not because there is some coherent causal structure that could account for the actions instrumentally.

To explore the *ritual*/*instrumental* stance theory experimentally, Legare and colleagues (2015) designed an experiment with two conditions: a ritual condition and an instrumental condition. In the *instrumental condition*, the children (five–six year-olds) watched a video with a series of actions involving colourful objects, ending with a woman putting one of the objects into a box. In this condition, the end state differed from the start state, so that the physical outcome could be interpreted as a goal. In the *ritual condition*, children watched the same video with a seemingly small difference: in the end, all the manipulated objects ended up back where they were originally placed at the beginning – in this condition, the end and start states were identical, so that children would not attribute a goal to the performed actions, as if the actions did not have any tangible purpose. After watching the video, children in both conditions were asked to interact with the objects shown in the videos and replicate the modelled actions. The results showed that when the start and end states were identical (i.e. in the ritual condition), children interpreted the action as a ritual (i.e. they adopted a *ritual stance*) and copied it with higher fidelity and fewer innovations – children's learning strategies were more rigid, possibly because the causal opacity obstructed the process of identifying which actions were effective in bringing about the potential desired outcome. In other words, children over-imitated the action sequence they observed. In the instrumental condition however, children replicated the demonstrated actions less rigidly: as the end state allowed the subjects to learn the demonstrator's intentions toward a physical goal, the space was left open for more individual innovations. The experiment suggests that if the apparent end states of an action are present, they become the most attention-grabbing aspects and those which are subsequently replicated. However, when there are no apparent end states, the actions themselves become salient and subsequently copied, because they might be considered to be the goals themselves instead of being the means to achieve a goal (Legare et al., 2015). Indeed, recent research with four–five year-olds (Nielsen, Kapitány, & Elkins, 2015) shows that children adopt conventional behaviours even when it is clear that they have negligible or no functional value – a result revealing sensitivity for learning ritualistic behaviours.

Similarly, Carpenter, Call and Tomasello (2005) showed that when children are presented with a toy mouse either sliding or hopping into the house, they do not replicate the action of sliding or hopping – they just put the mouse into the house. However, when there is no house the children are more likely to replicate the action of either sliding or hopping. Moreover, in the study by Legare et al. (2015) children offered different explanations for their actions according to the condition: they offered more conventional and less agentive explanations in the ritual condition than in the instrumental condition. The results suggest that, as Kenward et al. (2011) put it, children's over-imitation is based on declarative belief and not on behavioural procedure. In other words, "children over-imitate because they believe that a clearly intentional behaviour ought to be reproduced even if that behaviour's causal relevance is unclear. … Norms are actions done simply because they ought to be done in order to please others" (Rossano, 2012: 7). As such, the learning of conventions "entails especially careful observation of and rigid adherence to demonstrated patterns of object manipulation, gesture and action sequencing. … Conventions are not the inventions of those who perform them but are learned from others, typically passed down through the generations from nonspecific ancestral sources" (Legare et al., 2015). Human societies use imitative learning to learn and preserve cultural norms and conventions by deferring to the tradition and authority of others – individuals do not necessarily have to understand the actions' purpose in order to adopt them. As Bloch (1974) states, one does not necessarily need to understand something in order to believe it to be true, effective or advantageous – "for individuals to adopt norms it is sufficient that they observe that the action is normative – the detection of norms creates an intrinsic motivation to follow them, a motivation of which the norm follower may not even be aware" (Kenward et al. 2011: 1245).

Thus, to shed light on why normative conventions are so relatively easily spread even despite their cognitive opacity and apparent lack of technical motivations or rationality, it is important to consider how rituals influence the process of social learning by engaging affiliative motivations which result in the pressure to employ rigid copying of certain behaviours. It is also crucial to explore how this process is cognitively approached by children during episodes of social learning. From a very young age (two years) children learn and engage in variety of rituals and ritualised behaviours, which share common themes and courses of action across different cultures (Zohar & Felz 2001), and play important role in children's individual well-being, enculturation and social acceptance. The next section will briefly examine this issue.

1.2. Ritualised behaviour in development

Since the time of Piaget (1950) and Freud (1965), ritualised behaviour has been viewed as a normal part of children's development. Normal ritualised behaviour begins early in childhood and continues throughout development. It is characterised by repetitive elements and adherence to rules that are imposed by the child on his or her own behaviour and on the behaviour of others (Zohar & Felz, 2000). It involves preoccupation with the 'just right' ordering of things (e.g. the arranging of toys, pillows in bed placed in an exact way), the precise course of actions (e.g. the particular ordering of daily activities, with activities done precisely the same way as on previous occasions), preferred routines (e.g. performing bedtime activities in a particular order, sitting on the same spot while watching television), eating rituals (e.g. potatoes not touching any other food on the plate, using the same bowl for cereals) and bedtime rituals (e.g. requests to hear the same story, saying good night in a particular way, etc.)

As children age and gain more understanding about the surrounding environment, their rituals change: the near-compulsive rigidity gives way to less rule-driven behaviours (Evans et al. 1997; Leonard et al. 1990; Zohar & Felz 2001). Most children start to engage in ritualised behaviour in a limited range of situations starting at age two, peaking in middle childhood, with more sophisticated ritualised behaviour reaching as far as adolescence (Boyer & Liénard, 2006; Evans et al., 1997; Leonard, Goldenberg, Rapaport, Chelsow, & Swedo, 1990; Liénard & Boyer, 2006). At two and a half years of age, children begin to expect routines and require things to be done 'just so', preferring the familiar ways of activities and expressing high sensitivity in relation to minute details until "some subjective sensory-perceptual criterion has been reached" (Tregay, Gilmour, & Charman, 2009: 284). At this age, ritualised behaviours might help children to overcome anxiety and enhance their cognitive control over the course of daily activities through familiarity with the courses of actions, the people they interact with during those actions, the items used, etc. By the age of four, children are more comfortable with change. However, some rituals are still important (e.g. bedtime ceremonies) and must be performed rigidly (Evans et al. 1997; Tregay, Gilmour, & Charman, 2009). Between five and six years of age, children's ritualisation is characterised by group play with elaborate rules and rhymes (e.g. hopscotch, jacks, jumping rope, etc.; Rubin, Fein,

& Vandenberg 1983). From the ages of six to 11, children's play is dominated by elaborate rules and prohibitions (e.g., Adams, 1973; Oremland, 1973). Around the age of seven, children start collecting things (posters, stickers, stamps, etc.; Leonard et al., 1990) and later, at around ten years of age, obsession with an activity (e.g. after-school sport activities, arts) or famous person is common (Leonard et al., 1990; Zohar & Felz, 2001). However, during this period, children become more understanding of causal and temporal relations and rely less on repetitive rigid behaviours (Piaget, 1950).

Leonard et al. (1990) stress the fact that, although these behaviours might resemble those of patients with obsessive compulsive disorder (OCD), they are not emotionally distressing, incapacitating, isolating and do not lead to social isolation and withdrawal. Instead, normal rituals during the course of children's development are presumed to help with mastering anxiety and fears, and with enhancing one's socialisation (Evans et al. 1997; Leonard et al., 1990; Peleg-Popko & Dar, 2003). By using rituals, children try to enforce consistency on objects and significant others and make their environment more predictable (Zohar & Felz, 2000), thereby reducing the possibility of unpredictable, and potentially threat- and anxiety-inducing situations. Articulated rules included in rituals help the children govern their own behaviour and the behaviour of others (Zohar & Felz, 2000). In other words, rituals are important for mastering anxieties and fears, as well as for warding off dreaded events.

Reflecting children's understanding of the world and their place in it, the amount and character of these dreaded events change over developmental stages, and as a consequence, these changes influence the rituals children engage in, as shown by past studies on this subject (Elbedour, Schulman, & Kedem, 1997; King & Ollendick, 1989; Miller, 1992): between the ages of two and five, the fears commonly include imaginary creatures, monsters and small animals, and the fear of the dark – the fears resulting in demanding and engaging in very detailed rituals to impose familiarity on daily events. Later, with the start of school attendance and richer social interactions, fears related to injuries and death, and social fears such as peer rejection or other social anxieties, prevail. This results in abandoning private rituals to some extent and higher engagement in social rituals to ensure group acceptance and fulfil the need of belonging. These rituals – normative conventions – require individuals to comply with the requirements of the society they live in. This is hypothesised to involve higher cognitive control in order to perform normative convention in an appropriate manner for individuals to avoid social threats such as ridicule or ostracism. This is further discussed in the following chapters.

1.3. Rituals' demands on executive function

The overarching goal of this thesis is to shed light on the impact of children's ritual participation on the ability to delay gratification – an ability contributing to many highly valued competencies, such as future-mindedness, patience and prudence. It is proposed that ritual engagement improves this ability by enhancing children's executive function competencies, which are crucial for sustaining waiting periods in delay situations, as they help children resist tempting, immediately present rewards. Thus, one of the aims is to test the prediction that performance of ritualised behaviours improves children's executive function by making heavy demands on attention, working memory and inhibitory control: Because ritualised normative conventions are causally opaque, it becomes difficult for the learners to discern what aspects to copy rigidly and which aspects can be safely ignored, or individually modified. As a consequence, the learners must control their behaviour in light of different needs and situational constraints in order to employ socially accepted actions, thus creating greater demands on their executive function abilities. This in turn influences social learning of normative ritualised conventions, which differ from everyday routines, in being highly executive function demanding.

In what follows, the literature on the hazard precaution system is briefly reviewed. Briefly stated, if a threat is experienced, individuals become more cautious about what is done and greater attention is paid to ritual actions (Boyer & Liénard, 2006); resulting in a burden on executive function. Therefore, understanding how humans attend to hazards in their environment can help identify a potential reason why processing ritual behaviours may create greater demands on executive function than instrumental behaviours (as proposed by Legare et al., 2015).

1.3.1. Hazard precaution system

Because normative conventions represent shared values and ideologies, they are encouraged during the process of socialisation and are an integral part of group life. They serve to organise social life by enforcing activities that are considered to be right and proper (activities that ought to be done) and discourage activities that are considered to be improper or wrong (activities that should not be done) or present a threat to social life by undermining group-shared values and ideologies (such as norms violation, free-riding, criminal behaviours, etc.) As a consequence, humans likely developed a system of precautionary actions dealing with potential threats while applying conventional, normative prescriptions and proscriptions to everyday social life.

Norm following supports the belief that all the in-group members share similar ideologies and are also committed to a group; as this feeling increases, individuals' feelings of belongingness and tendencies to feel positive affection towards a group also increase. On the other hand, when widely shared norms and rules are violated, individuals are deprived of the feeling of stable social relations within a group, giving rise to negative emotions. As a result, those who weaken social cohesion are judged, ridiculed, or worse – ostracised (Baumeister & Leary, 1995; Haidt & Graham, 2009).

As norm and rule violations present possible harm or threats (attacks, illness, etc.), human groups apply different rules and prohibitions to various aspects of social life. These prohibitions are designed to deal with inferred threats and to shape moral domains (notions of what is 'right' and what is 'wrong'). This results in "prescriptive judgments about justice, rights and welfare pertaining to how people ought to relate to each other" (Turiel, 1983: 3). Thus, one hypothesis about the pervasiveness of rituals in human societies is that rituals help people to reduce or overcome the anxiety of potentially dangerous or unpredictable situations. For instance, Sosis (2007, 2008; Sosis & Handwerker, 2011) showed that ritual of psalm recitations helped participants cope with stress and reduced anxiety during times of political crisis. As noted in one of the studies, the ritual of "psalm recitation is likely to have emerged as an expected cultural norm during times of crisis … because of its ability to buffer against stress and uncontrollable conditions" (Sosis & Handwerker, 2011: 50). Similarly, Malinowski (1948) states that rituals have the power to help humans cope with fear and uncontrollable or unknown conditions. Furthermore, Bloch states that "when one is in trouble and one does not know what to do, one allows oneself to be taken over by the knowledge and authority of others" (2005: 135-136). Some, but obviously not all, rituals are dedicated to detecting and dealing with potential physical and also social hazards in the environment by providing feelings of certainty and control. Children in particular use various rituals to cope with stressful situations, such as bedtime routines that make staying alone in a dark room when falling asleep easier, or taking a favourite toy along when going to unknown places. Marks and Johnson (1993) found that even college students (roughly 20%) still engage in pre-sleep rituals, possibly to ward off fears and anxieties accompanying bedtime.

Some aspects of ritualization seem to be "expressions of evolved neural equipment dedicated to detecting and avoiding hazardous contaminants in the environment" (Whitehouse, 2006: 661), and thus reducing the anxiety of threat-implying situations (Boyer & Liénard, 2006). Whitehouse (2012) speculates – in line with Rozin (1999) – that when our ancestors moved from the jungle to the savannah, they became omnivorous in order to reduce vulnerability to food shortages caused by both climate and competition, and began to try new foodstuffs. However, trying new kinds of food involved the potential risk of inhibiting toxins. Perhaps to reduce this risk, humans evolved a system of stereotyped actions for dealing with dubious objects and substances, known as Hazard Precaution System (HPS; Boyer & Liénard, 2006). The HPS is a mental security system intended to deal with inferred or potential threats (e.g. social exclusion, contamination, the presence of predators, etc.) It is proposed that when humans deal with dubious objects or behaviours, the HPS is activated. This system engages stereotyped actions involving pollution anxiety, neatness, exactness, symmetry, cleanliness and boundary maintenance (Fiske & Haslam, 1997; Whitehouse, 2012). However, the system does not only deal with contagion and pollution sensitivity and health concerns; precaution sensitivity is also applied to other individuals and groups for social and symbolic reasons (e.g. different status, race or norm violation) to promote "pure" and "proper" living (Haidt & Graham, 2009; Rozin, Haidt & McCauley, 2000). According to Boyer and Liénard (2006), one by-product of HPS is that humans pick up various stereotyped forms of actions and behaviours (even when some of them might be unnecessary or random) resembling the outputs of the HPS. Because rituals mimic the normal outputs of the HPS, they are attention-grabbing and captivating (Boyer & Liénard, 2006). As people learn to apply rules to different aspects of life and demand these rules be followed by others, they form implicit judgements regarding what is considered to be appropriate. These judgments become part of intuitive morality. This partially explains why rituals are so compelling and easily spread: we expect others, and are equally expected by others, to act according to prescribed scripts of appropriate behaviours. Generally speaking, the threat of being judged, ridiculed or ostracised motivates people to comply with various normative conventions by enacting them properly at the right time and in the right place. Therefore, to avoid social threats it is crucial to perform ritual actions in a rigid and normative manner even if the actions are casually opaque. For example, research by Over and Carpenter (2009), and Watson-Jones et al. (2013), showed that children primed with ostracism cues copy the model's actions more precisely than children primed with neutral cues.

Indeed, threats to social attachments are an important source of negative affect – Baumeister and Tice (1990; also see Barden, Garber, Leiman, Ford, & Masters, 1985) posit that social exclusion may be the most common source of anxiety, and even memories of past rejections cause people to feel distressed and anxious (Tambor & Leary, 1993). In line with this approach, Mehta and Zhu (2009), as well as Friedman and Forster (2010), found that implicit danger cues narrow one's perceptual and conceptual focus, making people more concerned and attentive about making mistakes when performing a task. People pay more *attention* to the minute details of the actions instead of the goal itself. When the HPS is activated, people focus their attention on relevant stimuli and their *working memory* is swamped by precise replication of prescribed actions that require higher levels of cognitive control and attention and *inhibiting* alternative (improper) forms of action. When normative conventions are performed, HPS is very likely to be activated (Liénard & Boyer, 2006). Potential danger of not following the rules (moral threat, possible exposure to gossip, ridicule or social exclusion, worry about misfortune) – is very likely to activate the hazard-precaution system, which makes normative conventions more executive function demanding by placing increased demands on attention, inhibitory control, and working memory – cognitive abilities that are components of executive function.

1.4. Executive function and behavioural self-regulation

When a response is required that conflicts with automatic response tendencies, humans must consciously control their thoughts, actions and behaviours. Achieving desired outcomes often requires overriding and controlling maladaptive and prepotent responses, such as our impulses and urges. The cognitive ability enabling us to control and regulate our behaviour has been termed executive function, and as the "ability to plan, guide and monitor complex goal-directed actions" (Karbach & Kray, 2009: 978), it is considered to be one of the core features of human behaviour (Hofmann, Schmeichel, & Baddeley, 2012). Executive function entails both rigidity (i.e. pursuing long-term goals, staying focused on a task, resisting temptations and impulses, etc.) and flexibility of behaviours (thinking "outside the box", being able to adapt to changed circumstances, and use alternative courses of action) that are fundamental for pursuing "long-term goals in the face of tempting alternatives" (Hofmann et al., 2012: 177). Without the discipline to complete long time-consuming tasks, one would never be able to complete difficult, often challenging, projects such as writing up a thesis, running a marathon, dieting, etc. Indeed, research shows that executive function is important for a lot of different aspects of life, such as school success, marital relations, physical and mental health, and public safety (Diamond, 2013; see Table 1 below).

The regulation of behaviour depends not only on executive control but also on processes of emotion regulation. Developing the ability to regulate positive emotions (excitement) and negative ones (outbursts of anger and aggression) is very important for a child's socialisation and functioning in the social context (Kochanska et al., 2000). During emotional development, an ability to feel and understand more complex emotions increases and helps a child to adapt to social environment. Moreover, studies from cognitive development and developmental cognitive neuroscience suggest that the development of emotion regulation is supported by executive functions processes, such as attention and inhibitory control, which are often involved in emotionally demanding contexts (Tottenham & Casey, 2011; Zelazo & Cunningham, 2007).

Although research shows that emotional understanding is related to executive function development (Carlson & Wang, 2007; Simonds, Kieras, Rueda, & Rothbart, 2007) results also suggest that different aspects of executive function are affected differently by different emotions. For example, positive affect has been shown to impair children's performance on the strop task[6]. However, even among the same participants, positive mood increased the level of performance on a creative uses test of fluency, which is a general test of creativity and relations between concepts (Phillips, Bull, Adams, & Fraser, 2002). Furthermore, it has also been found that some children who suffer from anxiety-depression exhibit deficits in

[6] A common executive function task where individuals have to read aloud the names of colours, but the colour of the word does not match the word being read aloud: for example, the word "blue" could be spelled in a bold *red* colour and the word "black" could be spelled in a bold *green* colour

sequencing, alteration, and problem-solving tasks; as measured by the length of time to complete a task and the number of errors the child commits during the task (Emerson, Mollet, & Harrison, 2005). Although emotions play an important role in social interactions, this study will only focus on executive control of cognition, which "processes the ability to flexibly switch between modes of responding as environmental or task demands change" (Wiebe, 2008: 577), emotional development is a complex topic that is beyond the scope of the presented thesis.

However, future research should aim to look closer at the relationship between basic motivations (emotions, mood, etc.) and executive function. In particular, moral emotions that are socially motivated and arise from social interactions, such as shame, pride, guilt, etc., are undoubtedly important in connection to ritual participation because their understanding requires internalisation of societal norms, ideologies, and moral principles. In social activities (e.g., being at school), it is often necessary to control emotional reactions, either positive (e.g., excitement) or negative (e.g., frustration) in order to accommodate to norms and goals. It is recognised that social activities require one to control both positive and negative emotions in order to accommodate to normative prescriptions and proscriptions, but this is not the core concern of the present study which focuses on cognitive control of behaviour, i.e. executive function.

Aspect of life	The relevance of EF to this aspect of life	References
Mental health	EF is impaired in many mental disorders, including:	
	- Addictions	Baler & Volkow, 2006
	- Attention deficit hyperactivity disorder (ADHD)	Diamond, 2005; Lui & Tannock 2007
	- Conduct disorder	Fairchild et al., 2009
	- Depression	Taylor-Tavares et al., 2007
	- Obsessive compulsive disorder (OCD)	Penadés et al., 2007
	- Schizophrenia	Barch, 2005
Physical health	Poorer EF are associated with obesity, overeating, substance abuse, and poor treatment adherence	Crescioni et al., 2011; Miller et al., 2011; Riggs et al., 2010
Quality of life	People with better EF enjoy a better quality of life	Brown & Landgraf, 2010; Davis et al. 2010
School readiness	EF are more important for school readiness than IQ or entry-level reading or mathematics skills	Blair & Razza, 2007; Morrison et al., 2010
School success	EF predict both mathematical and reading competence throughout the school years	Borella et al., 2010; Duncan et al., 2007; Gathercole et al., 2004
Job success	Poor EF lead to poor productivity and difficulty finding and keeping a job	Bailey, 2007
Marital harmony	A partner with poor EF can be more difficult to get along with, less dependable, and/or more likely to act on impulse	Eakin et al., 2004
Public safety	Poor EF lead to social problems (including crime, reckless behaviour, violence, and emotional outbursts)	Broidy et al., 2003; Denson et al., 2011

Table 1: The executive function's (EF) importance in different aspects of life

(Diamond, 2013: 137)

Although research on executive function has been conducted for several decades, there is still no agreed-upon definition of the term. One school holds that executive function is a "unitary, domain general construct that manifests in different ways depending on contextual demands" (Wiebe, Espy, & Charak, 2008: 575) (e.g. Duncan & Miller, 2002). However, others have argued that executive function is a group of relatively independent but interrelated cognitive abilities (e.g. Diamond, 2013; Hofmann et al., 2012; Cameron Ponitz, McClelland, Matthews, & Morrison, 2009; Wanless et al., 2011), which most often include:

- **Updating**, which includes operations such as maintenance and updating of relevant information (Hofmann et al., 2012), and changing approaches and perspectives in light of new information, demands or priorities (e.g. if one way of solving a problem doesn't work, we can think of another way).
- **Shifting** represents switching back and forth between different instructions and mental sets (Hofmann et al., 2012; Monsell, 2003) and the ability to switch between different modes of responding when the demands change (Miyake, Friedman, Emerson, Witzki, & Howerter, 2000). This ability enables humans to abandon low-utility (although sometimes more tempting) means and employ different, more effective ways (such as exercising instead of drinking weight-loss drinks in order to lose weight) in order to meet new priorities, demands or rules (Diamond, 2013).
- **Working memory** is "the ability to keep information in [an] active, quickly retrievable state" (Hofmann et al., 2012: 174). It also enables us to hold information in the mind while processing other information. This includes the representations of goals and desired states (for example, losing weight) which are necessary to activate goal-directed behaviour (Kane, Bleckley, Conway, & Engle, 2001), as well as the means by which the desired states can be reached (healthy food, exercising, etc.) (Kail, 2003; McClelland et al., 2007; Cameron Ponitz, 2008; 2009). Working memory allows us to "hold information in mind and mentally work with it (e.g. relating one thing to another, using information to solve a problem)" (Diamond, 2013: 137; see also Cameron Ponitz et al. 2009), even when the information is no longer perceptually present (Baddeley & Hitch, 1994; Diamond, 2013). By manipulating the information in one's mind and mentally reordering pieces of information, one can make plans,

consider alternatives, see the relations and connect and combine different ideas and elements.

- **Attention** enables us to selectively attend to goal-related stimuli, including shielding relative information from distractive or tempting ones. It allows us to focus on a task and complete it (McClelland et al., 2007; Cameron Ponitz et al., 2008, 2009; Rothbart & Posner, 2005; Zelazo & Müller, 2002). It is because of a failure to direct attention from tempting (e.g. the taste of the cake when on a diet, chatting with a classmate, etc.) to goal-relevant (e.g. the number of calories in the cake, listening to the teacher, etc.) stimuli that individuals often fail in their attempts. As Hofmann and colleagues (2012) put it, one needs to "zoom in" on the goals he or she wants to achieve and keep the attention focused on these goals. It is attention that enables one to hold relevant information in the working memory by supressing intrusive thoughts and directing one's mind to follow the (often more difficult) course of action that is required to lower the discrepancies between the desired and actual states.
- **Inhibitory control** is a deliberate inhibition or suppression of automatic prepotent (sometimes incorrect or maladaptive) responses, impulses and emotions (such as suppression of anger when provoked), which are incompatible with our goals. It also relates to the ability to devise solutions to carry out more adaptive or appropriate actions (Carlson & Moses, 2001; Diamond, Barnett, Thomas, & Munro, 2007a; McClelland et al., 2007; Cameron Ponitz et al., 2008; 2009). In other words, inhibitory control refers to the active inhibition of automatic or "mindless" behaviours and reactions, which have been deemed inappropriate. Low inhibitory control leads to impulsive behaviour, which can compromise the pursuit of important goals (e.g. having pizza for dinner when one is trying to lose weight, remembering to raise a hand

in a class in order to speak, following classroom rules such as waiting for a turn, etc.) (Dowsett & Livesey, 1999; Cameron Ponitz et al., 2009; Wanless et al., 2011). Inhibitory control allows us to choose how to react by controlling emotions and internal predispositions and enables us to choose our behaviour and course of action according to what is more appropriate or needed (for example, not saying the first thing on our mind, suppressing our attention on what classmates are saying so as to concentrate on what the teacher is saying, etc.) It helps us to resist temptations and impulsively take what we want without regard to our goals (e.g. eating cake when trying to lose weight) or social norms (e.g. stealing or taking a toy from another child) (Diamond, 2013). Diamond et al. (2007a) stress the fact that it is not enough to know or remember something – one might know exactly what he/she should do, and want to do that, but might not be able to because of insufficient inhibitory control.

The debate about executive function as a unitary ability vs. executive function as a set of abilities has been investigated in some recent studies that focused on conducting statistical analyses to identify its latent structure (e.g. Friedman & Miyake, 2004; Hedden & Yoon, 2006; Hull, Martin, Beier, Lane, & Hamilton, 2008; Miyake et al., 2000). Using Confirmatory Factor Analyses and Structural Equation Modelling, Miyake and colleagues (2000) found that a three-factor model (including shifting, updating, and inhibitory control) fitted the data significantly better than a one- or two-factor model. Similarly, by analysing the performance of adults on different executive function tasks Hull and colleagues (2008) found that a three-factor conception of executive function fit the model significantly better than one- and two-factor solutions, which were not sufficient to explain task performance. Generally speaking, the studies have identified solutions using more than one factor in order to explain the variability in the executive function tasks (Friedman & Miyake, 2004; Hull et al., 2008;

Miyake et al., 2000), with a three-factor solution being the best fit for the data (e.g. Friedman et al., 2007; 2008; Miyake et al., 2000).

Based on these results then, executive function does not seem to be a unitary construct. It can rather be defined as a set of processes that "enables planning, decision-making, coordinating, sequencing and monitoring of cognitive operations" (Hull et al., 2008: 508). The term can be understood as an umbrella for various top-down mental processes that involve reflection on context and future consequences, used in situations when we need to pay attention and concentrate and cannot rely on automatic or instinctive responses and intuition, which are insufficient or inappropriate during processes like reasoning, planning and decision-making (Burgess & Simons, 2005; Diamond, 2013; Espy, 2004). Replicating these results in cross-cultural samples of children will provide a basis for comparison between studies as well as a foundation to investigate the extent to which executive function may be developing differently in different cultures (this is discussed further in Chapter 3).

However, differences remain in terms of the taxonomic specifications of executive function. Different studies and investigators usually present different sets of mental processes comprised in executive function (Diamond, 2013; Hofmann et al., 2012; Hull et al., 2008; Miyake et al., 2000; Wiebe et al., 2008; and many others). In this thesis, executive function represents a set of three cognitive processes: inhibitory control, attention, and working memory. Inhibitory control is widely accepted as an important part of executive function (Baumeister & Heatherton, 1996; Carver & Scheier, 1981; Diamond, 2013; Dowsett & Livesey, 1999; Hofmann et al., 2012; Hull et al., 2008; Miyake et al., 2000; Cameron Ponitz et al., 2009; Wanless et al., 2011; Wiebe et al., 2008; and others). As visual and auditory distraction have been shown to be responsible for older adults' poorer results in executive function tasks (Rutman et al., 2010), attention as the ability to attend to relevant stimuli has been chosen as the second cognitive process. Since updating and shifting can be considered mental manipulations of the information we hold in our minds (such as relating one idea to another and/or updating the content of what is held in the mind), working memory has been chosen as the third process.

It is important to note that cognitive processes involved in executive function are not isolated from each other – on the contrary, they are interrelated and support and complement each other. For example, working memory supports inhibitory control: holding the goal and the ways to achieve it in mind helps to inhibit irrelevant and impulsive behaviours. Inhibitory control in turn helps to control one's attention and prevents one (i.e. inhibits attention) from attending to irrelevant thoughts, stimuli and distractions ("mind wandering"). Furthermore, it helps us to clear the memory of extraneous and irrelevant thoughts that are no longer needed to guide our behaviour (Diamond, 2013; Duncan et al., 2008). Attention supports inhibitory control by making us stay focused on a task to completion despite various difficulties, distractions and temptations that need to be suppressed. It also supports working memory by shielding irrelevant information so that the working memory can focus and mentally manipulate relevant information and stimuli. A famous example illustrating the working and cooperation of these cognitive processes is Piaget's test of liquid volume (Piaget, 1941), where the same amount of liquid is poured into a thin long beaker and a fat short beaker. Because of the different beaker shapes, the liquid level is much higher in the thin long beaker. Seeing the higher level of liquid, attending to this information and not inhibiting the prepotent visual information, four- and five-year-olds believe that there is more water in the thin long beaker even though they certified that the amount of liquid poured into both beakers was the same. However, when children are shielded from seeing the liquid levels and are simply asked which of the beakers contains more liquid, they are able to focus on the relevant stimuli and information, manipulate it mentally, and give the correct answer (Bruner, Olver, & Greenfield, 1966). The next section will examine the development of executive function more closely.

1.5. The development of executive function

Given the importance of executive function-related abilities for quality of life, there has been considerable interest in understanding the development of this ability. Executive function refers to “cognitive abilities that are associated with or subserved by the prefrontal cortex and interconnected subcortical system” (Wiebe et al., 2008: 575). Since the development of the prefrontal cortex occurs later in life and takes longer than the development of other cerebral structures (Gied et al., 1999), the neural circuitry subserving executive function is also slow to develop (Wiebe et al., 2011). Neuronal generation, differentiation and synaptic pruning are not fully developed until early adulthood (Paus et al., 2001). This is supported by the general finding in the literature that executive function develops with age, with a critical stage being the preschool period when children make the transition from infancy into childhood. This transition marks a period of more complex interactions in contexts outside their home environment – whereas in the first months of life children’s behaviours are primarily regulated by their parents or caregivers, with age children become increasingly able to regulate their behaviour themselves.

In early research, children’s executive function competence was assumed to be negligible, based on the assumption that the prefrontal brain regions do not become fully functional until later in development (Chelune & Baer, 1986; Golden, 1981). However, it has been recognised that some basic aspects of executive function (e.g. the regulation of eye movement) emerge as early as during infancy (Diamond, 1990; Johnson, 1995). For example, in one study of four-month-old infants, recruited from an American University participant database, researchers found that they were able to use gaze aversion to reduce their anxiety in uncertain or disturbing situations, and later use motor movements (crawling, walking) to regulate their behaviour and feelings by approaching or withdrawing from people or objects (Repacholi, Meltzoff, Rowe, & Toub, 2014). Nine to 12-month-old children can successfully update their working memory content (Diamond, 1985), suggesting early development of working memory and attention (Diamond, 1995). Source, Emde, Campos, & Klinnert (1985) found that, among 12 to 18-month-old middle-class children recruited from birth announcements in the United States, social referencing emerges during the period of 12 to 18-months and children are able to use others' emotional cues and reactions (e.g. tone of voice, facial expression) to guide their behaviour (e.g. approaching a novel object after observing positive or neutral affect, but withdrawing from or avoiding a novel object if negative affect is observed). At this age, infants can also regulate their imitative behaviour based on *emotional eavesdropping*, i.e. emotional cues observed from the social interactions of two other people that are not directed to the infant (Repacholi & Meltzoff, 2007). In the second year of life, children become able to, and more sophisticated in, using social cues to govern their behaviour: e.g. not only are they able to follow a specific target of another person's gaze (Butterworth & Jarrett, 1991), they are also capable of following a gaze selectively (e.g. children follow an adult's gaze toward an object only when the adult can see that object, as shown by Brooks and Meltzoff, 2002). Interestingly, Repacholi and colleagues (2014) recently tested a sample of children drawn from an American university database, and were able to show that infants as young as 15 months are able to integrate two different and temporally distinct pieces of social information, and to consider not only (1) prior emotion of another person, but also (2) the current attention of this person, and to use these pieces of information to regulate their (i.e. the child's) own behaviours. In this study, infants were observers of a social interaction between two adults, in which one manipulated various objects that produced sounds and the other expressed an angry emotional reaction to this activity. When the infants were invited to interact with the objects themselves, they were hesitant about imitating the observed activity when the adult who had previously expressed anger was facing them; by contrast, when this adult left the room, the infants were eager to imitate the previously modelled behaviour. This study suggests that emotional information does not have to be present for children to guide and regulate their behaviours; instead children are able to extract it from their working memory. Importantly, the study also shows that infants are able to integrate multiple pieces of social information – a capability that is undoubtedly advantageous in a complex social world (Repacholi et al., 2014). The fact that children did not respond in a rigid manner but paid attention to social cues, used information stored in their working memory and regulated/inhibited their immediate responses lends credence to the position that executive function can be observed relatively early in infancy.

Executive function continues to develop in preschool years, but remains challenging for small children; compared to adults, children still find it more problematic and difficult to self-regulate their behaviours and inhibit prepotent tendencies. For example, in the experiments of Davidson et al. (2006), four–nine year-olds were recruited from Boston area schools to perform two tasks: In the first one, children were asked to respond on the same side as the stimulus, and then asked to inhibit this prepotent tendency and respond on the opposite side from the stimulus. In the second task, children were asked to hold two stimulus-response associations in mind, and then hold six stimulus-response associations in mind. The researchers found that the difference in performance was greater between the first pair of tasks than between the second pair of tasks. The opposite was true for adults, who had fewer problems inhibiting prepotent tendencies but found it harder to hold six associations in mind, suggesting that working memory declines with age and is connected to inhibitory control and attention decline: as shown in the study of Rutman, Clapp, Chadick and Gazzaley (2010), older adults are more vulnerable to visual and auditory distractions and are consequently worse at suppressing irrelevant information.

There is some evidence that the development of executive function is closely tied to the development of the ToM. The most rapid gains in executive function tasks have been observed between three and five years of age (Kochanska, Murray, & Harlan, 2000; Wiebe et al., 2011; Wiebe et al., 2012), which is the same time (around four years of age) that children also reach an important milestone in the ToM development, starting to understand that "people are mental agents whose actions are causally mediated by their internal states such as intentions, emotions, and beliefs" (Henning, Spinath, & Ascherslebe, 2011: 513). Children become able to understand that beliefs about the world may be true or false and that these beliefs may lead to successful or erroneous judgements and actions (Wellman, Cross, & Watson, 2001). The key in this process is that children must hold in mind two different and "conflicting representations regarding the same situation … and inhibit the prepotent response tendency exerted by one of the two (e.g. one's own true belief vs. another person's false belief)" (Henning et al., 2011: 514). Some studies suggest that there is an ontogenetic link between children's executive function and their ToM, with robust correlations found in performance on the executive function tasks and ToM tasks (e.g. Carlson, Mandell, & Williams, 2004; Carlson, Moses, & Claxton 2004; Flynn, 2007; Müller, Zelazo, & Imrisek, 2005). There are two different approaches to explaining these correlations. First, *the* *expression accounts approach* posits that successful performance on ToM tasks requires higher levels of executive function in order to shift attention from salient cues and one's own representations so as to reflect the less salient but more relevant cues and representations of others (Hughes & Russell, 1993; Russell, Mauthner, Sharpe, & Tidswell, 1991). Another approach – *the emergence accounts approach* – suggests that executive function and ToM are functionally dependent. For example, Frye (2000) argues that the relation between executive function and ToM can be explained by reference to the development of the general ability to reason about complex problems and situations. Similarly, Ozonoff, Pennington and Rogers (1991) posit that the correlations between executive function and ToM are a consequence of the maturation of common underlying brain structures. One way or another, similar mental processes are necessary for both ToM and executive function, which suggests that they develop together and are interconnected (or support each other). Related factors include holding information in one's mind and manipulating it (I saw someone replacing sweets with pencils, therefore I know that there are pencils in the sweets box), being attentive to what is relevant (other people did not see what I saw and therefore might not know what I know), and suppressing prepotent response based on the available information and its procession (other people would expect the box to have sweets in it instead of pencils).

Unlike studies with adults (Hull, et al. 2008; Miyake et al., 2000; Friedman & Miyake, 2004), studies with children in the early preschool age (three–six-years-old) have identified executive function as a unitary construct (Hughes, Ensor, & Graham, 2010; Wiebe et al., 2008; Wiebe et al., 2011). For example, the studies by Wiebe et al. (2008) and Hughes et al. (2010) found that unitary models best fit the observed data. Wiebe and colleagues (2011a) evaluated the fit of unitary and fractioned models and found that three- and two-factor models did not have significantly better explanatory power than a unitary model. However, it seems that the single-factor model representing simpler form of executive function may be specific to the early preschool years, with executive function being separable into three components later in development. This is supported by the body of literature and findings from research with adults and adolescents, as well as by studies with older children. For example, McAuley and White (2011) recruited children from the United States and found the three-factor model of executive function to be superior for participants across a wide age range (six–24-years old), suggesting that the crucial change in executive function ability takes place during the later preschool years (six–seven years of age) when it becomes increasingly differentiated and separable into three relatively independent cognitive abilities: similar to the one observed in adult individuals. From the age of six the structure of the executive function is tripartite – composed of three relatively independent and interrelated cognitive abilities (Huizinga et al., 2006; Lehto et al., 2003), with "the diversity of EF [executive function], at least from school age onward, now [being] broadly acknowledged" (Wiebe et al., 2011: 437). This tremendous change emerges during the transition period when children have to adjust from the less structured activities of preschool to the more formal, structured and rule-driven environment of school. Based on monitoring their environment, children are expected to develop and exhibit greater self-regulation of their own behaviours (Espy, 2004) and modulate these behaviours according to different contexts, situations and social cues (i.e. in terms of paying attention, remembering and following instructions and acting appropriately, working independently, but also establishing relationship with other classmates and with teachers; Cameron Ponitz et al., 2009; O'Shaughnessy, Lane, Gresham, & Beebe-Frankenberger, 2003). The improvement of the higher level cognitive processes (i.e. executive function) becomes necessary for planning and controlling children's own behaviour in increasingly complex social situations (Zelazo et al., 1997). To handle these situations and ensure fitting within a group and taking an advantage of group belonging, executive function undergoes fundamental structural changes which are likely to provide greater gains in its efficiency over this period (Wiebe et al., 2011). Together with language development and better representations of abstract and arbitrary rules, the pivotal changes in executive function are important in terms of children gaining the skills that allow them to exert control over their everyday actions and behaviours.

Indeed, the role of executive function as a critical component in school and social success has been emphasised by a number of researchers (Diamond et al., 2007a; 2007b; McClelland et al., 2007; Cameron Ponitz et al., 2008; 2009; Tominey & McClelland, 2011; Wanless et al., 2011). Behavioural self-regulation – a "manifestation of the executive function skills in overt, observable responses in the form of children's gross motor actions" (Cameron Ponitz et al., 2009: 605) – which is based on cognitive systems in which children must develop higher order rules to regulate their own behaviour in order to plan and carry out their future actions (Wiebe et al., 2008; Zelazo, Müller, Frye, & Marcovitch, 2003), is argued to be necessary for developing positive behaviour in the classroom and for academic achievement (McClelland et al., 2007). Recent research supports this view, and it was found that "children who can pay attention, remember instructions, and inhibit certain behaviours in classroom settings are more likely to take advantage of learning opportunities and do better on achievement tests" (Wanless et al., 2011: 374; also McClelland et al., 2000; McClelland, Piccinin, Acock, & Stallings, submitted). On the contrary, children with inadequate executive function skills (i.e. behavioural and emotional self-regulation) were found to be at risk of experiencing difficulties, such as peer rejection and low levels of academic achievement, in the school environment (Lin, Lawrence, & Gorrell, 2003; McClelland, Morrison, & Holmes, 2000; McClelland et al., 2007). In sum, the three cognitive processes comprised in executive function (attention, working memory and inhibitory control) allow children to follow and remember rules and instructions, focus on various tasks without distractions, and inhibit distracting behaviours (Blair, 2002; McClelland et al., 2007) – an outcome that underlies the importance of children's executive function research and developing effective strategies to improve it, including reliable measures to assess this improvement.

It is often the case that when working toward a goal (e.g. losing weight, educational achievement, but also fitting in to a group, wanting a partner's parents to like us, etc.) or trying to give an appropriate response, the easiest, most available and apparent way (e.g. visual information when looking at the liquid level in the beakers in the test of liquid volume) might not be the best one. On the contrary, what is apparent and easily available could be maladaptive and disadvantageous. Under these circumstances, paying attention to what is relevant to our goals, mental planning and suppressing prepotent response allow us to activate less available but more appropriate responses. The related sub-functions of executive function together allow us to do this and employ conscious, regulated behaviours and guided by deliberate using of one's knowledge in regard to one's goals. Such behaviour is also necessary to employ in situations when one is required to decide between a larger but delayed reward instead of a smaller but more immediate reward; that is to say, in situations where one would rely upon their ability to delay gratification.

1.6. Delay of gratification

Delay of gratification (also known as future discounting, intertemporal choice or time preference) is the ability to resist the temptation for a smaller but more immediate reward in order to receive a larger or more enduring reward later. Delaying gratification can be seen as a two-part process (Mischel, Ebbesen, & Zeiss, 1972): (1) the decision to delay is influenced by subject's attentional and cognitive conditions, when one must "consider the determinants of the choice to delay …influenced mainly by the subject's expectations considering the probable consequences of his choice". (2) After the choice to delay has been made, effective delay depends on the subject's cognitive and behavioural abilities and strategies to maintain "contingent behaviour for goal attainment" (1972: 217).

To forgo short-term, often very tempting rewards and desires in favour of long-term goals and higher pay-offs in the future presents particular challenges in human decision making. Although we may acknowledge that larger future rewards and reaching long-term goals are more advantageous choices in the longer or even life span perspective, it is very difficult to overcome the temptations presented by our immediate surroundings, which are often in conflict with our future plans. The impulsive, stimulus-driven behaviours may obstruct longer-term aims and payoffs. Indeed, poor ability to delay gratification was shown to be associated with lower ability to deal with stressful situations (Diller, Saunders, & Anderson, 2008), addictive behaviours, and poorer quality of life. The poor ability to delay gratification underpins many psychological and social problems, such as substance abuse, depression, anxiety, and anger (Bickel & Marsch, 2001; Hoerger, Quirk, & Weed, 2011; Kirby, Petry, & Bickel, 1999). The inability to delay gratification has been found among cocaine and heroin users, alcoholics, gamblers, smokers (Ayduk, Mendoza-Denton, Mischel, & Downey, 2000; Bickel & Marsch, 2001), and criminal offenders (Hanoch, Rolison, & Gummerum, 2013). It is also associated with unsatisfactory academic performance (Kirby, Winston, & Santiesteban, 2005), lower levels of empathy (Kirby et al., 1999), problems with emotions regulation (Ayduk & Kross, 2008; Gross, 1998), and relationship preservation

(Arriaga & Rusbult, 1998). These correlations between the inability to delay gratification and addictive, antisocial, and maladaptive behaviour stems from the fact that people sometimes cannot fight various temptations (emotions outbursts, anger, peer pressure, self-centredness, etc.) in order to improve their future quality of life (e.g. regulate their anger and prevent fighting with a partner, staying home and studying instead of going to a party, etc.) On the other hand, being able to anticipate future consequences of our present behaviours and not let our desires for immediate gratification lead us to impulsive decisions has been connected with improved social functioning, better academic performance and healthier relationships. It is associated with higher levels of education (Godoy et al., 2004; Kirby et al., 2002; Reyes-García et al., 2007), better abilities to cope with frustrations and stress (Mischel, Shoda, & Rodriguez, 1989: 933, also Mischel, Shoda, & Peake, 1988; Shoda, Mischel, & Peake, 1990), and reduced impulsivity and energy intake in overweight individuals (Daniel, Stanton, & Epstein, 2013).

Interestingly, the research on delayed gratification shows that this ability is relatively stable and “predicts reliable biases … that integrate motivational and control processes” (Casey et al., 2011: 14888). Some studies suggest that children’s ability to delay gratification partially determines their future scholastic and social performance. For example, Shoda et al. (1990) conducted a study among four-year-old children at a preschool for faculty at Stanford University. They found that who were able to delay gratification developed into “more cognitively and socially competent adolescents, achieving higher scholastic performance and coping better with frustration and stress” (Mischel et al., 1989: 933, also Shoda et al., 1990). Children who were able to delay gratification longer were described ten years later by their parents as more academically and socially competent, verbally fluent, rational, attentive and able to plan (Mischel et al., 1989). Eigsti and colleagues (2006) showed that children’s performance on delay of gratification task predicts the efficiency on cognitive tasks' performance during adolescence and young adulthood. In their recent study Casey and colleagues (2011) showed that the differences in the ability to delay gratification among children held up for over four decades. The researchers tested subjects who performed the delay of gratification task in their preschool age (four years old) and found that this performance predicted subjects' capacity to control thoughts and actions during adulthood (40 years later). Casey et al. (2011) found that the low, now adult, delayers were less able to resist temptations and had higher sensitivity to positive social cues, suggesting higher vulnerability to peer pressure and acknowledgement. In contrast, higher delay ability during preschool years predicted a lower vulnerability to positive social cues and a higher ability to resist temptations during adulthood. These consequential long-term outcomes of a seemingly simple ability have put the delay of gratification in the interest of many scientific fields, such as psychology, economy, sociology, neurology and anthropology.

Nevertheless, some studies suggest (and this thesis acknowledges) that delaying gratification might not always be the best or most adaptive choice, as discussed in the following section.

1.6.1. To delay or not to delay?

The aforementioned studies suggest that the ability to resist the temptations present in our immediate environment, i.e. the ability to delay gratification, is a crucial predictor of success in later life. Individuals who are able to resist rewards present in their immediate environment can cope better with unexpected and stressful situations, are more successful in academic and professional pursuits, and have a better capacity to deal with other people.

These individuals are generally considered to be pensive, rational and able to control their passions and impulses. On the other hand, individuals who seek instant gratification are considered to be impulsive, impatient, hasty, short-sighted, or lacking self-control.

Although there are times when immediate gratification is maladaptive, inappropriate or inconvenient, delaying gratification might not always be the most optimal strategy for achieving particular goals. For example, reluctance to disengage from an unprofitable task can lead to irrational or maladaptive behaviour. An example is the dollar auction game (Shubik, 1971) where participants bid on winning a 20-dollar bill. The winning bid can sometimes be 10 times higher than the actual value of the bill (a desirable prize) but some participants play to win, whatever the cost (thereby failing to maximise the utility).

Humans delay gratification for various reasons. Sometimes they act on personal preferences (internal motives to act, such as hunger, sexual arousal, sleepiness; or external motives to act, such as the sight or smell of desirable food). At other times they act in conformity with peer pressure, in order to fit in with various expectations and norms (e.g. not eating properly because of the desire to be thin, studying a subject because one’s parents wish it). Indeed, some research shows that individuals who exhibit higher levels of self-control and restraint exhibit greater levels of self–other agreement (Zabelina, Robinson, & Anicha, 2007), suggesting that, for such persons, others’ approval is more important than one’s own individual preferences.

Whereas some behaviours are medically undesirable or costly to society in various ways (e.g. stealing, violating moral norms), others are relatively arbitrary (e.g. a preference for thin bodies, alternative healthy lifestyles, heightened emotionality), with the individual costs of restraint being too high to motivate perseverance (Fawcett, Namara, & Houston, 2011; Polivy, 1998): although suppressing some behaviours (e.g. addictions) might be beneficial, repeated attempts to inhibit other motivations to act (emotional responses, thirst, sexual arousal, etc.) might lead to negative cognitive and behavioural consequences, such as health problems and other undesirable outcomes (Polivy, 1998; Wegner, 1989). Inhibiting or delaying gratification based on external pressures can result in negative affect (irritability, discomfort, frustration, anxiety; etc.), cognitive disruptions (intrusive thoughts, pressure to perform desired behaviour or actions) or maladaptive behaviour (excessive performance of inhibited actions and behaviours, such as overeating). Research suggests that supressing some behaviours may result in obsessive thoughts about these behaviours, or an excessive display of these behaviours (see, e.g., the research on restrained eating by Polivy, 1996). Thus, focusing on stopping doing something might paradoxically result in increased difficulty of suppression – e.g. trying not to think or do something might cause the thought or activity to be associated with more environmental cues (Logan, 1989; Polivy, 1998; Wegner, 1989), making it harder or even impossible to restrain from the activity. These effects likely have a physiological explanation: pleasurable activities contribute to the releasing of dopamine in the mesolimbic system (Hirsh et al., 2008). Because this system is associated with pleasure and positive affect, restraining behaviour can contribute to leaving an individual unhappy or anxious. As a result, an individual seeks ways to increase the dopamine levels, thus either replacing the restrained thought or behaviours with different ones (e.g. increased caffeine intake and smoking among dieters; Perkins, Mitchell, & Epstein, 1995), or bingeing behaviours once one’s self-control slips (e.g. overeating; Polivy, 1996).

To make the choice whether to delay or not, it is necessary to consider individual values and expectations as well as specific situation contingencies. Is the reward worth waiting for? Are there advantages/risks involved in waiting? Will the choice situation to be repeated? Is there an opportunity to gain a reward in another way? Will the reward still be available later? Some researchers suggest that humans do consider their options and modify their decisions according to different situational possibilities and restraints. Interestingly, this process can be observed in children as young as three to four years old: a recent study on delayed gratification (Kidd, Palmeri, & Aslin, 2013) has shown that children's ability to delay also reflects the stability and reliability of the environment. The study included two experimental conditions, "reliable" and "unreliable". In the "unreliable" condition, the children were provided with a container of used crayons and told that if they could wait, the researcher would return shortly with a bigger and better set of art supplies for the children to use. However, after a short time the researcher returned without the new art supplies, apologising for the mistake and explaining that there were no other art supplies available after all. In the "reliable" condition, the researcher returned with the promised set of art supplies. In the delay of gratification experiment that followed, participants from the "reliable" condition waited significantly longer than those from the "unreliable" condition, suggesting that self-control, although undoubtedly an important feature, is not the only element involved in delay situations. These results indicate that the failure to delay might only be apparent and the decision to stop waiting (i.e. not to delay gratification) are based on rational and self-consistent processes and predictions (this is in contrast to theories[7] that claim that giving in to temptation is based on impulsive decisions, or reflects unstable preferences in the case of changing one's mind after initially opting to delay). Rather than limited self-control capacity, the delay of gratification 'failure' is viewed by some as "an adaptive response to the perceived statistics of one's environment" (McGuire & Kable, 2013). In other words, it is not an

[7] E.g. dual system theory, depletion theory, environmental cuing, hyperbolic discounting; discussed in Section 1.8.2.

adaptive strategy that is adopted to maximise persistence, but rather to calibrate persistence according to our environment and a rational cost–benefit evaluation.

In some instances, it might be more adaptive not to delay one's gratification, and instead to live a more spontaneous and fulfilling life. Indeed, people with lower levels of self-control have been found to be more spontaneous and sensitive to affective and physiological states than individuals who exhibit higher levels of self-control (Zabelina et al., 2007). However, these individuals with lower self-control have also been found to be less consistent in their personality traits, and more self-indulgent and distractible (properties and processes connected to the "hot" system, relying more on basal cortical structures; Mischel & Ayduk, 2004). The opposite has been found to be the case for individuals with higher levels of self-control: although these participants were more consistent in their personality traits, and were calmer and more dependable (properties and processes connected to "cool" system, relying more on prefrontal cortical structures; Mischel & Ayduk, 2004), they were also more agreeable, shy, and less spontaneous. These results represent an interesting trade-off between levels of self-control and personality traits, with under-controllers being more distractible, but enjoying a richer and more spontaneous social life; and over-controllers being more dependable and consistent, but living blander and more restricted social lives (Zabelina et al., 2007). Over-controllers might experience greater fears of being overwhelmed by their desires or uncontrollable circumstances, or a fear of being out of control (causing them to be less flexible), with restricted self- and world discovery. However, more research is still needed on these topics, as thoughts, emotions, and behaviours have complex causes and consequences and, although the outcomes of restraining them might be similar, a wide range of cognitive mechanisms might be needed to control them. Moreover, both motives for expressing (social vs. personal motives) and restraining (self-imposed vs. required externally) gratification differ from one instance to another.

The main question is what makes it possible for some people to resist their temptations and effectively pursue their long and difficult paths to reach their desires and distant goals? On the other hand, why is it that "others seem to remain the victims of their own vulnerabilities and biographies"? (Mischel & Ayduk, 2004). Also, can the ability to delay gratification be improved and can its positive consequences be generalised outside laboratory environments? One way to better understand potential answers to these questions is to understand the neurophysiological structures that are associated with the ability to delay gratification. This understanding will provide a basis for interpreting later results as well as framing hypotheses (addressed in Chapter 2 and 3 specifically).

1.6.2. Neural correlates of delayed gratification

To better understand the variability observed in children's ability to delay gratification and the neurophysiological underpinning of decisions whether or not to delay gratification, this section provides an overview of the neural correlates involved in the ability to delay gratification. This will help to provide a better understanding of the complex relationship between executive function and the ability to delay gratification.

In the self-imposed choice paradigm, a subject faces two options: smaller immediate reward, and larger delayed reward. The choice is based on subjective valuations and preferences (rather than on objective values of the rewards) which differ across individuals. The delay ability can therefore not be predicted solely by the amount of delay or the values of the rewards. Individual differences in the delay of gratification can also be related to different patterns of neural activity. It is hypothesised that “the rate of neural activity (or some other candidate code) is linearly related to, and thus can serve as a representation of, the magnitude of a subjective mental experience” (Kable & Glimcher, 2007). Indeed, according to the investigations of neural mechanisms of delayed gratification, two separate cerebral systems are involved during inter-temporal decision making: when immediate rewards are chosen, parts of the limbic system associated with the midbrain dopamine systems are preferentially activated. In contrast, lateral prefrontal cortex regions and the posterior parietal cortex are preferentially activated when delayed rewards are chosen (McClure, Laibson, Loewenstein, & Cohen, 2003; also Hirsh et al. 2008; Mischel & Ayduk, 2004). This view is supported by several facts:

(1) The size of the human prefrontal cortex: in contrast to other primates, humans often delay gratification by years, even decades (Kagel, Battalio, & Green, 1995). These primates differ from humans in the size of their prefrontal cortex, which suggests that this area might be responsible for controlling impulsive decisions and choosing delayed rewards (McClure et al., 2003).

(2) Studies of brain damage, which showed that damages of the prefrontal cortex often lead to decreased ability to plan and immediate reward preference (Bechara et al., 1994).

(3) Addiction studies: an increased inability to delay gratification after exposure to addiction-related stimuli is caused by the activation of midbrain dopaminergic incentive-reward circuits which take control over behaviour and decrease the influence of higher cortical processes in addicted individuals (Hyman & Malenka, 2001).

(4) Evolutionary adaptations: whereas automatic processes might have reflected evolutionary adaptations to certain environments, the prefrontal cortex evolved more recently

to serve “the uniquely human capacity for abstract, domain-general reasoning and future planning” (McClure et al., 2003: 506).

To confirm the view that prefrontal cortex areas are activated when humans chose to delay gratification, and limbic areas are activated when participants prefer immediate gratification, McClure and colleagues (2003) measured the brain activity of participants during delay situations. Using functional magnetic resonance imaging (fMRI) the authors found that depending on the participants’ choices, different brain areas were disproportionately activated. Limbic areas were activated when immediate rewards were chosen, and lateral prefrontal cortex areas were associated with higher cognitive control and valuation of future opportunities. Similarly, Kable and Glimcher (2007) showed that neural activity (measured by fMRI) in three brain regions (ventral striatum, posterior cingulate, medial prefrontal cortex) tracked the neurally encoded subjective values of rewards, and was correlated with preferred choices of immediate vs. delayed rewards.

The neurological studies also support the importance of episodic future thinking in the ability to delay gratification. When we imagine future scenarios, we “mentally recompose elements stored in episodic memory” (Lebreton et al., 2013: 2). Medial temporal lobe regions, with the hippocampus as a key component, are thought to be recruited during this process. Lebreton and colleagues (2013) thus hypothesised that higher hippocampus activity will be associated with greater details in imaging future scenarios and preference for delayed rewards (that are not directly observable and need to be mentally simulated). They found that “richness of mental simulation is a crucial factor in valuating and hence choosing delayed options” (Lebreton et al., 2013: 7), with the hippocampus being significantly more activated among participants who preferred delayed rewards. However, the hippocampus was only activated when delayed future options were not directly observable. When the options were available to perception, the activation of the hippocampus was not required. The hippocampus activation was also absent when both options were simulated and not available for direct perception – mental simulation of both immediate and future rewards likely made both choices being represented in episodic memory with similar richness irrespective of the choice (Lebreton et al., 2013). The authors conclude that "whereas the dorsal prefrontal cortex seems involved in preventing impulsivity during various types of choice, the hippocampus is specifically recruited for selecting simulated future options against directly observable options" (Lebreton et al., 2013: 8), which is the case in most inter-temporal situations in our natural environment. We cannot directly observe our future successes, such as finishing studies, having a satisfying relationship, etc. All we can do is mentally manipulate elements from episodic memory and use them to guide our decisions considering their long-term consequences.

In the previously mentioned longitudinal study of Casey et al. (2011), the researchers studied the neural correlates of the ability to delay gratification among subjects, who performed the delay of gratification task four decades previously, as four-year-olds. The fMRI results measuring the brain activity of the adult subjects showed biased recruitment of the prefrontal cortex in high delayers, and higher activation of the ventral striatum (midbrain structure) in low delayers. In addition, low delayers had decreased recruitment of the right inferior frontal gyrus which, as the researchers found, was responsible for withholding impulsive response. The authors conclude that the cool cognitive system, as proposed by the cognitive affective processing model (CAP: Mischel & Ayduk, 2004; Mischel & Shoda, 1995), involves the activation of the prefrontal cortex and other control regions, and the hot emotional system involves deep brain structures and favours immediate, as opposed to delayed, rewards. Casey and colleagues (2011) confirmed that not only the ability to delay gratification integrates both motivational and control processes that represent subjective mental evaluations, but also that delaying gratification is a relatively stable individual ability, which significantly predicts behaviours later (even several decades later) in life.

The next section summarizes the research on the development of the ability to delay gratification. The developmental research described in this section sheds light on some of the factors that influence children's decisions to delay.

1.7. The developmental pathways of delayed gratification

The fact that children's delay of gratification behaviour predicts enduring individual differences in important developmental outcomes (higher levels of education, better control of stress and emotional outbursts, impulsivity, healthier relationships, resistance to antisocial behaviour and substance abuse) underlies the need to understand the psychological processes that allow a child to execute self-regulation in the pursuit of a desired outcome (Mischel et al., 1989). Although the initial desires and motivations are important as first steps, sustaining the delay often proves to be more difficult and frustrating than initially anticipated and the strength of commitment decreases: "decisions to forgo immediate gratification for the sake of later consequences … are readily forgotten or strategically revised as one experiences the frustration of actually having to execute them" (Mischel et al., 1989: 934).

The struggle with immediate temptations was first experimentally presented more than 40 years ago, when Walter Mischel made a group of preschool children face a dilemma of self-imposed delay of gratification: having one cookie right now or wait until the experimenter comes back and get two cookies. Having two cookies was obviously a very tempting choice preferred by almost all the children. In this experiment, the waiting period (usually 15-20 minutes) begins when the experimenter leaves the room. During the waiting period the child has continuous free choice to stop the waiting and have the smaller reward. The situation thus "creates a strong conflict between the temptation to stop the delay and take the immediately available smaller reward or to continue waiting for their original, larger, more preferred choice" (Mischel & Ayduk, 2004: 84). What it is that makes some children wait until the predetermined criterion time? What are their cognitive and attentional strategies that help them to overcome the delay? Mischel and colleagues propose that different mental representations of rewards serve as a cognitive reinforcement that helps individuals to sustain effort and goal-directed behaviour while the external reinforcement is delayed. Several modifications of self-imposed delay of gratification experiments with preschool children were conducted to clarify this issue.

Mischel and Ebbsen (1970) proposed that delay of gratification should be facilitated by making the rewards more salient and available for mental representation. When the rewards are present for attention, the individual should be motivated to sustain. This was based on Freud's theory that the delay of gratification ability begins with "the emergence of hallucinatory image of the need-satisfying object when tension rises to the point where discharge should take place but the need-satisfying object is not present" (in Mischel et al., 1972: 214). The conditions in the study of Mischel and Ebbsen (1970) with preschool children (age range 3.5 - 5.5 years-old) varied in whether or not the rewards were available for visual perception while waiting. In one condition, the rewards were present; in another the rewards were present but covered (out of sight, under the opaque cake cover). The authors predicted that if thinking about the reward facilitated the delay then children who are exposed to rewards would be able to wait longer. However, the results showed the opposite, namely that attention to the rewards (whether both of them or just one of them was present) decreased delay time. Preschool children were able to wait on average 11 minutes when the rewards were not exposed, but only approximately six minutes when the rewards were exposed. This suggests that the presence of rewards increases thinking about consummatory qualities and thus makes waiting more difficult. Additionally, Mischel et al. (1972) showed that even thinking of rewards (attending to them cognitively) that are not visually present makes their consummatory qualities salient and substantially decreases the delay abilities. Mischel and colleagues (1972) thus proposed that if children's attention was moved away from the rewards and oriented towards different types of thoughts, the activation of the hot system would be prevented. The authors reported that when distracting thoughts were suggested (e.g. thinking of playing with mummy), children (three to five years old) were able to wait for more than 10 minutes, whether or not the rewards were present. However, Mischel et al. (1972) also found that delaying gratification also depended on the content of distracting thoughts and became more difficult when children experienced additional stress. Indeed, recent study of Lerner, Li, and Weber (2013) showed that when children were primed to think "sad thoughts" (e.g. falling down and hurt their knee), they preferred immediate rewards; whereas when the children were primed to think "happy thoughts" (e.g. playing with friends) they were more willing to delay gratification.

Although the previous results showed the effect of attention to the rewards, the question of how children's mental representations affected their ability to delay gratification still remained unanswered. To shed light on this problem, in line with the CAP model, the study of Mischel and Baker (1975) examined the motivating power of mental representations and showed that when three to five-year-old children were encouraged to focus on abstract qualities and associations of the reward (thinking about pretzels as thin logs and marshmallows as puffy clouds), children were able to wait for more than 13 minutes. On the other hand, when the researchers encouraged children to think about arousing qualities of the reward (the crunchiness of the pretzels, the sweetness of marshmallows), they waited less than five minutes. Similarly, Mischel and Moore (1973) previously argued that the reward can be represented in two ways: (1) arousing (consummatory), when the focus is on the "hot" qualities of the stimulus (such as the taste of a sweet), which elicit completion of the action (eating the sweet); and (2) abstract (non-consummatory), where focus is on the "cool", informative, symbolic aspects of the stimulus (for example, remembering reasons for delaying). The researchers argued that shifting attention from hot to cool qualities enabled children to overcome waiting periods and wait for delayed rewards. Based on this theory, Moore, Mischel and Zeiss (1976) designed a series of experiments to examine this issue more closely. In their first experiment, the rewards were presented in forms of images. Moore and colleagues (1976) found that exposure to the images during the waiting period made it easier for children (3.5 – 5.5 years-old) to delay gratification – the images were more likely to activate the cool system and children who saw images of rewards were able to wait twice as long as children who were exposed to actual rewards. Moore et al. (1976) suggested that what applies for pictorial representations should also apply to other forms of cognitive appraisals of potential rewards. They conducted another experiment, where children faced the rewards, but were prompted by the experimenters to think of them as images by putting a frame around the objects in their head. In the other condition, children were shown pictures of rewards, but were asked to imagine them as though they were real. Moore et al. (1976) found that children who imagined the pictures of rewards to be real were only able to wait for less than six minutes, but the children who were asked to imagine real rewards as pictures were able to wait as long as 18 minutes. The result supports the view that "delay of gratification depends not on whether or not attention is focused on the objects of desire, but rather on just how they are mentally represented" (Mischel & Ayduk, 2004: 90). "The attention to the rewards may have either a facilitating or an interfering effect on the duration of delay, depending on whether the focus is arousing or abstract" (Mischel et al., 1989).

Peake, Mischel and Hebl (2002) found that the same mechanisms of attention deployment apply during both passive waiting and when participants need to work (perform a task) to attain the desired goal. When preschoolers had to complete a task to obtain a larger delayed reward, focusing on the reward decreased their ability to delay gratification. Interestingly, when the children had to complete a boring and frustrating task, their delay abilities were facilitated by occasional focusing on the reward. It was important though that their attention quickly shifted back to performing a task once their motivation was renewed. In conclusion, the delay of gratification ability "depends both on the activation of motivational processes, … and on the accessibility and activation of the necessary cooling strategies [which] serve to reduce the hot stimulus pull and the frustration aroused in the situation, so that hopeful wishing can be transformed into affective willing" (Mischel & Ayduk, 2004: 92).

In the course of development, children become more aware of the strategies that facilitate self-control. Around six years of age they start to develop various strategies, such as self-instructions, rehearsals, self-monitoring of progress, etc. (Mischel et al., 1989), to avoid focusing on the 'hot' qualities of the reward and make the waiting less aversive and frustrating. As Eigsti and colleagues (2006) put it an important "ingredient for success in the delay situation is the ability to allocate attention strategically during the waiting period" (2006: 479). Observation of children's spontaneous behaviour suggests that children who are successful in directing their attention and thoughts away from the reward are those who are most effective in sustaining the delay (Mischel, 1974).

Mischel and Mischel (1983) indicate that these abilities increase with age. In their research, four-years-old children used the least effective strategies, making their self-control difficult (they thought about the rewards and their 'hot' qualities). On the other hand, five-year-olds developed more effective strategies (singing a song, using self-instructions) and were able to recognise that thinking about the arousing properties of the object increases their own temptation. Several other studies also showed that the delay of gratification in children was positively correlated with age – older children frequently choose larger delayed rewards than the younger ones (Mischel & Metzner, 1962; Shipe & Lazare, 1969). For example, Shipe and Lazare (1969) found that "6-year-olds were significantly more willing to delay gratification than 5-year-olds, who in turn obtained higher delay scores than the 4-year-olds" (1969: 3). Using the choice paradigm, Mischel and Metzner (1962) found that the age of the child and length of delay of gratification interacted: in their study, only 29% of six to nine-year-olds preferred delayed larger over an immediate smaller food reward, whereas 80% of 10 to 12-year-olds chose the larger delayed reward when the delay was short (1-2 weeks). However, only 32% of ten to 12-year-olds chose a larger delayed reward when the delay was long (four weeks). These studies supported the theory of effectiveness of older children's strategies developed to overcome the waiting – since older children are able to develop more efficient strategies to beat the frustration and sustain the waiting periods, they can delay gratification longer than younger children.

Although cognitive and attentional strategies play an important role in the delay of gratification, there are other important factors influencing an individual's ability to sustain waiting for the rewards, such as age, and motivational and temporal considerations. Similarly, to the study of Mischel and Metzner (1962), Mischel and Grusec (1967, a study of nine to ten-year-olds) and Mischel, Grusec and Masters (1969, a study with adults) also showed that increase in the length of the delay resulted in reduced choice of the delayed rewards. In their study of three to five-year-olds, Schwarz, Schrager and Lyons (1983) showed that even very young children were sensitive to the anticipated length of the delay. Their study included four conditions: two conditions requiring a choice between immediate and delayed food reward (seven hours/one day), and two conditions requiring choice between immediate and delayed non-food reward (seven hours/one day). The results showed that the length of the delay had significant effect on children's choices. The authors conclude that when time is communicated in familiar terms (for example, "when you go home", "when you come back tomorrow"), even three-year-olds take into account the length of delay when choosing between immediate and delayed reward.

Not only are even young children able to consider the length of time, they are also able to judge which of the choices in the delay of gratification task is more advantageous, smart and has higher utility for them. In the study of Nisan and Koriat (1977), five to six-year-old children (N = 162) were asked to choose between a smaller immediate reward and a delayed larger reward. They were also asked to guess the response of a "smart" and "stupid" child in the same circumstances. When all the subjects were presented with a choice paradigm, one group of children was asked what a smart child would do in the same circumstances. The other group was asked what a stupid child would do in the same circumstances. The analyses indicated that the proportion of delayed choices was significantly greater for a smart child than for self or stupid child. In other words, children tend to attribute significantly more delay of gratification to the smart than to the stupid child. They themselves displayed significantly less delay of gratification than they attributed to the smart child. This suggests that "children's delay behaviour is not entirely determined by what they judge to be wiser choice" (Nisan & Koriat, 1977: 492). In Nisan and Koriat's study (1977), children's actual choices systematically deviate from their conception of profitable, smart choice. The results suggest that "the fact that a given course of actions is favoured on utility grounds does not in itself ensure its actual choice" (Nisan & Koriat, 1977: 493).

In the view of Shoda and colleagues (1990), qualities underlying successful self-imposed delay may be crucial for "intelligent social behaviour" which encompasses intellectual, problem-solving and coping competencies (Shoda et al., 1990: 985). To assess the correlations between the ability to develop effective strategies to facilitate self-control, the ability to delay gratification and academic and social competence later in adolescence, Shoda and his colleagues (1990) conducted the study with 185 six-year-old children. Children were divided into four groups defined by the features of the delay situation: exposed vs. obscured reward; ideation instructions given (what the child might think of during the waiting period) vs. ideation instruction not given. To assess children's coping competencies and self-control skills, they used the California Child Q-Set and created the Adolescent Coping Questionnaire. The authors also obtained SAT scores for 94 children. Shoda and colleagues (1990) found that when the rewards were exposed and no strategies were suggested to the child, the ratings of academic and social competence obtained 10 years later were significantly predicted by preschool delay: the children who delayed longer when the reward was exposed and ideation was spontaneous tended to be rated higher in both parental questionnaires and had higher SAT scores. On the other hand, in the conditions when the rewards were obscured, and when cognitive strategies had been deliberately suggested to children, preschool delay time did not predict later ratings. The association between preschool delay behaviour and adolescent competencies reflects, according to Shoda et al. (1990), cognitive construction competencies crucial for making and pursuing informed decisions enhancing one's quality of life.

Interestingly, the ability to delay gratification is marked by substantial individual differences and the studies show that "different individuals on different tasks exhibit spectacular variation" (Curry, Price, & Price, 2008: 781). These differences might have multiple causes, such as neurophysiological differences (which could be hereditary, environmentally determined, or both); differences in learned patterns of behaviour; differences in individual learning; or personal histories. It is also likely that besides stable causes, there are some situational constraints that might influence an individual's choice to delay (for example, one might prefer to have one sweet now than have two sweets later when one is hungry). Also, the type and value of reward might have an impact on people's discount rates. The variability of the ability to delay gratification and the correlations between the ability and various socio-economic variables is discussed in the following section.

1.8. Variability in the ability to delay gratification

1.8.1. Socio-economic variables

In the attempt to demonstrate experimentally the relationship between individuals' ability to delay gratification and different socio-economic variables, Kirby and colleagues (2002) conducted a longitudinal study among Tsimane' Amerindians of the Bolivian rain forest (N = 154, age ten–80 years old). By means of a structured interview, Kirby et al. (2002) collected information on several explanatory variables proposed by previous research and theoretical frameworks, including formal school attendance, literacy, age, parents' education, the monetary value of physical assets (canoes, cattle, tools, etc.), income and nutritional status (body mass index, body muscle and fat). The analysis by Kirby and colleagues (2002) showed that delayed gratification improves with age and decreases as people get old. The authors did not find a significant relationship between delaying gratification and nutritional status, which could be explained by the restricted range of nutritional values among the subjects (relative to Western societies). Positive correlations were found between cash income and delayed reward preference. Delayed rewards were also preferred by subjects with a higher degree of literacy (fluency in Spanish, Spanish literacy, Tsimane' literacy, arithmetic) and by individuals who had at least some education.

In general, the research on the delay of gratification has identified several socio-economic variables and individual factors that determine an individual's ability to delay gratification. Some of these are:

- *Wealth and income* – Becker and Mulligan (1997) suggest that wealthier people are more willing to wait for delayed payoffs, because they can afford to forgo immediate rewards and invest more in future-oriented capital. This was confirmed by Hausman (1979), Green, Myerson, Lichtman, Rosen and Fry (1996), and Pender (1996). For example, Pender (1996) reported that household wealth was correlated with better ability to delay gratification. Shipe and Lazare (1969) showed that even four to six-year-old children are sensitive to the socio-economic status of their families, with the children with low socio-economic status being less willing to wait for delayed rewards.
- *Conflict in family* – The study of McBride, Paikoff and Holmbeck (2003) showed that if pre-adolescents perceive greater conflict in their family, they are more likely to have

an earlier sexual debut. In other words, they are less able to delay gratification and are more likely to make poor decisions, such as neglecting contraception and attaining their educational goals.[8]

- *Feelings of injustice and deprivation* – Callan, Shead and Olson (2011) found that when participants were told that their income was lower than the income of their peers, they tended to prefer a lower but immediate monetary reward over the larger but delayed monetary reward. Similarly, participants who felt that they did not receive what they deserved in life preferred immediate rewards over the future ones. This suggests that when people feel resentful or dissatisfied they might be sceptical towards their future and thus prefer to satisfy immediate needs instead of investing into their future. The participants with lower ability to delay gratification were also more likely to gamble and purchase lottery tickets.
- *Feelings of sadness* – in the study of Lerner, Li and Weber (2013), participants who watched a sad video were more likely to prefer smaller immediate rewards than participants from control groups, who watched disgusting or neutral videos. The authors refer to the phenomenon as myopic misery and found that sad participants provided more reasons for possible immediate purchases than the control participants. This result might be connected to affective reactions humans have after receiving a

[8] Although some evolutionary theorists maintain that early sexual debut may be an adaptive response, this is incongruent with the social norms of the groups in which these studies have taken place. In addition to the norm-violations that can accompany early sexual debuts, they can also result in lower income, greater stress levels, and lower educational attainment. Theorists such as Frankenhuis, Panchanathan, and Nettle (2016), discuss how individuals who live in more harsh or stressful environments delay gratification less and have children at a younger age. This issue is further addressed in the discussion (Chapter 7)

reward – when humans feel sad, immediate rewards often serve to stimulate their mood (as can often be seen in stress-eaters).

- *Information exposition* – in the study of Callan et al. (2011) one half of the subjects was exposed to the article titled "Good things come to those who live in the moment: Research highlights the importance of living in the here-and-now". These subjects were more likely to choose immediate rewards than their peers who were exposed to the article titled "Good things come to those who wait: Research highlights the importance of patience", who were more willing to wait for future rewards.
- *Catastrophes* – Li, Li and Liu (2011) showed that after people heard about catastrophic events, they are less willing to invest in the future and prefer immediate gratification. Hearing about major catastrophes (floods, earthquakes, etc.) presumably increases the feelings about the vulnerability of life, which makes people more prone to enjoy 'here and now' pleasures.
- *Schooling and literacy* – Becker and Mulligan (1994; 1997) propose that investment in education improves the ability to delay gratification, because schooling focuses attention on the future and children learn to simulate and plan their future lives. Shoda et al (1990) found that SAT scores of US adolescents were positively correlated with the ability to delay gratification at four years of age. Assuming that SAT scores indirectly measure investment in schooling, this result is consistent with Becker and Mulligan's model.
- *Attractive images* – Wilson and Daly (2004) showed that after observing the images of attractive women rather than unattractive ones, male participants preferred immediate rewards. Ronay and von Hippel (2010) speculate that observing attractive pictures

increases testosterone levels, which evoke senses of urgency and people are more likely to make impulsive decisions.

- *Impulsivity cues* – Zhong and DeVoe (2010) reported that when participants were exposed to the logos of fast-food chains, they preferred immediate gratification and were also more likely to buy time-saving products (e.g. 2 in 1 shampoo).
- *Mortality and health* – Becker and Mulligan (1994, 1997) posit that healthier people delay gratification longer, because increasing life expectancy increases the likelihood of the return of future invested resources.
- *Age* – Becker and Mulligan (1994; 1997) suggest that as children are taught to plan and imagine their future, their ability to delay gratification improves during childhood. As people are getting older (and the probability of death increases) people place less weight on future consumption and the importance of future benefits decreases. On the contrary, Rogers (1994) argues that the ability to delay gratification decreases during young adulthood and starts to increase during middle age. However, as Kirby and colleagues (2002) state, direct evidence supports neither of these models: some studies showed that throughout childhood, an improvement of the ability is observed. As children get older, they become more patient (Mischel et al., 1989; Shipe & Lazare, 1969) (consistent with Becker and Mulligan, but contradictory to Rogers). With age, people become better in delaying gratification and reach a stable level when they are in their 30s (Green, Fry, & Myerson, 1994) (contradict Becker and Mulligan).

Besides various socio-economic variables, the ability to delay gratification hinges in part on cognitive abilities and attentional strategies. These abilities and strategies not only help an individual to make his or her choice (making an informed decision after considering the options), but also help to sustain the delay when an individual decides to do so. Given that these abilities can vary between individuals, the following section will briefly discuss the theoretical perspectives addressing why some individuals are better able to delay gratification than others from a cognitive perspective.

1.8.2. Theoretical perspectives on the ability to delay gratification

As mentioned in the previous section, the ability to delay gratification is marked by substantial individual differences. Individuals belonging to the same social group, who find themselves in similar social situations, still exhibit notably different preferences when faced with the choice between a smaller immediate reward and a larger delayed reward. In an attempt to try to explain what undermines an individual's motivation to abandon his or her long-term endeavours when tempting short-term rewards are immediately available, several theories have been proposed. For example, depletion theory attempts to explain quitting after an initial period of waiting, which is often seen in delay of gratification experiments: an individual first chooses to wait, but as time goes by, this decision is revisited and waiting is often abandoned. According to depletion theory, the balance between impulsiveness and self-regulation changes over time, with self-regulatory mechanisms being weakened (depleted) the more they are used (Baumeister and Heatherton, 1996). Therefore, even individuals who initially possessed the willpower to delay, and decided to do so, might surrender to immediate gratification as their self-control is partially depleted.

Another possibility is that the decision-making process is influenced by environmental cues. Environmental cuing theory (e.g. Liabson, 2001) posits that changes in external surroundings, such as the presence of the immediate reward, can undermine an individual's decision to delay gratification (i.e. it is harder not to have one more cigarette if a full packet of cigarettes is put on the table). The theory, however, fails to explain situations where the external surroundings remain unchanged, such as in the marshmallow experiment (e.g. Mischel & Ebbsen, 1970) that has been widely used to assess the delay ability, in which the immediate reward is constantly present (as described further in section 1.7).

The hyperbolic discounting framework explains the failure to endure waiting periods by reference to dynamic inconsistency: the subjective value of a reward increases as the reward draws closer in terms of time (Frederick, Loewenstein, & O'Donoghue, 2002). That is, sooner rewards gain value faster, and even if an individual initially chooses a later reward, the preference might be reversed as time passes, with the individual succumbing to an immediately available reward. The issue again is, that in the classic delay of gratification paradigm (ex. Mischel & Ebbsen, 1970), when the sooner reward is always present, and thus is not drawn any closer or pushed any further away in time, hyperbolic discounting theory is insufficient to explain the self-control failure that leads to ceasing to wait.

Another perspective, the cognitive affective processing model (CAP), uses a framework of two closely interacting systems – hot and cool (Mischel & Ayduk, 2004; Mischel & Shoda, 1995). In the CAP model, the cool system is described as emotionally neutral, cognitive, complex and slow, sensitive to informational stimuli and generating rational, strategic behaviours. In contrast, the hot system is described as emotional, impulsive, simple, fast, and directed by appetitive stimuli. In contrast to the more pensive cool system, the hot one is automatic and generates stimulus-response-like reactions. As supported by the empirical evidence, the hot system develops at birth, whereas the cool system develops with age and maturation: for most children under four years of age, the delay of gratification during experiments is almost impossible[9], even incomprehensible, but by 12 years of age around 60% of children are able to wait until a predetermined criterion time (Mischel & Ayduk, 2004). It is important to note however that the two systems do not operate separately. On the contrary, they interact with one another and operate together (consistent with parallel-processing neural network metaphor). The same external referents can activate both systems and subsequently, the hot system can be cooled down by the cool one and, vice versa, the hot system can undermine the cool one (Mischel & Ayduk, 2004). Importantly, it was documented that both systems are necessary for advantageous decision making: the study of Bechara, Damasio, Damasio and Lee (1999) showed that both patients with ventromedial prefrontal cortex damage (the locus of the cool system) and amygdala damage (the locus of the hot system) made disadvantageous decisions in the gambling game. Since patients with amygdala damage cannot develop affective reactions after winning or losing, they cannot perceive the impact of this kind of information. The patients with ventromedial prefrontal cortex damage, on the other hand, cannot integrate the information in an effective manner and use it in subsequent decision making. This suggests that to make the choice in the delay of gratification situations, we need both systems to encounter the dilemmas and make our choice.

[9] It is complicated for a child to represent herself in a different state or situation than that which she is currently experiencing. We know that even adults sometimes have difficulties making decisions with their future self in mind. A striking example is adults shopping for food that will be consumed later, who are to a large extent influenced by their current states (e.g. shopping when hungry leads to buying more groceries, craving for something sweet leads to buying sweets; e.g. Gilbert, Gill, and Wilson, 2001; Nisbett and Kanouse, 1969). Some researchers argue that the underlying processes that lead to mispredicting future states while grocery shopping are similar to those that lead to mispredictions about major life events (education goals, marriage, etc.; Loewenstein and Angner, 2003). In other words, it can be said that people who experience a *hot* state (feeling hungry or thirsty) have difficulty imagining that they will get into a *cool* state (being satiated or having their thirst quenched) in the future (Atance, 2008).

Hirsh, Morisano and Peterson (2008) suggest that individuals who do not have sufficient cognitive resources available during decision making prefer smaller immediate rewards. On the other hand, greater cognitive ability is connected with greater control over stimulus-driven systems, and with greater ability to delay gratification. According to the authors, immediate reward preference is due to the bursts of dopamine, which activates incentive-reward circuits in the ventral striatum. The process is essentially similar to those among addicted individuals, when the reward circuits take control over behaviour and consequently, the higher cortical processes have a lower degree of influence (Hirsch et al., 2008). Similarly, stress hormones have a disruptive effect on higher cognitive processes and reduce the individual's ability to control and regulate behaviour. In their study, Hirsch and colleagues (2008) showed that "when individuals have fewer cognitive resources, the motivational appeal of the immediate reward appears to be stronger in discounting behaviour. With more cognitive resources available, it becomes possible to regulate initial impulse … in favour of longer-term goals" (2008: 1650). For this reason, extrovert individuals, whose ability to use higher-order control mechanisms is lower (and their ability to regulate motivational impulses decreases), display lower ability to delay gratification.

Another approach to explain the delay ability is the episodic future thinking (Daniel et al., 2013; Peters & Büchel, 2010; Suddendorf & Busby, 2005). According to Suddendorf and Busby (2005) "humans have the ability to engage in prospective imagery to anticipate the future consequences of present behaviours" (Daniel et al., 2013: 120). However, our immediate desires and temptations often lead us to devalue the future consequences. Using episodic memory for imagining future events activates the brain regions responsible for prospective thinking, which reduces impulsive decisions based on consummatory qualities of immediate rewards (Peters & Büchel, 2010). Research by Daniel and colleagues (2013) showed that the imagery in episodic thoughts facilitates the consideration of delayed outcomes during decision making and thus improves the ability to delay gratification. Moreover, it was found that personal past and recent events bring greater vividness and improve the delay ability to a greater extent than non-personal episodic thinking. The importance of the imagery was also shown in the recent study of Lebreton et al. (2013). The authors showed that participants who imagine future scenarios in greater detail displayed greater preference for delayed rewards. It seems that imagining possible future scenarios helps in providing motivation to resist the attraction of immediately available rewards (Boyer, 2008; Rick & Loewenstein, 2008) and trade them off for delayed payoffs. The study of Lebreton and colleagues (2013) also showed that there are some neural correlates of the delayed behaviour, supporting the results of other neurological studies, presented above.

The motivation for this research lies in its practical application to educational settings. Generally, the ability to delay gratification was found to be connected with better academic performance and higher levels of education and literacy. When examining the relationship between the ability to delay gratification and different socio-economic variables, Kirby et al. (2002) found that the most significant relationships were between the ability to delay gratification and schooling, with more patient people being “more willing to invest in schooling, which has delayed payoffs” (2002: 311). This result was confirmed in the follow-up study by Godoy and colleagues (2004). The following section examines the relationship between rituals and schooling more closely.

1.9. Rituals and schooling

It is argued that the research presented here can impact the understanding of schooling practices and can have some practical implications in educational settings. As mentioned above, recent research has found that schooling is the most significant predictor of delayed gratification (Godoy et al., 2004; Kirby et al., 2002; Reyes-García et al., 2007). Interestingly, research shows that a single additional year of schooling correlates with a 11.2–11.6% improvement in the ability to delay gratification (Godoy et al., 2004). To explain the relationship, Becker and Mulligan (1994; 1997) have speculated that school attendance cultivates the ability to imagine future scenarios, thereby enabling children to better appreciate the benefits of delayed reward choices. Indeed, the importance of the ability to imagine future scenarios in greater detail and vividness has been shown to be correlated with greater preference for delayed rewards (Daniel et al., 2013; Lebreton et al., 2013; Peters & Büchel, 2010; Rick & Loewenstein, 2008; Suddendorf & Busby, 2005). It is possible that imagining future rewards increases motivation to resist the attraction of immediately available rewards. However, Bowles and Gintis (1975) have provided a different explanation. According to their theory the positive relationship between schooling and delayed gratification reflects behavioural traits learnt in school, where obedience and respect for authority are taught. Along with the predictions presented in this thesis, the view of Bowles and Gintis may be slightly modified: to the extent that schools are highly ritualised institutions and daily activities are rigidly scheduled and organised, school attendance promotes the adoption of a *ritual stance* (a psychological system supporting the learning of conventional, ritualised behaviours), improving children's ability to delay gratification.

Rituals' rigid and invariant stipulation of manner, context, and timing of specific procedures (e.g. eating lunch in a dining hall at a precise time or conducting greeting sessions on the carpet every morning) provide a stable framework for daily school activities, and construct a specific classroom culture with accepted ways and patterns of doing things (Maloney, 2000). Rituals thus contribute to, and maintain, a sense of order and stability in school life. Thanks to their positive effects on executive function, children are able to anticipate upcoming events and manage their actions and behaviours by consciously and actively reflecting previously established and institutionalised hierarchies and rules (Maloney, 2000; McLaren, 1986). It is generally recognised that in addition to the official curriculum schools also teach socially stipulated and accepted (conventional) behaviours and ways of thinking. As such, the proposition that school attendance promotes the adoption of a *ritual stance* provides a possible explanation of the correlation between schooling and the ability to delay gratification.

In parallel with *ritual* vs. *instrumental stance* theory (Legare et al., 2015), Bernstein, Elvin and Peters (1966) refer to the two cultures (or curricula) transmitted in school as: (1) *instrumental* – i.e. vocationally important and verbally explicit instrumental skills, such as maths or reading skills (usually known as the official school curriculum); and (2) *expressive* – i.e. the transmission of socially accepted and consensual values, norms, ideologies, etc. (usually referred to as the unofficial or hidden curriculum). The expressive (we would say 'ritualised') aspects of the school curriculum serve a symbolic function of relating students to an established social order, "to heighten respect for that order, to revivify that order within the individual, and, in particular, to deepen acceptance of the procedures used to maintain community, order and boundary and which control ambivalence towards the social order" (Bernstein et al., 1966).

The ‘hidden’ curriculum is often regarded as an undesirable by-product of formal schooling, which should focus instead only on assessing individual qualities and promoting the goals of each student. But the reality is that schools also teach general consensus and obedience to authority, promoting institutional goals and norms. Indeed, it is often forgotten that schools were designed explicitly for this purpose as the primary agencies for the inculcation of society’s norms and values (Apple & King, 1977; Boli, Ramirez, & Meyer, 1985; Young, 1917).

Boli and colleagues (1985) speculate that the principal social function of education has long been to make society work better and to provide means for individuals to understand their place in society. School rituals are not created out of nothing; on the contrary, they are socially conditioned, formed around different roles, hierarchies, and institutions, and thus created by cultural and political life: “Classroom rituals represent a field of discourse or dominant mode of representation which naturalises, sanctifies and privileges certain forms of knowledge and symbolic practice over others and, in so doing, shatters the force of other discourses” (McLare, 1993: 128). Social structure depends on rituals, because they transmit symbolic codes of culture that shape children’s perceptions and behaviours (McLaren, 1993). Rituals facilitate the internalisation of values and conventions that are approved outside the school (e.g. age and gender differences, social hierarchies). The school teaches socially accepted norms, morals, duties and rights, which are normative and stem from a broadly shared moral order; and in fact children are encouraged and expected to follow them not only in the school environment but in the wider social context (for example, parents and caregivers want their children to respect the social order promoted in school, such as respecting a parent as an authority, or following the law or established social norms), without questioning the established values and social order which transmits them. Violators of the moral order are punished or sanctioned, which contributes to schools distributing a system of meanings, norms and attitudes, and serves to legitimise the social order. In fact, the most prestigious schools are often those with the most elaborated ritual traditions (strict rules, uniforms, standardised methods of streaming and grading, etc.)

Schools can thus be understood as repositories of rituals, with ritual processes being intrinsic to institutional life. Indeed, McLaren (1993: 4) refers to ritual as the “cultural equipment of school”, with social rituals representing means of regulating social relations according to what is considered to be acceptable, and thus contributing to transmitting and internalising the social structure. In fact, the role of the teacher as not only an educator (i.e. being proficient in a particular subject), but also as a facilitator of *expressive* culture (socially accepted norms and ways of acting) is fairly explicit: students are expected to not only listen to the academic directions of their teacher, but also to regulate their behaviour according to teacher’s (as the school’s representative) instructions and commands related to social organisation in a classroom.

According to their function, Bernstein and colleagues (1966) divided school rituals into *consensual* and *differentiating*. Whereas *consensual* rituals provide a coherent set of shared values and norms, and serve to unify and bind all the school members into a single collective by relating the school’s values and norms to this collective as distinct from the non-school society, *differentiating* rituals serve to mark off groups within a school by ritualising differences in order to maintain control, order and boundaries. The different groups can be based on age (ex. different classes with their own territory and property, with different ages occupying distinct statuses in a hierarchy), sex (ex. controlling sexual behaviour via dress codes or segregation in sport activities), or position (ex. teachers vs. students, with each group having its own rights, duties, responsibilities and spaces for interaction). It might be argued that school rules and rituals do not create but 'merely' transmit an already established social order.

However, this does not imply a process of slavish copying. Clearly children are not merely passive repositories for cultural learning. Research shows that children are able to flexibly navigate their learning strategies (e.g. Carpenter et al., 1998; Gergely, 2003; Kinzler et al., 2011; Legare et al., in press; Zmyj et al., 2010) and, importantly, they are able to switch between modes of behaviour according to different environments. That is to say, different rules apply in different environments; for example, there are different established ways of behaving when at home, and different ones when playing outside with friends, and even different ones when playing with other friends (McLaren, 1993). Children differentiate and interact within different *states* (as suggested by McLaren, 1993) and apply different behaviours (norms, conventions, etc.) accordingly – children themselves are able to decide when and how to modify not only their learning behaviours, but also their ways of interacting with others. For example, McLaren (1993) refers to the time spent in school as the *student state*. This is a state of conformity, with a set of social standards that is expected from students by both authorities and their peers. Interaction space is thus more formal and rigid. Students adopt specific gestures and movements (e.g. raising a hand before talking), attitudes and habits (e.g. returning to a classroom after hearing the bell, sitting properly). Compared with other environments, the school is more predictable (ritualised), because time is monochromatic and divided into discrete segments that require specific well-learnt behaviours and actions. The *student state* requires more self-control – students conform to an established social and normative order wherein emotional displays (whether positive or negative) are often considered inappropriate or antisocial (see also Apple & King, 1977). By ritualising, transmitting, facilitating, and internalising shared values and norms, rituals constitute a system of symbols – a school culture that is distinct from family and household life (Johnson, 1985) as well as from life ‘in the street’.

Conversely, time spent outside school is referred to by McLaren (1993) as the *streetcorner state*. This state is defined by its episodic character, is less predictable, with spontaneous expressions of emotion (e.g. fighting, crying, etc.) being frequently apparent. Unlike in school where everything happens on schedule, time outside the school is polychromatic, with activities often overlapping or happening simultaneously and individuals creating their own schedules. However, this does not mean that the streetcorner state is unorganised or chaotic. It has its own rules (hierarchies, conventions, etc.), but it lacks the demarcation of precise gestures, with more plastic boundaries (e.g. younger children sometimes play with older children, which is less likely in school where each age group spends time in separate classrooms doing grade-specific activities) and more irregular speech (vernacular languages and slang are often used, including using the body for communication).

Besides the *streetcorner* and *student states*, McLaren (1993) further distinguishes the *home state* (interaction between children and family members), and the *sanctity state* (acknowledgement of supernatural entities and deities, the existence of something beyond children themselves). Every day, children must make multiple transitions from one state to another. Even though these states often overlap, the behaviours and actions cluster in a relatively organised fashion, and children switch their behaviours and learning strategies accordingly. This makes the commonplace distinction between ‘ritual’ and ‘inventiveness/ originality’ during the educational process appear overly simplistic. Each of the environments within which children interact requires careful computations with regard to specific sets of behaviours. Moreover, street or home interactions can hardly be said to be ‘ritual-free’. Although less formal than the school environment, children are not allowed to do whatever they like at home or on the street, and their actions are shaped and constrained by social structures and hierarchies that are specific to these environments.

The criticism that school fosters slavishness and uninventiveness may, in the end, be rather superficial. According to McLaren (1993) the word ritual (so often connected with institutional environments) suffers from embedded clichéd images (as being connected to primitive cultures and exotic practices) and by being associated with mindless conformity and mechanic gestures without necessarily entailing inner commitment to ideas and values (see also Douglas, 1966). The reality, however, is that social interactions in school, which are imbued with social conventions, require rigorous computations of details to enable children to engage in effective interactions with other individuals who occupy various positions in the social hierarchy, at various times (recess, lessons, etc.) and in various places (classrooms, dining hall, etc.)

Even if it could be argued that in modern individualistic societies ritualism is on the decline, this should not be simply assumed. After all, rituals are embedded in everyday social life in all human societies. Moreover, individuals may be just as highly motivated to learn and reproduce rituals in modern as well as traditional settings. Rituals in the form of various normative prescriptions and proscriptions ('oughts' and 'musts') are rooted in the process of socialisation, and as such influence social learning everywhere. Apple and King suggest that schools are institutions that "embody collective traditions which, in turn, are products of identifiable social and economic ideologies" (1977: 343). As already mentioned, present research shows that the fact that social conventions require conformity to previously established structures and order does not mean that it requires fewer cognitive computations or less behavioural self-control.

The difference between school and other environments is that school teaches a broader, more applicable social order (respecting hierarchies, moral order, duties and rights, etc.) that is nurtured by the wider society. In other words, one of the reasons why schools are so effective in fostering conformity to social conventions is the support of the society in which they are embedded. Another factor might be the exceptional efficiency of the mechanisms of information transmission used in schools. Complex cultural knowledge that is specific to human societies, such as social norms, laws, moral order, justice, etc., require that highly reliable mechanisms be used to spread them. Cultural evolution has spawned a variety of pedagogic techniques through which fitness-enhancing knowledge that would be difficult to learn without direct instruction may be acquired and passed on (Boyd & Richerson, 1985; Fogarty et al., 2011).

According to the theory of *natural pedagogy* (Csibra & Gergely, 2009; Gergely & Csibra, 2006), by being communicated in a clear and intentional way, children assume that it is crucial to learn modelled actions and behaviours, even when they are not necessarily associated with an instrumental outcome. Both the spoken and written word (what is said in school is often reified and objectified in text books) is used for the purpose of ensuring that children assume that they are being taught relevant and important information. The teacher's position allows her to structure and enforce established conventions (what is right and what is wrong) by using instructional language. Children often hear from teachers about what is considered polite and appropriate. Appeals like "what you do today will influence you forever", "hard work pays off", "this is not how a big/well-behaved girl/boy behaves", etc. create conventional effects and formalise rules that are not to be questioned. Consequently, both teachers and students internalise established cultural categories and accepted behaviours, rendering how everyday life should look. The explanations provided when students question everyday rules take the form of ritual conventions, with no rationale or explanation provided for the actions ("Why do I have to work?" – "Because I said so."; "Why do I have to wear a uniform?" – "Because it is a tradition."; "Why can I not laugh loudly?" – "Because it is inappropriate." etc.) It is often not explained why or in what way some behaviours or actions are wrong or inappropriate, but it is often stressed that even if rules and regulations might be boring, they are necessary for a healthy and adaptive social life. Importantly, neither teachers nor students must necessarily believe in everything that is said, done or taught in school (e.g. children prefer play activities, but when asked, they still maintain that work activities are more important); however, it is crucial that they comply with the rituals.

Geertz (1957) argues that ritual possesses the capacity to fuse ethos and world view, with social reality becoming acceptable when it is lived on an everyday basis: meanings, values and rules become clearer to students as they participate in school activities. They learn about the nature of authority and hierarchy, personal relationships with their peers and authorities, and the community. Classroom life contributes to children's growing awareness of their role in the classroom and wider society, and to their understanding of this social setting (Apple & King, 1977). In schools, children can interact and identify with their peers, promoting social motivations to learn and reliably reproduce social conventions and communicate likeness to their social partners. Schooling and teaching thus underlie the transmission of skills and information that facilitates cumulative gaining of knowledge and normative culture (Boyd & Richerson, 1985; Fogarty, Strimling, & Laland, 2011).

In light of the above, we can reasonably examine the assumption that schools that promote a determination to work hard, overcome obstacles, finish what one has started, and to be creative, etc., are the most likely to support and improve executive function, and in turn the ability to delay gratification, contributing in the longer term to a successful social and professional life. On the contrary, if obedience, perseverance, and participation are valued and rewarded in classroom life, perhaps even more so than academic performance, the benefits to executive function and delayed gratification may be even greater still. As school is the only institution that stands between family life and economic activities, Apple and King state that school life is a "selection and generalisation of personality attributes and normative meanings that enable one to have a supposed chance at economic rewards" (1977: 347, see also Boli et al., 1985). School activities are often presented as a preparation for adult life, with even activities like colouring neatly within lines being presented as a prerequisite to a successful future life by stressing carefulness, hard work and competence.

Schools teach that good things come to those who wait, are patient and work hard, i.e. individuals who are able to curb impulsiveness and immediate desires, and can wilfully control their actions – i.e. individuals, who can delay gratification. Indeed, previous literature on the ability to delay gratification suggest that this ability is associated with many important positive consequences, such as higher levels of education (Godoy et al., 2004; Kirby et al., 2002; Reyes-García et al., 2004), better abilities to cope with frustration and stress (Mischel et al., 1989; Shoda et al., 1990), better emotion regulation (Ayduk & Kross, 2008; Gross, 1998) and preservation of relationships (Ariaga & Rusbult, 1998). On the other hand, the inability to delay gratification has been associated with maladaptive and addictive behaviours (Ayduk et al., 2000; Bickel & Marsch, 2001; Hoerger et al., 2011; Kirby et al., 1999), as well as antisocial behaviour (Hanoch, et al. 2013). Importantly, it has been found that the ability and its consequences are relatively stable – children who as four-year-olds were able to delay gratification were found to be more academically and socially competent in adolescence (Mischel et al., 1989), achieved better performance in cognitive tasks (Eigsti et al., 2006), and were able to retain this ability until adulthood (Casey et al., 2011). It is argued in this thesis, that the ability to delay gratification can be improved by ritual participation. More precisely, it is hypothesised that *rituals (i.e. normative conventions) challenge and improve executive function, which in turn leads to the improvement of the ability to delay gratification*.

Although cognitive abilities that are the focus of this thesis are supported by certain neurophysiological structures, it is assumed here that these structures are situated within socio-biological environments which can have an effect on executive function and the ability to delay gratification. As reviewed extensively above, it appears that neurophysiological structures and their development interact with socio-economic and cultural environments, and have impact on the ability to delay gratification. The next chapter focuses on the socio-economic and cultural aspects of two cultures, Slovakia and Vanuatu, and how their differences – and similarities – may help one to better understand how ritual can improve executive function and the delay of gratification before moving onto the empirical chapters of this thesis.

2. Ritual stance adoption in two contrasting cultures

Rituals appear to be found in all human societies. However, sensitivity to ritual cues may differ cross-culturally: for example, due to differences in normative tightness (Gelfand et al., 2011), social cohesion (Whitehouse & Lanman, 2014), or relational mobility (Yuki et al., 2007). To avoid the problem of 'WEIRD' subjects (i.e. Western, educated, industrialised, rich, and democratic samples) being highly unrepresentative of our species (Henrich, Heine, & Norenzayan, 2010)[10], and to examine possible differences in how rituals are cognitively approached in different cultures, this study includes participants from two countries – Slovakia, a rapidly changing Western culture which places a relatively low emphasis on customs and rituals (as discussed further on), and Vanuatu, a relatively traditional and ritualistic Melanesian culture.

In this thesis, it is not assumed that different cultural groups would exhibit any biological differences. Although the research presented here assumes that the mind is the result of a complex evolutionary history, it does not seek to make any explicit claims about the nature of evolution or the ultimate causal mechanisms that may have given rise to the ability to delay gratification or executive function. Although some schools of thought in

[10] Henrich, Heine and Norenzayan (2010) have reviewed the comparative database from across the behavioural sciences and they have concluded that there is a substantial variability in experimental results across populations (including children), and that WEIRD subjects are, compared to the rest of the species, frequent outliers in several domains associated with fundamental aspects of psychology, motivation, and behaviour (i.e. visual perception, fairness, cooperation, spatial reasoning, categorisation and inferential induction, moral reasoning, reasoning styles, self-concepts and related motivations, and the heritability of IQ). Therefore, conclusions that address a particular behavioural phenomenon in a single sub-population (especially a WEIRD one) may be highly unrepresentative of our species, and the findings from such a study cannot be considered as universal, as is often mistakenly reported.

anthropology have stated that cultural differences can be assumed to be biological differences (Henrich, 2016)[11], this thesis expects that all normally developed humans would have the cognitive capacities necessary to adequately understand and perform all of the tasks related to this research, including instrumental and ritual behaviours – even if the backgrounds of the participants will not result in equal performance on any specific task. As such, it is assumed at this point that any significant differences between that may be observed between the two groups are the result of cultural – but not biological – differences.

2.1. Introduction to Vanuatu culture and history

Vanuatu – an archipelago of more than 80 islands in the southwest Pacific – was chosen to examine the impact of ritual attendance on children's executive function and their ability to delay gratification. Vanuatu (or the Republic of Vanuatu) is a small-scale society that is divided into smaller societies that have their own languages and authorities, and which are subject to limited influence from modern nation states (Mulder, Bowles, Hertz, Bell, Beise, et al., 2009; Rozov, 2000). Vanuatu first experienced contact with Europeans in 1606, when Spanish explorer Fernandez de Queiros first saw and named one of the islands – Espiritu Santo. Later, in 1768, French explorer Louis Antoine de Bouganville returned to the

[11] In his recent book on how culture can drive biological evolution, Henrich states that "Recognising the cultural nature of our species means both realising that human populations are likely to be psychologically rather different along numerous dimensions related to institutions, technologies, and practices and that these psychological differences are (nongenetic) biological differences. Equating *genetic* explanations with *biological* explanations and distinguishing these from *cultural* explanations makes no sense" (original emphasis; 2016: 278-279).

area and named two other islands – Pentecost and Aurora (nowadays known as Maewo). In 1774, most of the remaining islands were discovered and named by the English Captain James Cook. Captain Cook, realising that he had found the southern continent previously visited by Queiros, also first named the whole cluster of islands the New Hebrides, creating "a novel cognitive unity" of the islands (Miles, 1998: 16-17). Together with a new trading economy (trade of sandalwood and sea slugs), the influx of European missionaries to the New Hebrides began in the 1840s. The missionaries outlawed various indigenous practices, such as tribal warfare and cannibalism, and some of the puritan Protestant missions even banned singing, drumming, dancing, kava consumption, and the wearing of penis sheath and grass skirts. However, the missionaries of different denominations were often at odds with each other: the religious competition between the Catholics and the Anglicans and Presbyterians also gave rise to national rivalry. As most Catholic missions were French, and Anglican and Presbyterian missions were British, the New Hebrides experienced tension between the two imperial powers that were trying to colonise the islands. Britain and France, however, waited for almost half a century to extend their formal jurisdiction over the islands, and it was not until 1886 that the empires began negotiations regarding the colonisation of the islands. Since both powers had land interests in the archipelago (Australian business interests on the British side, and on the French side France's nearby colony, New Caledonia), and settled the islands on their own, they came to an unusual arrangement whereby both parties shared (not divided) the custodianship over the archipelago. This decision was formalised in 1914, creating the Anglo-French Condominium and thus beginning the period of colonisation of the New Hebrides. In 1980, after a nationalist movement leading to a rebellion, France and Britain came to the decision to disband the Condominium and Vanuatu was declared an independent nation. The colonisation however has had a lasting impact on the culture and development of Vanuatu, as discussed across the chapter.

Many of the people living on the islands place a high emphasis on traditional ways of life. The people of Vanuatu (ni-Vanuatuans[12]) live in communities consisting of self-sustaining groups. These groups are highly cooperative – when an in-group member has a job to do (preparing copra – dried coconut flesh – for sale, working in the garden, fishing, etc.) and needs help, the group comes together and each individual contributes to the work, without claiming a wage. Instead of receiving a wage, each in-group member is helped when needed. Quite often, in-group members also share food: for example, when an individual goes fishing and catches a big fish, he shares it with other members of the group. Food sharing is partly determined by the lack of electricity and the climate on many of the islands – because food cannot be properly stored or preserved, it must be processed immediately. Nevertheless, surplus food that is not distributed and shared with in-group members can be sold or bartered for different foodstuffs or goods. However, instead of selling the food or working for a wage to ensure immediate personal gain, ni-Vanuatuans typically engage in costly signals of group commitment (e.g. cooperation, food-sharing), creating and expressing strong bonds between the in-group members, emphasising pro-social feelings and adherence to normative conventions. This practice is consistent with the theory that in addition to the *ethic of autonomy* (individual justice and harm principles; Haidt & Graham, 2007; Haidt, Koller, & Dias, 1993), people in small-scale societies are guided by other moral principles and ethics,

[12] A term used mainly in English and French, which refers to Melanesian ethnicities that originate in Vanuatu, and more broadly to all nations and citizens of Vanuatu. The participle *ni* encodes the genitive (similar to English ‘of’). Ni-Vanuatu can thus loosely be translated as ‘of Vanuatu’, and unifies all the Vanuatu islands and their inhabitants.

which influence individuals' actions. According to Shweder, Much, Mahapatra and Park (1997) these include the *ethic of community* (the obligations of individuals as tied in a certain social order, e.g. sharing food, helping out others within the cooperative group), and the *ethic of divinity* (individuals have a moral obligation not to act in ways which degrades the divine within them, e.g. observing the church commandments).

2.2. Introduction to Slovak culture and history

Slovakia (officially the Slovak Republic) is a land-locked country located in the geographical centre of Europe. The history of Slovakia is scattered with periods where the area was part of different coalitions or empires. Starting in the 5th century, it was a Slavic country. In the 10th century it integrated into the Hungarian empire, which itself was integrated into the Hapsburg and Austrio-Hungarian empires. The territory of the present-day republic was part of the Austro-Hungarian Empire until 1918. After the Empire's dissolution at the end of the World War I, Slovakia became part of a mutual state of Czechs and Slovaks: Czechoslovakia. During World War II (1939 – 1944) a separate Slovak state existed, as a client state of Nazi Germany. Although Slovakia was not a key geo-political unit for the Nazi war effort, the central location of Slovakia in Europe made the war and its tragedies inescapable. After the World War II, Czechoslovakia was re-established in 1945 under communist rule. In 1968, Czechoslovakia was invaded by five countries from the Warsaw pact forces (the Soviet Union, Bulgaria, Hungary, East Germany, and Poland) in order to strengthen the communist influence in the area. This led to a demonstration against the communist rule known as the Warsaw Pact Uprising. The uprising resulted in over 100 deaths and many hundreds wounded. Later, in 1988, the Communist party's single-party influence ended with demonstrations leading to the institution of a parliamentary democracy. This event is known as the Velvet Revolution to commemorate the peaceful shift to the parliamentary system. After this, Slovakia became an independent nation state (a parliamentary democratic republic with a multi-party system) on 1 January 1993 after the peaceful dissolution of Czechoslovakia. Today, it exists as an independent nation but still has many close cultural ties with the Czech Republic and Austria. For example, it is not uncommon for Slovaks and Czech to speak Slovak and Czech (respectively) when in conversation with one another. The linguistic similarities between Czech and Slovak are largely intelligible by speakers of both languages, although as time passes since dissolution of Czechoslovakia, this becomes more difficult as the languages become more separate over time.

Currently, Slovakia is a member state of the European Union, within the Schengen Area, as well as the mutual currency area known as the Eurozone. Slovakia is also a member of the North Atlantic Treaty Organization (NATO), the United Nations, the Organisation for Economic Co-operation and Development (OECD) and the World Trade Organization (WTO). According to statistical data and predictions of the European Commission it is one of the fastest growing economies in the European Union (European Economy, 2012). Slovakia currently has a market economy. Slovakia's public education system values and promotes analytic reasoning (detachment from context, focusing on individual attributes). Education focuses on individual attributes and qualities (Pupala & Kaščák, 2014) and cultivates post-conventional moral reasoning based on abstract ethical principles and individual rights (Kohlberg, 1971). The detachment from traditional values and promotion of individualism and rational thinking could possibly weaken the sensitivity to ritual cues, and as a consequence reduce the extent of a *ritual stance* adoption.

A working hypothesis of this thesis is that ni-Vanuatuan subjects, who despite Western influences (European-exported Christianity and education, erosion of chiefly authority, monogamy, influx of new goods into the country, a money economy, television, etc.) still maintain some important aspects of customary life, and will attend to model actions more rigidly than Western populations. If this is the case it is hypothesised that their executive function abilities can be improved to a greater extent, compared with the Western (Slovak) subjects, through ritual participation. This hypothesis is based on the existence of certain important aspects of the ni-Vanuatu society, which are discussed in more detail and are compared to the Western society in the following sections. These aspects are: (1) a customary lifestyle that requires the strict observance of social categories, hierarchies and conventions – *kastom*; (2) the presence of high-arousal imagistic rituals which are likely to promote greater group cohesion, in turn facilitating adherence to pro-social group-based norms and conventions; and (3) traditional schooling which promotes shared ni-Vanuatuan identity and traditional ways of life. Ni-Vanuatuans have a blanket term for traditional lifestyles and rituals – *kastom*, a Bislama word that means more than simply 'custom.'

2.3. Schools and education in Vanuatu[13]

At present, the Vanuatu education system recognises six levels of education: preschool (for three–five year-olds), primary school (for six–12 year-olds), junior secondary

[13] The information about the education and schooling in Vanuatu contained in this section was provided by a representative at the Vanuatu Ministry of Education, the Vanuatu Cultural Centre, the International Council for Open and Distance Education, and the Vanuatu National Population and Housing Census 2009.

school (for ages 13–16), senior secondary school (for ages 17–20), technical education (for ages 13–18) and tertiary education (for ages 19 and higher). Although public spending on education is by world standards relatively high (averaging 6.4% of GDP and 28.1% of total government outgoings in 2008), there are persistent problems with school curricula and teaching outcomes. Teachers are often absent, and are usually not properly trained, with more than a third of all teachers in Vanuatu not having completed secondary school. Despite the great efforts (research, educational programmes, workshops, etc.) that have been invested in improving schooling standards and education, they remain among the main concerns in Vanuatu (and in Melanesia more broadly). For example, preschool education is a new concept in the region and in Vanuatu it is not included as a part of the basic education provided by the government, who accord it a low priority (the situation is now slowly changing, with the Ministry of Education now giving increasing attention to preschools; with new approved guidelines on preschool standards; and a network of Preschool Coordinators, who train preschool teachers and raise community awareness). Early childhood education (four to five-years-old children) is provided through preschools run privately by communities or churches. Owing to cultural factors (lack of tradition), cost (only 0.1% of total budget in 2009 was allocated to the preschool department of education) and limited availability of preschools, only a very small percentage of children are enrolled in preschool education. Moreover, the teachers often have little support from the community or the government, and have very few opportunities for professional development (Hughes, 2004). In general, there are very few preschools and the teachers are often perceived as baby sitters, with low salaries and low levels of respect.

Concerning primary education, school attendance is compulsory for seven years (grades 1 to 7) and starts at the age of six. There are a number of primary schools in Port Vila (the capital city of Vanuatu), with some of the smaller villages also having a primary school. As a legacy of former joint British and French colonial administration, a complex system evolved: French, English or Bislama may all be the language of instruction in schools, depending upon which island it is being delivered in, or what church runs the school. This system, however, is ineffective and gives rise to some concerns, because it results in considerable duplication of effort and lack of consistency.

Schools in Vanuatu promote a sense of belonging to a community and church. For example, praying and singing the religious songs of various local denominations is a common practice, and indeed is encouraged, in the classrooms. The connections of the communities and churches is apparent: pupils start their day with prayer, and most of the schools start the week with a school assembly where the Vanuatu flag is raised and the state anthem is sung together.

One of the biggest issues facing primary education in Vanuatu is the fact that schools very often lack basic teaching materials (crayons, paper, blackboards, etc.) and books in the children's own language are practically non-existent. According to the National Population and Housing Census (2009), rates of attendance are very low (in fact, school attendance in Vanuatu is among the lowest in the Pacific): 24.9% of children younger than 15 years have never gone to school, and most ni-Vanuatu children do not continue education beyond the primary school level – 51.5% of children go through primary school only. A perennial problem in the area is high drop-out rates and non-attendance – the completion rate for Vanuatu primary students is estimated to be only 73.2%, and together with poor retention rates of students moving on to secondary education (it is believed that only 20-25% of students who complete primary education levels go on to secondary levels) this is likely to be linked to low adult literacy rates.

Although 85.9% of children between the ages of six and 13 attend school, from the age of 11 school attendance drops significantly. There are two main reasons for this decrease. First, schools are unaffordable for a lot of families because of the high fees charged to maintain them – schools remain too expensive for almost 80% of Vanuatu's population who live a rural subsistence lifestyle. The fees reach approximately 27,000 VT (vatus – the local currency, an amount equal to around 160-170 pounds sterling) per school year. Although this amount might not seem much, when the average monthly income of 20,000 VT is taken into account, it represents a considerable expense for families, which usually have at least three children. In addition, both primary and secondary schools charge fees for boarding, textbooks and other materials and services, creating an even bigger barrier to school attendance.

The second reason for the decrease in school attendance after the age of 11 in Vanuatu is that there are sometimes large distances between the islands in the country (with some of the islands isolated due to physical barriers and a lack of transport) and so children on these isolated islands have restricted access to schools. School non-attendance can also be partially attributable to poor quality schooling, shortage of places, student health issues, and the competing demand for child labour from the household economy – many children are required to help with domestic chores or to work on small family farms and gardens to help out their families. Missing school is thus usually frowned upon by the teachers, but not punished by either parents or teachers, with an understanding that sometimes there are 'more important' things for children to do (e.g. helping with household work). However, the teachers are quick to admit that many children miss out on classes just because they do not feel like going to school, are lazy, or do not want to go because of bad weather.

The discipline in Vanuatu schools, as compared to Western-style education, can be seen as less strict, with children often arriving late or leaving early, and with pupils often speaking at once, getting easily excited (e.g. jumping up on a desk while shouting an answer to a teacher's question).

Crane (1998: 47) reports that in Vanuatu, "only 50% of primary school students go on to high school and less than 1% have access to higher education." To address this issue, the Vanuatu Government has started to place an emphasis on vocational education, and several state-run vocational agencies have been established (e.g. Vanuatu Institute of Technology, Vanuatu Agricultural Research and Training Centre, Vanuatu Agricultural College, Vanuatu Maritime College, Vanuatu College of Nursing Education, the Malapoa Teacher Training College, Institut de Formation des Enseignants de Vanuatu, Centre Universitaire Francophone). Still, less than 5% of the population is enrolled in post-secondary education.

Concerning university education, practically the only provider is the University of the South Pacific, with its campus in the capital city, and smaller sub-centres elsewhere in Vanuatu. The University provides students in Vanuatu with both foundation training and degree-level programmes. However, in 2008 only 5.5% of the total University enrolment was made up of students from Vanuatu.

One of the interesting aspects of ni-Vanuatu education is that from as early as preschool it is emphasised to the children that they are part of a wider community, which they are encouraged to pay respect to, and to help (including passing on the knowledge learnt in school: for example, educating family members about the importance of washing hands or going to vote). They are reminded of the nation's past, and about the importance of following and preserving *kastom* and customary practices (listen to the elders, follow the conventions and participate in community activities), which "make them who they are", as explained by one of the teachers during the fieldwork. The pupils also learn to recognise local plants and their use, and many schools have their own garden where yams, kumala, island cabbage and other local fruits and vegetables are grown. A few times a week students work in these gardens. This has a twofold purpose: first, schools and families are able to save some money by growing, cooking, and eating their own food; and second, besides academic subjects, children are encouraged to learn certain life skills in school.

2.4. Schools and education in Slovakia

Public education in Slovakia is compulsory and free from the age of 6 thorough 16. The Slovak education system recognises six levels of education: preschool (for three–five year-olds), primary school (for six–11 year-olds), secondary school (for ages 11–15), high school (for ages 15–19), higher education (19 and higher). The Slovak education system currently resembles that of most modern European countries.

In contrast to Vanuatu, although there are a few church-owned and private schools in Slovakia, most schools in the country are run by the state. School curricula must be strictly followed and there are rules about what the students can be taught or exposed to. For example, any religious symbols and practices are banned from classrooms (unless a school is church-owned) and students are usually exposed to a variety of backgrounds, which increases the *ethic of autonomy* by emphasising individual preferences and abilities, and decreases the willingness to defer to previously established conventional practices.

Unlike Vanuatu, where families are charged for school attendance, Slovakia has a free education system, with most textbooks and instructional materials distributed to children for free at the start of each school year, and returned at the end of the school year. School attendance is compulsory and students are expected to arrive on time for their classes. Unless there is a serious reason, they are expected to attend all curriculum classes without exception (as in many other schools with a Western style of education). In fact, many schools no longer accept parents' notifications of their child's illness – a doctor's notification is required.

Slovak students are held to a high standard of education and are periodically subject to standardized testing to ensure that minimum standards are being met. Students study a wide variety of subjects related to mathematics, history, science and language. In addition, students are now expected to learn basic English. Attendance at institutes of higher education is free for students who wish to go on to university studies.

As such, Vanuatu provides an interesting contrast to 'WEIRD' cultures (such as the Slovak one) and their style of education. Modern Western-style education strongly emphasises the importance of an individual and his/her abilities, his/her rights and duties (as opposed to traditions, conventions, and cooperation).

2.5. Ritual in Vanuatu: Kastom and rispek

Ritual in Vanuatu is penetrated by the idea of *kastom*, which became particularly important during the colonisation era. During the period of colonisation, the missions, schools, and official institutions carried either Anglophone or Francophone stamps (demarcating linguistic and religious affiliation rather than territorial differences), and the national administrations were created solely for the benefit of the European (British and French) citizens, maintaining jurisdiction over their own nationals. As a result, the two forces operated separately (and less efficiently), following their own aims and interests, and it became practically impossible to settle legal matters that were not justiciable by either system.

The imperial rivalry even permeated the native society, and as Miles (1998: 38) notes, there was not "Aneityumese versus Mota" [i.e. islands in Vanuatu], but rather "French versus English" and "Catholic versus Protestant", a situation which later resulted in a schism during the struggle for the independence of the New Hebrides (as discussed later on). To settle the "inter-national" conflicts within the islands, the decision was made to create the Joint Court, with a three-member panel – comprising British, French and Spanish judges. However, the French and British judges still made major decisions about their respective citizens (van Trease, 1987), which became even easier when the Spanish court president retired before World War II, and was subsequently "temporarily" absent for four decades (O'Connell, 1970). Moreover, the so-called "sphere of joint influence" neglected the New Hebrideans, who became stateless, with neither community nor jurisdiction. Playing with the official designation, MacClancy (1980) called the system "the sphere of joint neglect", and entitled his history of the New Hebrides *To kill a bird with two stones* (MacClancy, 1980; Miles, 1998). As Miles (1998) summarises, the New Hebrideans were not consulted or involved in the operations of the Condominium. They were denied commercial and administrative possibilities, could not form companies or enter into contracts, could not register boats, and until 1976 could not register births, deaths or marriages. The islanders were subject to 'native law' and their disputes and conflicts were resolved by legal middlemen (assessors) appointed by the Condominium. Serious transgressions were still reported to the district agents and to the Joint Court, but the main function of the assessors was to "substantially reduce the number of disputes that required official resolution" (Miles, 1998: 165). Even though one of the official responsibilities of the legal assessors and the Joint Court was to protect the natives from exploitation, in most cases the settlers' laws prevailed over the customary ones. In addition, the traditional chiefs and men of rank lost most of their authority (as the legal jurisdiction was divided between the Condominium's legal assessors and traditional authorities), and as a result the customary law was not practically applied. This situation, together with new perceptions of the world (strengthened by American soldiers arriving on the islands during World War II) encouraged the nationalistic movement in the New Hebrides. During this period, *kastom* became particularly important for Melanesian identity and political rhetoric.

Strictly speaking, the people of the New Hebrides had little in common before the colonisation period – there was minimal contact and no solidarity between the populations of the islands; on the contrary, they were often at war with each other (Miles, 1998). It was therefore difficult for the nationalist leaders to overcome "geographical dispersion, religious rivalry, and parochial identities to create a sense of New Hebridean nationalism. Along with Bislama [a new national language which was supposed to be used instead of vernacular tongues], *kastom* – a common denominator of indigenous customs, rituals, and practices, with which all islanders could broadly identify – was chosen as the means to achieving this unity" (Miles, 1998: 61). *Kastom* represented traditional, 'genuine' cultural practices and ideas about family, places, ceremonies, food, hierarchy, knowledge, and rituals. (Bolton, 1999; Jolly, 2003; Lerche, 2008; Lindstrom, 1990; MacClancy, 1980; Patterson, 1981). "The diversity of meanings Melanesians attribute to *kastom* underlines the way such symbols do not carry meanings, but rather evoke them. Their very abstractness and lack of precise content allow a consensus that would otherwise be impossible, among peoples whose material circumstances, class interests, and ethnic affiliations are often deeply divided" (Keesing,1982: 299). Wittersheim (1998) refers to the process of bringing *kastom* into life as the "invention of tradition" (Carrier, 1992; Hobsbawm & Ranger, 1992), because it created (1) a new political sense of continuity in the modern era; (2) referred to the roots of the nation existing before colonisation and reaching independence; and (3) symbolically connected the local (more than 80 islands) and the national. As such, during the struggle for independence *kastom* became associated with opposition and resistance to colonial government and churches. Bolton (2003) observed that *kastom*, as a system of ideas, beliefs and political practices, was initially used as a way of distancing Melanesian beliefs, values, and practices from those introduced by the missions, which were referred to as *skul* (school): in other words, whereas *skul* referred to beliefs that originated outside the country, *kastom* referred to beliefs that originated in the islands and that began to play an important role in political rhetoric.

This need for commitment to a traditional ideology could be explained as precautionary behaviour that was designed to deal with colonisation as a social threat. As Navarrete and colleagues (Navarrete & Fessler, 2005; Navarrete, Kurzban, Fessler, & Kirkpatrick, 2004) note, threat-implying situations (e.g., colonisation) are likely to result in stronger group norms and commitment to group ideologies, and stronger expressions of affiliation with fellow group members. The authors state that by exhibiting a pro-normative orientation, individuals are trying to enhance and maintain alliances and coalitions. People manifest normative mental representations "emanating from psychological systems designed to enhance coordination and membership in social groups" (Navarrete & Fessler, 2005: 297). Thus, when the Vanuatu islands were jointly administered by Britain and France, and indigenous Melanesians had no citizenship, local government, political participation or resident police, *kastom* became particularly important to the local communities (Forsyth, 2007) as a signal of self-identification, group cohesion and commitment[14].

[14] Nevertheless, the local circumstances (Anglophone and Protestantism vs. Francophone and Catholicism) entailed that even the most radical pro-independence New Hebrideans identified with either the British or the French. This, however, was not a matter of political identification (or citizenship), but rather a matter of religion and language (religio-linguistic connections: Francophone + Catholic = pro-French, Anglophone +

Although in 1980 Vanuatu was declared an independent nation built upon Christian values, (along with Lini's ideology) *kastom* remained an important symbol of unity "upon which they [the people of Vanuatu] could form a nation separate from their oppressors" (Lerche, 2008: 1). Vanuatu thus represents an interesting blend of nationalism, *kastom* and Christianity (e.g. political leaders of Vanuatu are often also religious authorities), with *kastom* (unlike Christian values, which were integrated into Vanuatu society during the colonial era) being interpreted as representing the traditions of pre-colonial times and becoming a symbol of shared islandhood and identity. As such, the importance of *kastom* and its transmission is

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Protestant/Anglican = pro-British), creating an inability to dissociate from either of the colonising empires and an "incarnate indigenous cultural authenticity in opposition to colonialism" (Miles, 1998: 64). Thus, two anti-colonial movements emerged in the New Hebrides. The first was represented by Jimmy Stephens (also known as Stevens or Steven), the founder of Nagriamel (1965) – a traditionalist movement that attempted to create an autonomous society based on *kastom*, not another nation state. Nagriamel did not call for the independence of the New Hebrides (and in fact rejected the very notion of the New Hebrides), but for cultural and economic autonomy. Stephens followed traditional customary rituals to achieve his status of chief, promoted traditional ways of life, and rejected "colonially collaborationist churches" (but interestingly, not the fundamentals of the New Testament; Miles, 1998). A second, more cosmopolitan, movement was founded by Father Walter Lini. To overcome the identity crises imposed by colonialism and Christianity, Lini and his followers claimed that Melanesian customs are spiritually compatible with the doctrines of Christianity. Lini's Vanua'aku Pati, the first political party in the New Hebrides, normalised and nationalised *kastom*, making it a symbol of national consciousness. In contrast, Nagriamel challenged the nationalist interpretation of *kastom* and held that it was "inherently conservative … and could not be corrupted into a force for revolutionary independence" (Miles, 1998: 72). The foundation of these two nationalist movements again divided the population of the New Hebrides into Anglophones and Francophones, and gave rise to the tension between British and French powers: because Lini as an Anglican and Anglophone was more sympathetic to the British government, the French were determined to oppose him and took the side of Nagriamel. The tension culminated in the 1970s, when Lini's Vanua'aku Pati refused to recognise the Condominium and set up its own government. The pro-French refused the government headed by the pro-British, leading to clashes between the Anglophones and Francophones, a series of events known as the Santo rebellion. Neither France nor Britain deployed their troops to defuse the crisis, which (after a brief intervention by Papua New Guinean troops) was ended by the surrender of Jimmy Stephens, who was later sentenced for mutiny and imprisoned (and released in 1991, after the reconciliation of the Anglophone and Francophone parties). France and Britain came to the decision to disband the Condominium and Lini became the first Prime Minister of the newly established republic of Vanuatu (1980).

still emphasised by political authorities (government representatives) and social authorities (teachers, chiefs). It is presented as a shared identity that identifies and binds the otherwise culturally diverse society together, forming a new, ni-Vanuatu identity. Indeed, an *Environmental Studies Handbook* for teachers states: “Here is one important thing to remember. You are a ni-Vanuatu, a citizen of Vanuatu. Try not to think of yourself as someone who comes from Santo or Tanna, Epi or Aniwa or one of the other islands. Instead, think of yourself as a ni-Vanuatu…”.

According to Lerche (2008), the foundational value of *kastom*, which is “promoted as a basis for regulating social conduct” (Miles, 1998: 169), is respect, or in Bislama *rispek*. *Rispek* is used to negotiate justice and dealings with differences, on the one hand (Vanuatu comprises more than 80 islands, dispersed over a distance of approximately 850 km), and equality, on the other (all the islanders are ni-Vanuatu). *Kastom* integrates and unifies various social categories, which can be either mutual (e.g. within the basic family unit) or hierarchical (e.g. between community members and a chief) (Lerche, 2008). As Bolton (2003) claims, “preoccupation with rank and status is allied today with a widespread concern with the idea of respect … – the showing of honour and respect to others” (2003: 4). Further, she notes that *rispek* is an indigenous concept often identified by ni-Vanuatuans as a defining characteristic of *kastom* (Bolton, 2003: 3–4): Selwyn Garu, the former Secretary of Malvatumauri (the Vanuatu National Council of Chiefs) states that *rispek* influences peoples’ relationships, their conduct and the way they deal with each other. He states that it requires “heavy thinking” about the person, and that there is always a proper, *respectful* way of doing things: “the correct way is the respectful way. Now, if you do it any other way, you can have it done, but then […] the impact of the process that you have taken, would be negative on other aspects of the life, of the totality, of everything, you know, life.” *Rispek* in Garu’s words, is “doing something in the right time in the right way" (Garu 2008 in Lerche, 2008: 6), that is, in a normative conventional way, which requires rigid conduct and does not allow for personal modifications – in other words, in a ritualistic manner.

Although *kastom* partially represents nostalgia for traditional ways of life, Melanesians admit that some ancestral practices were "evil" (Miles, 1998: 103). This enables *kastom* to be rendered compatible with Christianity and Christian values: on the one hand, the ni-Vanuatuans preserve some of their cultural traditions (singing, drumming, dancing, kava drinking, etc., which were needlessly attacked by the missionaries); on the other, some gratitude is expressed that "missionaries brought the Gospel to the New Hebrides and eliminated some indigenous depravities", such as polygamy, infanticide, cannibalism and tribal warfare (Miles, 1998: 103, paraphrasing former Prime Minister Father Walter Lini). Still, part of the discourse about *kastom* remains fundamentalist, with people lamenting the loss of *kastom* and *rispek*, and the erosion of traditional authentic traditions, religions, and authorities. This prompts a moral discourse that highlights customary (non-Western) ideologies and conduct, which are considered to be proper and respectful. This requires recognising mutual and hierarchical relationships (one's own position within the society, the social positions of others, social categories) and understanding and recognising social relations, following a moral order shaped not only by the *ethic of autonomy*, but also to a large extent by the *ethic of community* and the *ethic of divinity*, as described earlier. One needs to recognise one's status as a social actor and recognition from others comes in the return of proper conduct (Lerche, 2008). Compared to 'WEIRD' societies that emphasise individualism and analytical reasoning, this preoccupation with proper, conventional ways, and emphasis on individuals as tied within a community (family, church, village, tribe, etc.) to which they owe respectful conduct, likely requires executive function abilities to be employed to a larger extent.

2.6. Ritual in Slovakia

For centuries, Slovakia has been a predominantly Catholic culture, even though during periods of communist rule, atheism was the presumed religious affiliation. Nonetheless, Catholicism still has a visible effect on Slovak culture today. Although the Slovak government is officially secular, the Catholic Church does receive support. For example, salaries of the clergy and clerical administration offices are both paid by the state. Also, religiously affiliated parties have a strong showing in the nation's parliamentary system. Overall, the type of Catholicism practiced on a daily basis in Slovakia is not unlike that which can be observed in many European countries. It has a heavy emphasis on the sacraments and frequent ritual behaviours and there is little outward evangelism. Although the percent of Christians has shrunk since 1900 (largely due to an increase in agnostics, which currently make up approximately 10% of the population), it remains a visible aspect of Slovak culture.

Generally, Slovakia is a less constrained society than Vanuatu. There are fewer norms and less harsh sanctions for their violation. Some of the most widespread customs involve wishing a good appetite upon someone about to eat (saying "dobrú chuť" – trans. good appetite) which is a near-mandatory custom and will be stated to and by everyone present (not to express it is considered impolite); or drinking to another person's health (saying "Nazdravie" – trans. to your health – before drinking). Whereas in Vanuatu there are often gender restrictions (such as the restriction against women participating in certain rituals, or entering certain places or even touching some objects), such restrictions based on gender are generally rare in Slovakia. Although there are set contexts within which there are tight normative behavioural scripts, for which the violation will be noticeable (e.g.. attending a cultural event where clear scripts are followed); but there are no official sanctions addressing these normative violations.

There are no comparable aspects of Slovak culture which would correspond to *kastom* or *rispek*; although Slovak culture emphasizes “custom” and “respect” (close cognates of their Bislama counterparts), their instantiations in Slovak culture are not nearly as enshrined nor are they framed in such functional terms (i.e. to create a singular identity among disparate peoples in a post-colonial era). Naturally, there are subtle behavioural scripts in Slovak culture regarding how one should act, but they are not institutionalised in the same way.

Importantly, the nationalist undertones of many ni-Vanuatu norms are not present in Slovak culture. Compared to many modern nation states, it is relatively rare to see individuals displaying symbols of Slovak nationalism (ex. the flag); although these symbols can always be seen on government and official buildings. The reason for this may be due to Slovakia’s geo-political history. Whereas Vanuatu went from being an aggregation of islands with colonial jurisdictions imposed later to create an endogenous identity around a common cultural theme, Slovakia has had a number of periods of independence and coalitions with other nations, even within the past few decades. Comparatively, whereas *kastom* or *rispek* function to promote nationalism in Vanuatu, Slovakia has a sceptical attitude toward promoting nationalism. Although this may be due to historical factors such as the Nazi occupation being the result of rampant nationalism during the World War II, it also may be due to the fact that Slovak culture has been influenced by so many non-Slovaks during its history, when many of the key cultural icons were German, Austrian, Czech, Hungarian, or

Russian in addition to Slovak. As such, Slovakia lacks the exceptionalism that often accompanies nationalism. Therefore, few cultural practices are aimed at fostering nationalism in the ways observed in Vanuatu.

2.7. Theoretical considerations for ritual in Vanuatu and Slovakia

Given the cultural and socio-economic differences described above, one could argue that *kastom* became a special form of normative "tightness" that implies a lower tolerance of normative transgressions, which in turn leads to more precise replication of normative conventions. The tightness of a culture refers to the amount of norms a culture has and the severity of sanctions incurred for violating norms (Gelfand et al., 2011). Currently, it is believed that among the underlying proximate factors that give rise to differences in cultural tightness are personal self-regulation, the structure of everyday interactions, and the degree of situational constraint. In case of Vanuatu, these parameters can serve as heuristics for highlighting the differences between the normative tightness imposed by the previous colonial regime and that which is observed in the post-colonial era. Although both systems of norms and sanctions are types of normative tightness, that which was imposed by the colonial regime is related to imposed situational constraints. On the other hand, the traditions in Vanuatu now are self-imposed and appear to be due more to a personal self-regulation and the structure of everyday interactions than any externally imposed constraints.

The different individual correlates of tightness, such as behavioural self-regulation, epistemic needs or the desire for clear knowledge and information, self-monitoring abilities (the ability to monitor and adjust one's behaviour according to a context), and self-guides (higher cautiousness, higher dutifulness, concern with normative rules and prescribed duties and generalized order) are related to a number of group level correlates of tightness, including religious attendance, resource scarcity, and the prevalence of disease (Gelfand, et al. 2011). The relationships discovered between the structure of everyday interactions, situational constraint, resource scarcity, and tightness would plausibly imply a greater sensitivity to social norms (i.e. rituals cues) among the participants in Vanuatu. This would plausibly imply a greater sensitivity to rituals cues among the participants in Vanuatu.

Thus, together with a greater emphasis on group bonding and cohesion, *kastom* might promote higher sensitisation to ritual cues, and, consequently, a greater impact of adopting a ritual stance on executive function and the ability to delay of gratification among the ni-Vanuatuan participants (relative to the Western sample), leading to greater improvement of executive function and the ability to delay gratification.

2.8. Rituals and modes of ritualisation

As a specific, traditional way of organising social and political life, *kastom* binds people together not only by promoting shared beliefs and group markers, but also by promoting the performance of specific social rituals. Although Vanuatu, as a democratic state built on Christian values (Lerche, 2008), has adopted many Christian traditions and rituals (doctrinal practices such as masses on Sunday, celebrating Christmas, etc.), various traditional customary practices remain woven into the fabric of the everyday life of the ni-Vanuatuans. One specific aspect of ni-Vanuatuan culture, as opposed to Slovakian culture, is a relatively rich practice of various imagistic rituals, which represent one end of the spectrum in the theory of the modes of ritualisation.

According to their frequency of performance, the ways of remembering, and the emotional arousal involved, Whitehouse (1992; 2000; 2004; 2012) distinguishes two modes of ritualisation: the *doctrinal mode* (involving high frequency/low arousal rituals, employing implicit, semantic memory) and the *imagistic mode* (involving low frequency/high arousal rituals, engaging explicit, episodic memory). Although Whitehouse's theory as described in this section is most often associated with the transmission of religious rituals (i.e. the rituals of religious organisations), it can be applied to ritualised behaviours in general. Each of these modes facilitates group bonding in a different way by prompting different ways of remembering and emotional arousal, as described further on.

One way of remembering a piece of information is being exposed to it enough times (with no particulars about its acquisition remembered) and storing it in our memory, from where it can be retrieved or expressed in words any time we need it – this is the process of constituting semantic memory. Besides prompting the learning of explicit information (e.g. the value of pi, someone's telephone number, the lyrics of songs, etc.), repetition and practice also help humans to learn many technical and social skills. These learnt patterns of behaviour become an automatic response to regularised cues and are performed without the conscious representation of particular actions. Conscious representing might even become an obstacle in an otherwise fluent performance (see Whitehouse 2004: Chapter 5). One example of such a technical skill is walking. We walk without realising how we lift and put each foot on the ground, or how we switch the left and right feet, lifting only one at a time. However, when people are asked to focus on single movements during walking (e.g. the way they stand straight, the way they place their feet, the way they maintain equilibrium, etc.), they usually have to slow down and pay considerable attention to their movements. Concerning social skills, an example of a stereotyped automatic response is a handshake, which is usually a response to sealing a deal or meeting new people. Humans do this automatically, without breaking the behaviour down into single actions or representing the knowledge they have acquired about a hand shake. The moves are activated implicitly, with no need for conscious control or explicit processing of the script.

Another way of making information memorable is emotional arousal (Whitehouse, 2005). If a new input is emotionally arousing, the memory of this new episode will be stored in episodic memory and, consequently, “any future stimulus that sufficiently resembles the initial, highly emotional one, will activate various aspects of the original encoding experience” (Whitehouse, 2005: 94). Importantly, when an experience is repeated frequently, it loses its arousing qualities – “frequency varies inversely with arousal” (Whitehouse, 2005: 95). An example of highly emotionally arousal rituals are certain rites of passage, wherein novices have to endure various physical (e.g. beating, scarring, etc.) and psychological (e.g. fear, social pressure, etc.) ordeals. An example from Vanuatu is back scarification after a girl has had her first period. This is a rite of passage, marking girls’ transition from childhood to adulthood – girls with scarred backs are considered to be ready for men to show a mating interest in them. As one of the informants put it, when a man sees that a girl has her back scarred, he knows that she is an adult and can be married. During the ritual, the girl’s aunts cut shapes and ornaments into the girl’s back, using a coconut shell, piece of glass, or another sharp object. After scarring, the girl either enters the water (e.g., the ocean, a stream), or washes herself to clean herself both physically (from the blood) and symbolically (‘washing away’ her previous status to become a new woman after the ritual). On some islands, the scarification ceremony is followed by the girl being chased, and sometimes swished with sticks by her male peers. The ceremony itself is both physically painful, and psychologically difficult: a participant must endure the pain, while behaving properly during the whole ceremony, as she is being watched by her family and other community members.

Of course, not all rites of passage are violent. For example, the wedding ceremony marks the passage from single life to wedlock, and does not usually include violence or trauma. However, we can assume some emotional arousal and a once-in-a-lifetime, personally consequential experience on the part of the bride and groom. That said, "it is not rituals *per se* that are low or high in arousal, but rather the experience that particular categories of people have of those rituals" (Whitehouse, 2005: 96). On the other hand, rituals that are performed with high frequency deliver lower levels of arousal and emotional stimulation. They become heavily routinised and some might even become tedious, which negatively affects the motivation of participants. In his ritual frequency hypothesis, Whitehouse (1992) assumed that rituals were easily remembered if (a) they were shocking and arousing, or (b) were frequently repeated. However, some rituals are repeated more frequently than is necessary for them to be remembered. It seems more likely, as Whitehouse points out, that "variations in frequency and arousal have a decisive effect on the way ritual *meaning* is constructed and transmitted" (2005: 98).

Importantly, the high frequency of repetition of some rituals negatively influences the morale, and rates of adherence, of participants. The loyalty and devotion of ritual participants must thus be ensured in different ways. Most often, this depends on techniques of verbal persuasion, which usually take the form of official exegesis. Probably the most common example is the Roman Catholic religion and the ritual of Sunday mass, which occurs every week. The mass takes place at the same time, at the same place, with the same religious authority, and usually the same participants. The participants know exactly what follows next, and some of them even know the relevant parts of the prayer book and Bible by heart. As the exegesis is always externally generated and provided, ToM mechanisms and spontaneous interpretation become supressed and the actions become habituated. Doctrinal rituals play "a major role in the formation of large-scale identities, enabling strangers to recognise each other as members of a common in-group, facilitating trust and cooperation on a scale that would otherwise be impossible" (Whitehouse, 2012: 274; see also Whitehouse, 1995; 2000; 2004). These doctrinal practices are a hallmark of world religions and political systems – in fact, they are necessary for the emergence of imagined communities (Anderson, 1983). Since these rituals are performed with high frequency, they instigate the creation of procedural scripts and schemas. Everyone who performs the same scripts and schemas is recognised by other participants as someone who shares similar beliefs and traditions – as a co-member – despite the fact that no individual knows or could even hope to meet all the others. Complex doctrines and rules with elaborate explanations and high routinisation reduce the need for spontaneous reflection. The in-group members' cohesion, trust and tolerance are spread across all individuals who carry the insignia of this shared body of beliefs. However, compared to smaller groups bound by high arousal rituals, the feeling of companionship is less intense. This is not to say that the doctrinal mode is less effective: it still has the power to promote great investments and cooperation within large-scale societies (e.g. paying taxes, being prone to help people from the same country or home-town, etc.), such as would otherwise be impossible.

In contrast, low frequency rituals with high emotional arousal promote cohesion and group bonding in a different way, by using the psychological mechanisms of cognitive dissonance (Festinger, 1975). Here, ritual participation incurs costs (e.g. physical ordeals during initiation rites), which are sometimes poorly (or not at all) paid off. These costs, however, promote the liking of other group members – “the experience of *disliking* aspects of the group will be *dissonant* with the experience of having paid the price to join” (Whitehouse, 2012: 271; Aronson & Mills, 1959). Moreover, traumatic and high arousal experiences are vividly remembered for longer time periods. Participants not only remember the details of the actions but also who was present. Importantly, imagistic rituals are not subject to official exegesis – because of their low frequency, they are seldom subjected to centralised regulations and their teachings might be exposed to distortions and possible decay (Whitehouse, 2005; 2006), or variations across different communities, such as in the case of Vanuatu.

Although some of the ritual practices were influenced by the missions and the colonisation period,[15] some of them still remained relatively untouched by these influences and are presented as a part of indigenous *kastom.*[16] A specific example of an important indigenous ritual is kava drinking, which is popular in Melanesian and Polynesian regions. When the roots of the kava plant are pulverised and mixed with water, they create a drink with both physical effects on an individual’s body (numbing the lips, making the limbs feel heavy and heightening sensory perception, such as making the eyes sensitive to light) and hallucinogenic properties. The ni-Vanuatuans say that drinking kava makes the mind “happy”, clever and relaxed, and unites people. Formerly, the ritual of kava preparation and drinking

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[15] For example, funeral rituals are performed similarly to Christian rites, but include indigenous practices such as putting traditional woven mats into the grave under the coffin. The mats, which are used to sleep or rest on, are put under the coffin in an upside down manner, symbolising the different nature of sleep and rest after a person’s death (as described by the locals).

[16] It is important to note that ritual practices vary across the different groups and islands of Vanuatu. Some of the rituals (e.g. kava drinking) are practised across all the islands, with various modifications in preparation and practice, and taboos that concern them; other rituals (back scarification, land diving) are group- or island-specific, and are tied to specific places, times or groups.

was tied to strict taboos and restrictions (e.g. no female could witness any part of the ceremony, drinking was reserved for chiefs, the kava roots must have been chewed by an innocent boy, etc.) After independence however, kava became a relatively common beverage in many (but not all) communities, drunk after daily work activities, with some areas even permitting women to drink it. The practice of kava drinking, which formerly was a mere accompaniment to social gatherings the purpose of which was to sing, dance and tell stories, became the central focus of these gatherings (with other customary activities being neglected), a fact often criticised by older community members. Nevertheless, kava is still considered an important part of indigenous culture and, in addition to being consumed during social gatherings and occasions, it is drunk during various important political events, such as sealing alliances or deals (at both national and local levels), welcoming visitors and commemorative ceremonies. As such, kava drinking became an important theo-political ritual representing the rehabilitation and reinterpretation of formerly outlawed practice, and acting as an example of the ni-Vanuatuan *kastom*-Christianity-nationalism blend.

Another example of traditional imagistic *kastom* rituals is tied to special places, such as volcanoes, lakes, waterfalls, etc. – places believed to have special (good or bad) spirits, or places believed to be connected to important events and ancestors. Before entering these places for the first time, visitors must perform protective rituals, which include reciting spells, being 'dusted' by special plants, planting a plant, etc. Ni-Vanuatuans are particularly insistent on all people performing these rituals before entering these places and areas, to ensure both the protection of those who enter the place, and the due respect of the place. These protective practices are likely associated with the practice of magic and healing. Practising black magic is considered a serious and dangerous matter by ni-Vanuatuans and practitioners are often feared and avoided, as they are believed to be able to lure people to follow them to unknown places (where they may become lost or may be held captive), or to poison the food one is eating. Certain medical issues (often connected with food consumption and food poisoning), which are believed to be caused by black magic, are thus treated by visiting traditional doctors using customary medicine and healing rituals. Some of these rituals, as stated by the informants, include profuse sweating, shivering and vomiting triggered by healing plant substances and practices.

Vanuatu is probably best known to outsiders for the relatively extreme, imagistic ritual of nangol (also known as nahgol, nagol, naghol, n' gol, and other forms of the name) or land diving. The ritual is specific to the south of Pentecost Island and its purpose is to ensure a good yam harvest. Every year, the men of Sa village build and climb a wooden tower that is more than 30 metres high, and with vines tied around their ankles jump off the tower and 'dive into the land'. The length of the vines is said to be crucial for a successful jump, which ends with only slightly brushing the shoulders against the ground – vines that are too short swing the diver into the tower, while overly long vines can cause serious injuries. However, the length of vines is not measured precisely; instead it is estimated by a village authority (such as a chief or other important man-of-rank) for each diver separately. Only men and boys who have undergone circumcision are allowed to perform the ritual (younger individuals jump from lower platforms of the tower); women are not allowed near the tower. Before jumping, each participant makes amends to clean himself from his sins and transgressions, to ensure that, in the case of death, he will end his life clean and chaste. Meanwhile, to help him remain brave and strong, each diver is encouraged and cheered by the singing and dancing of other villagers. Although the ground under the tower is tilted, and the ritual is performed during the rainy season (around April) when the vines are more elastic and springy, it still represents a considerable physical and psychological ordeal (the risk of death, the fear of being ridiculed in case of an unsuccessful jump – the men who decide to refrain from jumping are considered cowards). Participants believe that a successful dive is an expression of masculinity that can cure illnesses and improve health.

Because the imagistic mode does not police orthodoxy in the same way that the theory predicts for the doctrinal mode, the imagistic mode does not necessitate complex hierarchies to police distortions or the decay of central beliefs. If any leadership is required, it usually consists of very few individuals at a local level (as is the case in Vanuatu). The potential size of doctrinal groups and the complexity of their beliefs often require extensive hierarchies to maintain stability; as is the case in the type of Catholicism that is seen throughout Slovakia. Furthermore, the way that one becomes part of a group in the imagistic mode is by participating in one of the rare and emotional rituals. As such, the group can only grow as fast as the ritual can initiate new individuals into the group. In the case of many cultures, such initiations happen so infrequently that the group cannot achieve the same group sizes predicted in doctrinal societies, where entry is extended to any individual who shares the same set of central beliefs.

As an official exegesis is missing in the case of low frequency/high arousal rituals, such as those described above, people tend to seek meanings and significance themselves. Participants, driven by distinctive personal episodic memories, which are equally powerful to – or sometimes even more powerful than – official authoritative exegesis, internally generate speculations about the hidden meanings and purposes of rituals, conceptualised by Whitehouse as *spontaneous exegetical reflection* (2002; 2004; 2005). Because there is little opportunity to compare these reflections with those of others, participants form the impression that the others had the same experience.[17] This sense of shared experience increases the sense of fellowship and camaraderie. The feeling of shared experience creates a feeling of shared identity, binding the ritual participants together and supporting their sense of trust, cooperation and tolerance. At the same time, out-group hostility and suspiciousness are promoted. In small groups, imagistic rituals might give rise to a higher level of commitment to dangerous pursuits (e.g. warfare, hunting, raiding, etc.) and perhaps to greater violence and brutality (Whitehouse, 2012). Ritualised behaviour thus enables one to identify with other in-group members and has the power to extend trust and tolerance among people who are not entirely familiar with each other by making them social partners in possession of shared beliefs, values, customs and norms – conventional practices which it becomes crucial for children to learn and reproduce appropriately.

However, different modes of ritual action engage different types of memory, use different transmission practices, and vary in the degree of emotional arousal they involve. For example, unlike going to a church, the ritual of a first period is highly emotionally arousing, and as such takes the form of an extraordinary (and quite possibly disturbing) episode stored in episodic memory and generating spontaneous exegetical reflection (Whitehouse, 2002; 2004; 2005). Because the ritual is causally opaque (the direct causal connection between ritual actions and their outcomes are often missing or are unclear), participants form an impression that others who went through similar ordeals feel the same and have formed similar reflections. This feeling of shared identity might, compared to doctrinal rituals prevailing in 'WEIRD' cultures (like Slovakia), promote tighter group cohesion and greater cooperation and tolerance. It is thus likely that in Vanuatu, a society where imagistic rituals are practised

[17] Possibly a result of false consensus bias (Bauman & Geher, 2002; Marks & Miller, 1987), wherein an individual assumes that his/her experiences are similar to, or the same as, those of others, as discussed in pp. 24.

and embedded in group life, people feel more bonded within their group, which facilitates adherence to pro-social group-based norms and conventions.

As a consequence, curbing selfishness and greater tolerance, emphasising the *ethic of community* and *divinity* (which are likely to employ greater behavioural self-control), become important for everyday social interactions. As a consequence of the prevalence of imagistic practices, compared to Slovakia, individuals in Vanuatu are more likely to experience a visceral feeling of oneness with a group – identity fusion – which involves perceived psychological interconnection, or overlapping, between the self (the idiosyncratic features of an individual) and the group (Jimenéz et al., 2015; Swann, Jetten, Gómez, Whitehouse, and Bastian, 2012). Recent research has shown that fusion results from reflection upon highly arousing – and often dysphoric – personal experiences (Jong, Whitehouse, Kavanagh, Lane, 2016). This reflection is also posited to be a crucial element in the imagistic mode (known as spontaneous exegetical reflection; Whitehouse 2000, 2004). Examples of such instances are generally rare in recent Slovak history; and those examples that do exist can be problematic. For example, World War II would qualify for such a dysphoric ritual. However, most living Slovakians do not remember the war. More recently, the Warsaw Pact Uprising that protested the invasion by Russian forces and resulted in over 100 deaths and 500 wounded, might have been a source of fusion for Slovakian citizens at the time. The incident however did not appear to heighten identification with Slovakia per se, as it was a combined Czech and Slovak state (Czechoslovakia) that resulted from the uprising. Lastly, it is possible that the Velvet Revolution would appear to be an emotional incident focused on commitment to a singular identity; however the more recent formulations of the theory of fusion focus on *dysphoric* experiences and the theory does not state that euphoric experiences can result in fusion in the same way as dysphoric experiences do (Swann et al., 2014; Swann, Jetten, Gómez, Whitehouse, & Bastian, 2012; Whitehouse & Lanman, 2014).

Given the ethnographic and historical information provided above, it seems reasonable to state that the differences between Slovak and ni-Vanuatu culture largely map onto the differences between the doctrinal and imagistic modes, respectively. These relationships are presented in Table 2 below (à la Whitehouse 2004). Although there are some deviations from the predictions of the theory of divergent modes of religiosity (italicised in the table below) these differences are subtle and they would not constitute a rejection of the theory. Rather, the general close mapping between the two cultures and the predictions of the modes theory suggest that it is a reasonable theoretical heuristic that can be used in this comparison.

Variable	**Slovakia**	**Vanuatu**
Group Size	Large	Small
Social cohesion	Diffuse	Intense
Exclusivity	Inclusive	Exclusive
Ritual Frequency	High	Low
Emotional Arousal	Low	High
Structure	Centralized	Noncentralized
Degree of Uniformity	High	Low
Ritual meaning	Learned	Generated by reflection
Spread	Rapid	Slow
Leadership	Dynamic	*Present, but not as complex as predicted by the theory*
Scale	Large Scale	*Embedded small scale groups within a jurisdiction (the state)*
Principle Memory System	*Both, more reliant on semantic memory*	*Both, more reliant on episodic memory*

Table 2: Comparing Slovakia and Vanuatu from the perspective of the Divergent Modes of Religiosity

In case of Vanuatu, higher fusion plausibly motivates greater sensitivity to ritual cues, enabling individuals to comply with community-shared conventional practices. Because conventional actions and behaviours require greater levels of self-control, it can be hypothesised that, along with *kastom*, imagistic rituals promote the activation and employment of executive function abilities to a greater extent than doctrinal rituals (which are prevalent in Slovakia), and, in turn, the ability to delay gratification is likely to be facilitated to a higher degree, compared to a society (i.e. Slovakia) where doctrinal rituals are practised.
Given that the imagistic mode (associated with Vanuatu) relies upon vivid episodic memories, it is useful to recall from the previous chapter that the ability to delay gratification has neurophysiological correlates that are associated with episodic memories. As discussed in the previous chapter, individuals use episodic memories to project themselves forward into new situations (known as mental time travel; see Schacter, Addis, & Buckner, 2007); this is supported by research showing that the same neurophysiological structures are employed for episodic memories and future mental time travel as for the ability to delay gratification. Therefore, it can be expected that individuals from cultures which are more reliant upon episodic memories, such as Vanuatu, which – as noted above – is not *exclusively* reliant upon episodic memories but nevertheless relies heavily upon episodic memories for rare and intense ritual experiences, will have a greater ability to delay gratification than individuals from cultures that are not reliant upon episodic memories in the same way, such as Slovakia, wherein intense ritual experiences are more rare.

2.9 Possible causes of differences in the ability to delay gratification across cultural contexts

The two cultures (Vanuatu and Slovakia) involved in the following studies represent an interesting contrast, because the lack of traditional settings in Western schools might be thought to hamper the development of a ritual stance and therefore inhibit executive control and the ability to delay gratification, as compared to the more traditional and ritualistic ni-Vanuatu society. Because significant correlations have been found between schooling and the ability to delay gratification in previous research (e.g. Godoy et al., 2004; Kirby et al., 2002; a topic further discussed in the above chapters of this thesis) this is indeed an interesting issue; especially taking into account the fact that the relationship between the two phenomena has not yet been fully explained. It may be that the ability to delay gratification, as the ability to invest in delayed payoffs, promotes school attendance and a determination to invest in education. On the other hand, it may also be the case that schooling, which engenders respect for social norms and conventions, and promotes the ability to imagine future scenarios with greater vividness[18] (Becker & Mulligan, 1994; 1997), facilitates the ability to delay gratification.

Taking into account previous research on executive function and the ability to delay gratification (discussed in the following chapters), this project might have important practical implications. If the ability to delay gratification can be found to promote a willingness to invest in education, and if the ability to delay gratification can be experimentally improved

[18] Children are encouraged to think of their future and discuss their plans, and it is emphasised that whatever they do now will affect their future.

and its positive consequences generalised outside the laboratory environment, countries like Vanuatu, which face serious problems and challenges in the formal educational system, could improve school curricula by incorporating games and practices that facilitate an ability to delay rewards. As access to quality education has become a great challenge for both families and government, and has been of particular importance for the nation in recent years, because it could help to achieve greater income equality and alleviate poverty in Vanuatu, the present thesis, which aims to examine the role of ritual in the process of improving children's executive function and the ability to delay gratification, may contribute to the issue not only theoretically, but possibly in a more practically applicable way.

Thus, the question remains, can a more conventional style of schooling, the presence of imagistic rituals and everyday emphasis on customary lifestyle as an important identifier of the ni-Vanuatu nation, prompt adoption of a ritual stance (as compared to western, Slovak society), and in turn facilitate potential improvement of executive function and the ability to delay gratification?

Alternatively, it is possible for socio-economic factors to have greater influence on the ability to delay gratification. As discussed in greater detail in Section 1.8., there are a number of relevant variables that will affect one's ability to delay gratification. Some variables are positively correlated with the ability to delay gratification, such as education level, value of physical assets, income, nutritional status, and literacy. For example, it has been found that individuals with greater levels of education and literacy are better able to delay gratification (Becker & Mulligan, 1994; 1997; Kirby et al., 2002, Shoda et al. 1990). Given that Slovakia has a literacy rate of over 98%, and its education system is ranked 19 amongst the world's education systems, one would presume that Slovak participants would be better able to delay gratification compared to participants from Vanuatu, a country that has to overcome many struggles in its education sector (as discussed above in section 2.3) and is currently ranked 150th in the world by the quality of their overall education system (The World Bank, 2016; Wolfram Alpha, 2016).

Furthermore, although the analysis of Kirby et al. (2002) addresses physical assets and income of adults, it can be applied to children as well. We can assume that children in Slovakia, which is an OECD nation in the EU and ranked 39th by per capita GDP, will have greater physical assets available to them than children in Vanuatu, which is ranked 146th by per capita GDP globally (The World Bank, 2016). It is very common for Slovak children to have many books, toys, electronics, and other goods purchased by their parent's expendable income. In Vanuatu, such luxuries are extremely rare, and most traditional income – if any – is used for sustaining the household. Furthermore, in most areas of Vanuatu there are no stores that would specialize in children's merchandise such as toy stores or children's book shops, which are common in Slovakia. Therefore, children in Vanuatu, where families have lower wealth and income, might exhibit lower ability to delay gratification than children in Slovakia (Becker & Mulligan, 1997; Green, Myerson, Lichtman, Rosen & Fry, 1996; Hausman, 1979; Pender, 1996; Shipe & Lazare, 1969).

Concerning nutritional status, Vanuatu has a number of noted health issues that are not as prominent in Slovakia. For example, iron deficiency, lack of vitamin A, diabetes, and cardiovascular diseases (Carlot-Tary, Harvey, & Menere, 1996; Carlot-Tary, Hughes, & Hughes, 2000). Children in Vanuatu are at a greater risk of nutritional insufficiency. In Vanuatu, there is a well-documented issue with underweight children that has been prevalent since the early 1980s (Carlot-Tary, Harvey, & Menere, 1996). Based on the results of Kirby at al. (2002) which showed that people with lower nutritional status have lower ability to delay gratification, participants from Vanuatu would be expected to have a lower ability to delay gratification than participants in Slovakia.

Meanwhile, other variables are negatively correlated with the ability to delay gratification, such as the prevalence of catastrophes in the area, the number of impulsivity cues (e.g. advertising for fast food companies) in the environment, life expectancy, and family conflict. For example, Vanuatu is regularly subjected to large cyclones and earthquakes. Participants in Vanuatu, which is a country located in the "ring of fire" and experienced over 25 earthquakes with a magnitude of 6.5 or greater in the past decade, would be expected to have lower ability to delay gratification than their Slovak counterparts, who do not experience such catastrophes (Li, Li & Liu, 2011).

There are another potential factors that might cause participants from Vanuatu to be lower delayers than the participants from Slovakia. In Vanuatu life expectancy is 73.06 years, and the DTP children immunisation (diphtheria, pertussis and tetanus) only reaches 76%. Due to a lower immunisation rates and low amount of physicians per 1000 people (only 0.12, with physicians being totally absent in rural areas[19]) (Wolfram Alpha, 2016), people in Vanuatu experience higher health risks than people in Slovakia. Although there is a comparable infant mortality in both countries (6% in Slovakia, 7% in Vanuatu), after the age of two (which is roughly the age when children are stopped being breastfed), children in Vanuatu are known to experience underweight. However, as in other Pacific areas, unhealthy lifestyle causes high amount of adults to be overweight, causing cardiovascular diseases which has become the main cause of mortality in the area (Carlot-Tary et. al., 1996; Carlot-Tary et al., 2000). To

[19] People have often no possibility to see a physician when experiencing health issues, because the travel expenses to see one, which often includes flight to another island, are too high for most of the people living on remoted islands. Although there are remote areas with no access to health care in Slovakia, such areas are often visited by a physician on a regular basis.

compare, Slovakia has a 76.88 years life expectancy, there is 3.12 physicians per 1000 people, and DTP immunisation reaches 99% (Wolfram Alpha, 2016). Slovakia, as other countries from European Union, is experiencing a trend of alternative healthy lifestyles (bio, raw, vegan, etc.), and it is very common for both children and adults to engage in regular sport activities. Moreover, access to drinking water, which is 100% in Slovakia, only reaches 59% in Vanuatu.

An important factor that might cause differences in the ability to delay gratification is conflict and violence in family. Although no accurate statistics exist, violence against women and children is very common in Vanuatu. Although child abuse is not believed to be extensive (again, no statistics are available) and children are generally protected by an extended family system, there are no specific laws against violence against women and children, and most cases (including rape) are unreported. Police are often reluctant to interfere in domestic matters and no government programme addresses these issues[20]. On the other hand, Slovak law prohibits domestic violence and provides strict sentences (two – 12 years of imprisonment), and allows for continued criminal prosecution even when a violence victim drops charges. As the conflict in family was reported to influence the ability to delay gratification (McBride, Paikoff & Holmbeck, 2003), Vanuatu participants might be found to be delay gratification to lower extent than participants in Slovakia.

An interesting contrast between the two cultures is the exposure to impulsivity cues. Whereas in Slovakia, the exposure to information and promotions (billboards, commercials, journals, magazines, etc.) is relatively high, such factors are missing in Vanuatu, where most people have no access to television, print media or other forms of advertising. This might

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[20] Exceptions are non-governmental organisations such as National Council of Women and the Vanuatu Women's Center, who are working to educate the public about domestic violence

cause participants in Slovakia to be less able to delay gratification then participants in Vanuatu (Callan et al., 2011; Zhong & DeVoe, 2010).

Variable	***Potential effect on the ability to delay gratification***	***Participants expected to have a higher ability to delay gratification***
Ritual and customary lifestyle	Positive	Vanuatu
Education	Positive	Slovakia
Literacy	Positive	Slovakia
Income and wealth	Positive	Slovakia
Nutritional status	Positive	Slovakia
Health and life expectancy	Positive	Slovakia
Catastrophes	Negative	Slovakia
Exposure to information and impulsivity cues	Negative	Vanuatu
Conflict in family	Negative	Slovakia

Table 3: Variables influencing the ability to delay gratification

The two cultures presented above, ni-Vanuatu and Slovak, present two cultures with interesting historical and cultural differences that can serve to test hypotheses concerning the relationship between ritual, executive function, and the ability to delay gratification. As described above, Slovakia generally fits the description of a doctrinal society: it has frequent rituals (largely informed by its Catholic historical roots), with low sensory pageantry, and large hierarchically structured social groupings. It also has a high quality of life (as measured by standard socio-economic variables such as access to resources and education), and more modern education system. Vanuatu, on the other hand, generally fits the description of an imagistic society: it has many rituals which are infrequent but dysphorically arousing. Many of the social groups are exclusive (one has to go through a costly initiation ritual) and smaller than those found in Slovakia. Furthermore, many in Vanuatu undergo a more traditional education and do not have the same access to resources that their Slovakian counterparts do.

This is not to say that the cultures are perfectly described by the two modes; nor does this attempt to dichotomise the two cultures at the focus of this thesis. Rather, the modes are used as a theoretical abstraction, as the two cultures exhibit many of the key properties that define each of the two modes.[21] These differences may suggest that children who are brought up within these different cultural practices will attend to actions differently when they are framed as rituals. Although Slovakia has a religious system which is reliant on the performance of frequent rituals, ni-Vanuatu culture stresses more subtle ritualised interactions among members of the group on a daily basis. As such, we can expect there to be differences between the two cultures if it is primarily cultural differences, as opposed to cognitive structures, that drive differences in executive function and the ability to delayed gratification.

This thesis focuses specifically on the effect of ritual on the ability to delay gratification. However, it is important to note that the ability to delay gratification, like executive function, is a complex cognitive capacity that can also be affected by various socio-economic variables. Given the analysis above, it would be expected that individuals in

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[21] Indeed, Whitehouse has noted that the two modes are not exclusive typologies; rather, the modes represent cultural trajectories that appear to result in cultural systems that occupy one of two cultural attractor positions. "… modes of religiosity are attractor positions. They do not specify a set of law-like rules for building individual behavior. The claim is not that all instances of ritual action conform to one or another mode of religiosity. Indeed, that would be impossible by definition, since roughly half the variables in which the theory is concerned itself… relate to distributed population-level attributes rather than particular instances of thought or behavior (even though it is the latter that cumulatively cause the former). So we cannot say that the particular ritual, for instance, is doctrinal or imagistic. We can only say that its long-term reproduction through the innumerable thoughts and actions of many people results in the coalescence of features specified by the modal theory. These features, in other words, are discernable only as marked tendencies within a religious tradition, taken in the round (Whitehouse, 2004: 75-76)."

Vanuatu will be better able to delay gratification due to their cultural and ritual practices. However, it remains to be seen whether ritual and customary practices in Vanuatu would be stronger than the socio-economic factors that would suggest that Slovak participants would be better able to delay gratification. These ideas are expanded upon and empirically investigated in the next three chapters, which present an in-depth analysis of data collected during an extensive period of fieldwork in both Slovakia and Vanuatu.

3. The impact of ritual on executive function

This chapter explores the proposition that a ritual stance places heavier demands on executive function than an instrumental stance. Therefore, a training programme that promotes the adoption of a *ritual stance* will improve children's executive function abilities to a greater extent than an intervention that promotes the adoption of an *instrumental stance*. Previous research methods showing that carefully designed interventions can improve executive function are adapted here to test these hypotheses. It is hypothesized that when interventions designed to increase executive function are associated with ritual rather than instrumental cues the cognitive abilities involved in executive function (attention, working memory, inhibitory control) will be enhanced.

Based on the evidence from previous studies, it is predicted that the adoption of a *ritual stance* results in higher employment of executive function – as individuals become more sensitive to possible mistakes in learning and replicating normative conventions, and potential consequences of these mistakes, more demands are placed on executive function (as discussed in section 1.4.1). Executive function represents cognitive abilities (attention, working memory and inhibitory control) enabling us to monitor complex actions and control our behaviour in light of different circumstances, needs and situational constraints. Indeed, Kopp (1989) suggested that ritualised behaviours help children gain a sense of self-control and regulate their emotional states, and recently Peleg-Popko and Dar (2003) found that children experiencing more fears were engaged in more ritualised behaviours. Thus, it might be that when children are able to predict changes in their environment and in the behaviours of others; i.e. engage in ritualised behaviours, they are better at behavioural self-control:

children pay attention to changes in the environment and respond to different stimuli (e.g. bringing a favourite story book to his or her parents when it gets dark and it is time to go to bed), remember certain scripts of the action (e.g. after being tucked up in bed, it is the mother who always reads the story), and are able to inhibit immediate desires (e.g. not going to sleep and staying with the parents). It could thus be that the more a child is engaged in ritualised behaviours (which create demands on attention, working memory and inhibitory control), the more his or her executive function is challenged, and as a consequence, improved.

The analyses presented here assess the first prediction of this thesis, namely that:

(1) The rule-based intervention games will improve children's performance in the executive function task, with games that incorporate a 'ritual stance' having the largest effect on this improvement.

The fact that executive function has been shown to be an important predictive factor of early academic achievement (in terms of literacy, vocabulary, and mathematics), as well as social and cognitive functioning during adulthood (e.g. Borella, Carretti, & Pelgrina, 2010; Denson, Pederson, Friese, Hahm, & Roberts, 2011; Diamond, 2013; Duckworth & Seligman, 2005; Eigsti et al., 2006; Gathercole, Pickering, Knight, & Stegmann, 2004) calls for a more detailed understanding of this cognitive ability, and the possible ways it can be improved. It is argued here that normative conventions, which are presented by using generic normative language, require more precise ways of learning and replicating, and are thus are more executive function demanding. As discussed later in this chapter, this claim is investigated using a priming paradigm to frame a set of normative or instrumental behaviours with the only difference between conditions being a verbal cue given at the start of the task.

3.1. Enhancing or impairing executive function? The role of rituals in executive function processes

Section 1.3.1. discussed how the hazard precaution system (HPS) can serve to protect one from potential threats in their environment. However, the system's over activation or a lack of its inhibition can result in distress and disrupt social functioning. Children's ritualised behaviours are often viewed as belonging to a spectrum which includes obsessive compulsive disorder (OCD), "a neuropsychiatric disorder characterized by obsessions (intrusive, troubling thoughts) and compulsions (ritualistic, repetitive behaviours)", which "cause subjective distress and interfere with social and occupational functioning" (Evans & Maliken, 2011: 174). It is commonly assumed that children's proclivity for ritualised behaviours and for things to be done 'just so' is a result of children's executive function abilities being not yet fully developed. As a consequence children are unable to deal with change and have a harder time maintaining social relations, much like OCD patients. An example is the study of Evans & Maliken (2011) with six to 12-year-old typically developing children, where the researchers found that compulsive-like behaviours were associated with faster processing of an asymmetrical target stimulus, suggesting that "frontal and midline brain regions implicated in disorders such as OCD and autism spectrum disorders are also active during ritualistic behaviour in normally developing children" (2011: 178). OCD is indeed linked to deficits in the executive function, having been found to impair shifting abilities (e.g. Hymas, Lees, Bolton, Epps, & Head, 1991; Lucey et al., 1997) and inhibitory control (e.g. Casbon, Curtain, Lang, & Patrick, 2003). The evidence from positron emission tomography (PET) and functional magnetic resonance imaging (fMRI) studies with OCD patients show the involvement of certain brain regions in the disease, namely atypical activity in the orbitofrontal and anterior cingulate of the prefrontal cortex (Baxter, 1990; Rauch et al., 1997) – the brain regions found to be activated during the executive function-related task performance (Casey et al. 2011; Shamosh et al., 2008).

It has been suggested that repetitive behaviours in both cultural rituals and OCD are conducted to create order, regularity, predictability and clearly demarcated boundaries and categories (e.g. Fiske & Haslam, 1997: 221), in order to reduce anxiety and gain a sense of control over events that are beyond an individual's influence (e.g. performing a ritual before an important sport match or before going to bed). In OCD patients however, the precautionary system dealing with inferred threats and anxiety-inducing situations (i.e. the Hazard Precaution System; Boyer & Liénard, 2006), which includes threats of not being accepted into a social group, is excessively activated and interferes with normal functioning, resulting in adding numerous individual-specific superfluous and non-functional acts (Zor, Hermesh, Szechtman, & Eilam, 2009). Compared with healthy individuals in whom precautionary actions (such as deferring to normative social conventions) are adaptive and helpful in confronting anxiety-inducing situations, the functional performance of OCD patients is interrupted and reduced by performing a variety of idiosyncratic ritual-like behaviours (Keren, Boyer, Mort & Eilam, 2010).

By contrast, it is predicted in this thesis that ritualised behaviours enhance executive function rather than signalling its impairment. The important step to test this argument is to examine the (often neglected) differences in activation and inhibition of ritualised actions between the rituals of OCD patients and normally functioning individuals and the neural processes that underlie them. Indeed, the fact that OCD impairs brain areas activated during executive function performance does not necessarily mean that *all* ritualised behaviours impair this functioning. The important difference between OCD patients and healthy individuals lies in how the activity of security systems which prompt humans to perform ritualised behaviours in order to avoid inferred threat (diseases, violating of rules, impurity, etc.), such as HPS, is initiated, sustained and terminated. When a threat or hazard is detected (often influenced by learning history), a repository of precautionary programmes is activated and elicits the performance of precautionary acts. The performance of these acts then generates feedback to terminate the activity of the precaution system. It has been argued that, unlike in the case of ritualised behaviours of healthy individuals, in OCD patients the system fails to 'shut down' the security motivation (Woody and Szechtman, 2011), leading to performance of abundant idiosyncratic acts. Woody and Szechtman (2011) hypothesise that the risk of potential hazard involves activation of the same brain areas that are involved in fear-based learning (LeDoux, 2002) – namely medial and orbital prefrontal cortices, and the anterior-cingulate cortex (note that atypical activity in these cerebral areas was found in OCD patients; Baxter, 1990; Rauch et al., 1997) – because there "likely is a continuum across unconditioned, conditioned and potential threat" and "different parts in such anatomically defined continuum are likely to act on information in a similar fashion" (2011: 1022). Moreover, damages to the medial prefrontal cortex were shown to cause a limited ability to detect potential hazards (Bechara, Damasio, Damasio, & Anderson, 1994; Bechara, Damasio, Damasio, & Lee, 1999). The HPS thus facilitates social interaction by bringing attention to various threats, including potential threats to one's social standing (e.g. uncertainty of one's position in a social group, fear of being ridiculed or ostracised). Since similar cerebral areas are hypothesised to be activated during threat detection and during the executive function-related task performance (Casey et al. 2011; Shamosh et al., 2008), it can be hypothesised that there is an important connection between performing social rituals and executive function: to successfully function in social environments, humans have to be able to attend to potential threats (paying attention to even subtle signs of potential threats and hazards) – a process that is usually based on previous learning or memories (integrating and manipulating information in working memory), and to be able to inhibit precautionary acts once the hazard or threat is over (applying inhibitory control to restrain oneself from impulsive acts). As attention, working memory and inhibitory control are some of the crucial components of executive function, it is likely that participation in social rituals (which serve social purposes, such as bonding and group affiliation) increases – not impairs – executive function abilities.

Further evidence for the interconnection of executive function improvement and ritualised behaviour is suggested by the fact that executive function as well as ritualised behaviours develop and change with ageing in a similar way. The executive function of young children (i.e. two- to five-year-olds) is less structured and unitary; the executive function, along with the subserving neural circuitry, is not yet fully developed. This is the likely neurophysiological explanation for why it is that younger children have – what appears to be – unitary executive function, but later in development there appear to be 3-factors to executive function. In addition, young children have greater difficulty inhibiting impulsive responses and carrying out working memory operations (i.e. shifting and maintaining cognitive sets) (Dowsett & Livesey, 2000; Zelazo, Carter, Reznick, & Frye, 1997); this is also a factor that constrained which age range of children would be recruited for this study. The ritualised behaviours of young children (requiring different activities to be performed in a very precise way) can thus be a result of their poor executive function abilities, such as shifting attention from salient to relevant cues, being attentive to what is relevant, understanding causal relations, etc., and an attempt to reduce possible anxieties and emotional distress arising from not-yet-fully-understood physical and social environments. Consequently, young children are more prone to use and rely on previously effective strategies, which allow for greater control of, and relief from, their fears and feelings of uneasiness. By contrast, the ritualised behaviours of older children (of six to eight years of age) may reflect very different strategies and can be understood as “more intentional, purposeful behaviours indicating greater executive control” (Pietrefesa & Evans, 2007: 38). As was pointed out earlier, it is around the age of six that children’s executive function gains in efficiency and develops into a more structured ability. In this period, children make the transition from preschool to the more structured school environment and executive function undergoes changes that are crucial to ensure the development of the skills that allow them to take control of their actions and interactions. These changes are necessary in order to face new fears: children’s fears switch from imagined monsters to more real social ‘monsters’, such as peer rejection, ridicule and social exclusion. These fears are reduced by engaging in social rituals (e.g. children meeting every day before school, exchanging items in their collections, eating together, etc.) that are regulated by various rules and prohibitions which ensure group acceptance and a sense of belonging. Because each member of a group is being monitored by other group members, these rituals require participants to abandon their personal inclinations (e.g. sleeping with a stuffed animal in one’s own bed) and instead stick to the script of social rituals (e.g. sleeping on the floor with friends during a slumber party, leaving a favourite toy at home) to ensure they flourish within the group. Thus children (and, indeed, all humans) must be sensitive to group conventions (rituals, values, beliefs, etc.), and be competent at reproducing them in appropriate ways and contexts (Whitehouse, 2012). As discussed earlier (section 1.1.1) even preschool children are alert to the distinction between ritual (conventional or normative) and instrumental action, and are liable to copy the former more precisely, with less propensity to innovate or embellish modelled behaviour (Legare et al., 2015). Research also indicates that these effects increase when conformism cues (Herrmann et al., 2013) or ostracism threats

(Watson-Jones et al., 2014) are made salient. The ritualised behaviours of older children, with their more developed ToM, greater understanding of physical and causal relations, and greater understanding of social categories, may thus reflect their self-awareness, self-consciousness and greater voluntary behavioural self-control. This may allow them to operate more effectively within a group. This view has been experimentally confirmed by Pietrefesa and Evans (2011), who found that children older than six years who engaged in fewer ritualised behaviours exhibited greater difficulty in restraining impulsive responses, indicating a greater degree of carefulness in not making errors (see also Tregay et al., 2009).

Controlling one's own behaviour and using stereotyped behaviour instead of impulsive reactions and personal innovations is considered to be a by-product of the HPS (Boyer & Liénard, 2006): in order to avoid an implied social threat, such as peer rejection or ostracism, humans undertake precautionary measures by acting according to prescribed scripts, and thus producing an optimal response to avoid a threat. Studies with social animals suggest that behaviour under threat involves a socio-cultural component in that precautionary behaviours are socially activated (Eilam, Izhar, & Mort, 2011). Izhar and Eilam (2010) have reported that members of groups under threat adopt a similar behavioural code and thus display reduced individual variation: in other words, their behaviour is more ritualised, in order to avoid potential danger. Implicit social dangers cause actors to be more cautious about their acts and behaviours, and to employ higher levels of executive function: individuals are focused on the details of their performance and become more sensitive to possible mistakes. Although the participants might have no representation that explains to them why particular sequences are included, each action is still considered an indispensable part of the script. Individual innovations are not allowed – participants cannot add whatever they think might be appropriate or suitable. They are also not allowed to change the course of actions or drop some of them out. Simply put, participants must inhibit their immediate impulses and defer to tradition: “One of the effects of prescribed, rigidly compulsory action-sequences is a momentary overloading or ‘swamping’ of working memory” (Boyer & Liénard, 2006: 605). Moreover, detailed ritual prescriptions require “focused attention on a set of different stimuli and their arrangement” (Boyer & Liénard, 2006: 606).

It is proposed in this study that although some of the aspects of ritual episodes – usually physical movements or utterances – may eventually become routinised This is especially the case for ritual officers or long-term members who witness dozens of ceremonies. This routinisation can lead to “implicit behavioural habits that occur independently of conscious thought or control” (Whitehouse, 2004: 68) and require executive control to a greater extent by demanding high control, attentional focus and an explicit emphasis on proper performance than everyday tasks, and thus cannot be accomplished automatically.

Along with some of the previous work on ritualised behaviour (Boyer & Liénard, 2006; Keren et al., 2010; Liénard & Boyer, 2006) we speculate that some parts of ritual episodes (rigidity of performance, goal demotion, imitative learning) require higher levels of executive control and might be connected to the area of the prefrontal cortex, which processes stimuli related to threats and integrates them with existing cognitive information such as experience, beliefs, norms, etc. (Woody & Szechtman, 2010). As such, rituals differ from routines in requiring behavioural self-regulation, a high level of control over one’s actions, attentional focus and an emphasis on proper performance. As Keren et al. (2010; along with Boyer & Liénard, 2006) has proposed, ritualisation and routinisation are different processes that focus attention on different mental-event hierarchies. Zacks, Tversky and Iyer (2001) have proposed three levels of attentional focus. The spontaneous (normal) focus of attention is on the level of episodes. This level is considered to be a basic mid-level of attention that is involved in daily activities that are neither routines nor rituals. However, when routines are performed, the attentional focus shifts from mid-level episodes to the broader level of scripts (a series of episodes, such as pouring a cup of tea, driving to work, getting dressed, etc.), with performers not being necessarily conscious of the episodes (sets of acts that are relevant to each other, such as putting on a shirt, putting on a skirt, etc. when getting dressed) comprised in these scripts and attending only to a general script. On the other hand, when rituals are performed, attentional focus shifts from the mid-level of episodes to a narrower level of single gestures (acts of movements), requiring fine-grained performance, precision, and concentration, thus requiring higher levels of cognitive control. Thus, although both rituals and routines are relatively rigid performances, the underlying processes are different (Keren et al., 2010), in that routines have a lesser emphasis on proper performance and involve low demands on cognitive control. In contrast, in rituals proper performance is an implicit demand, which requires higher levels of attention, working memory and inhibitory control. Therefore, "rituals are not mere amplification of motor routines, as they seem to involve inversed cognitive and attentional processes" (Keren et al. 2010: 94).

The implicit requirements in rituals are likely to challenge and improve individuals' self-control, as indicated by the study with Tae-Kwon-Do students conducted by Trulson (1986) and Lakes and Hoyt (2004). The results of these studies revealed that the students exposed to traditional intervention condition had below average aggressiveness scores, lower anxiety levels, and increased self-esteem and social adroitness (Trulson, 1986), and showed greater cognitive, affective and physical self-regulation, and had greater gains in prosocial behaviour (Lakes and Hoyt (2004). It is emphasised that to promote these qualities, an intervention in the form of a *traditional* martial arts programme was required. In sum, there seems to be an important difference between rituals and routines, in that rituals require higher levels of concentration and thinking and thus cannot be accomplished by simply conducting mechanistic movements or relying on impulses.

Although ritualised actions are sometimes applied to routinised activities (e.g. making a cup of tea), they turn these activities into more cognitive control-demanding tasks with indispensable acts (e.g. pouring milk into a cup first, pouring tea into a cup without touching the edge of the cup with a tea pot). On the other hand, it is likely that routinisation in rituals emerges as a result of the need to focus attention elsewhere. As noted by Fentress (1976), rigid motor actions are constructed and performed when we need to concentrate on other aspects of an activity. Consequently, although some of the action sequences in rituals are conducted without conscious control (e.g. walking around a pole, lifting up a chalice during the celebration of the Eucharist), some of them (or some aspects of automatic actions) need to be modulated by conscious control (e.g. walking around the pole five times precisely, the timing of actions while reciting appropriate epiclesis during the Eucharist). Norman and Shallice (1986) refer to this mechanism as *contention scheduling* and propose that it is activated in order to permit simultaneous actions of cooperative schemas or to inhibit simultaneous actions of conflicting schemas, thus allowing “suitably activated schemas to be initiated at the precise time required” (Norman & Shallice, 1986: 3), and preventing incompatible or improper actions. Thus in rituals, in which different stimuli often require focused attention, or numerous (often incompatible) schemas overlap one another at the same time (e.g. turning around a pole five times without looking down), some of the activities can be executed by employing more basal brain structures to enable attention to be focused on other aspects of ritual episodes which require rigorous computation of arbitrary detail and cannot be accomplished by relying on impulses or mindless conformism, because they require precise timing and accurate performance. In contrast, routinised actions are executed automatically, place low demands on attention, and have a lesser emphasis on proper performance (Liénard & Boyer, 2006).

The literature on ritual and ritualised behaviours mentioned so far suggests that rituals are important for both individual well-being (in terms of warding off potential threats and anxieties) and social well-being (group bonding and recognition, cooperation), creating an emphasis on the need to properly learn, use and transmit normative and socially stipulated rules. However, as ritualised (and normative) behaviours are causally opaque, they allow for many possible interpretations. And because participants do not know what others are privately thinking or representing, they form an impression (although it might be illusory) that "what is personally meaningful and motivating about the ritual experience, for them, is shared by all other participants" (Whitehouse, 2012: 269). This is likely a result of false consensus bias – a cognitive bias wherein an individual overestimates the extent to which his or her own experiences, values, opinions, preferences, values, habits, etc. are also held by others (Bauman & Geher, 2002; Marks & Miller, 1987). This bias leads people to believe in the existence of a consensus that might not exist in reality. However, as a way in which an individual interprets his or her social environment, it may play an important role in increasing the individual's feelings of belonging and fitting into a group. Since group belongingness seems to be an important concern, it seems likely that it influences cognitive activity and processing during social learning. Indeed, Haidt and Graham (1999; 2009) suggest that engagement in rituals are a result of the human need to belong, which influences social learning instead of being a product of social learning.

3.2. Rituals and social learning

Although with age children gain a more mature understanding of their environment and interactions and the number of fears decreases, social anxiety-inducing situations (rejection, ostracism, embarrassment, ridicule, etc.) still prompt humans to engage in social rituals, which are pervasive feature in every society. According to the symbolic transmission hypothesis, no culture lacks rituals; even though some features of rituals (e.g. cognitive opacity, goal demotion) are at odds with traditional notion of idea transmission (Schjoedt et al., 2013) and some social rituals and normative conventions are relatively costly (Henrich, 2009; Whitehouse, 2012). On the other hand, they are effective in signalling commitment and creating sense of belonging by identifying with other in-group members. Although substantial part of research has been focused on ritualisation's effect on social identification and group affiliation (e.g. Baumeister & Leary, 1995; Brooks, 2003; Durkheim, 1915; Rappaport, 1979; Sosis & Ruffle, 2003; Turner, 1969) not much is known about how rituals are cognitively approached, and which cognitive mechanisms are involved when humans engage in ritualised behaviours. It is hypothesised in this thesis that affiliative motivations involved in social learning of normative conventions (which serve as a reliable signs of group commitment) and feelings of anxiety induced by potential rejection by a group when one fails to learn and reproduce them in appropriate context, result in adopting a *ritual stance*, which involves more rigid copying of these behaviours (Herrmann et al., 2013; Legare et al., 2015; and Watson-Jones et al., 2014). Some studies showed that mere expectation of social interaction, even with a stranger, alters cognitive processing in that humans pay more focused attention to information about the other person, and information is processed in a more detailed manner

(Erber & Fiske, 1984; Devine, Sedikides, & Fuhrman, 1989). It is thus very likely that group-belongingness and fear of rejection, which are very important for humans, their interactions, and well-being, as well as issues to which humans devote large amount of cognitive processing (Baumeister & Leary, 1995), will influence not only learning of social normative conventions, but also cognitive processing of normative conventions itself.

Following, and acting according to, group normative conventions is both self-informative – as the individual looks for potential meaning in a ritual and represents it to him- or herself as a group member (*self-referential* focus) – and informative – by performing a ritual, an individual displays an alignment towards, and a commitment to, a group (*canonical* focus represented by general, enduring and universal sequences of actions to which individual adjusts his or her actions) (Rappaport, 1999). According to Jennings (1982) ritual is one way in which individuals make sense of their world and their place in it. As a result of self- and group-identification, learning of normative behaviours and behavioural sequences is likely to be driven by the communication of group membership and commitment, and by implicit affiliative motivations and goals. Indeed, social life is possible precisely thanks to individuals' submission to various rules and restraints (Durkheim, 1951; Haidt & Graham, 2009). To ensure appropriate reproduction and preservation of causally opaque behaviours, humans learn those behaviours by means of imitation, which is one of the key mechanisms for the transmission and stabilisation of cultural knowledge (Bandura, 1986; Meltzoff, 1999; Tomasello, 1998; Tomasello, Kruger, & Ratner, 1993; Whiten 2000), and which serves as a way of learning how in-group members behave and ought to behave in different contexts.

As the research from developmental psychology shows, imitation and socially inherited means of actions are used even in cases when other means are available. This is likely a result of the imitative behaviours representing a means of learning cultural practices and norms. Such imitation may provide cultural novices with learning opportunities, teaching them how to treat different individuals and groups, as well as how to appropriately act in various social situations. Meltzoff (1997) suggests that imitation in social learning stems from *self–other equivalence* in social cognition, suggesting that "not only is the process of imitation social, the content of imitation can also be social" (Over & Carpenter, 2012: 8) by means of identifying with social partners (to be like them) and communicating likeness to them. In other words, imitation often serves a social function and is motivated by affiliative goals – for example, children sometimes imitate in order to communicate the message 'we are alike' (Carpenter 2010; Nielsen, Simcock, & Jenkins, 2008; Over & Carpenter, 2012) or to try to be more similar to others. Rossano (2012) proposes that attachment and the precise replication of social rituals, and their acquiring, enacting, and enforcing, allows individuals to please others and gain social acceptance. During imitative social learning, teacher and learner share a mental state, which creates an emotional bond between the two: "the caregiver embodies social/cultural values to which the infant becomes emotionally committed" (Rossano, 2012: 5), again motivating children to learn and replicate social conventions in a normative, rigid manner to display honest signs of group commitment and similarities with other in-group members.

To closer examine children's imitative learning strategies, Meltzoff (1988) carried out an experiment with 14-month-old children as participants. In this experiment, a female model leaned toward the light box and, touching it with her forehead, illuminated it. Meltzoff (1988) reported that after one week most of the children re-enacted the head action. However, none of the children from the control group used the head action to illuminate the box and used their hand instead. Regarding these results, Meltzoff and Moore (1989; 1997) argued that children identified perceived others as similar to self and had what the authors termed as an "inbuilt drive to act like their [i.e. children's] conspecifics" (Meltzoff, 1996: 363).

The experiment with the light box has since been replicated by different researchers in an attempt to examine children's motivations and the processes shaping imitative learning. For example, Tomasello and colleagues used a modified version of the experiment to show that children do not just imitate the actions of others but that they understand the intentions of the model (Carpenter et al., 1998). According to Tomasello, identifying the intentions of a model is part of "genuine" (or "insightful") imitation: "True imitative learning … involves the infant's reproducing the adult's actual behavioural strategies in their appropriate functional contexts, which implies an understanding of the intentional state underlying behaviour" (Tomasello et al., 1993: 497). According to this theory, imitation without understanding of the underlying intentions – blind copying – is not 'true' imitation but only mimicry. Tomasello et al. (1993) argued that the criteria of 'true' imitation are the novelty and transparency of the new observed behaviour. In Tomasello's view, cognitive transparency in social learning ensures the relevance of what is being learnt: as the learner understands the underlying intentions behind observed behaviour, he or she becomes capable of detecting the behaviours to be reproduced. Meltzoff's findings (1988) were consistent with Tomasello's first condition of 'true' imitation, i.e. the novelty of response: children imitated the head action because it was unusual and somewhat novel behaviour. To test the second condition of 'true' imitation (cognitive transparency of behaviour), and to demonstrate that the children were not just mimicking and were aware of the goal-directed nature of such behaviour, Carpenter et al. (1998) replicated Meltzoff's experiment with the light source separated from the box. They found out that the majority of participants not only reproduced the unusual action, but also looked to the interesting result in anticipation – an outcome which in authors' view demonstrated that the children were not just mimicking (Tomasello, 1999: 82).

However, as Gergely and Csibra argue (2005), if the model's behaviour was really cognitively transparent and the children understood how the action performed was connected to the desired goal, they would then not replicate the strange head action (because it would be cognitively opaque in such a situation) and would use their hands instead. After all, as violation-of-expectation studies (Gergely, Nádasdy, Csibra, & Bíró, 1995; Gergely et al. 2002) showed, "by 12 months infants exhibit a sophisticated ability to attribute goals to observed actions and to evaluate the relative efficiency of the means act in relation to the goal and the physical constraints of the actor's situation" (Gergely & Csibra, 2005: 468). However, Meltzoff's and Tomasello's conclusions were in conflict with these results. To examine this issue more closely, Gergely and colleagues (2002) performed another modified version of Meltzoff's experiment. In their view, children as young as nine- and 12-months-old are able to attribute goals to observed actions, and considering physical restraints of actor's situation, they can evaluate the efficiency of actions needed to bring about the observed modelled goal (Gergely & Csibra, 2006). Although one-year-old children lack ToM and do not have the capacity to represent intentional mental states, they are nonetheless capable of attributing goals to actions, evaluating the efficiency of their actions, and inferring the non-visible aspects of goal-directed actions (Gergely, 2003). Gergely and Csibra (1997; 2003) argued that this was possible thanks to *teleological stance* – reality-based strategy, which establishes a teleological (rather than causal) relation among three relevant aspects of current and future reality: the observed behaviour, relevant aspects of physical reality, and future state of reality; with an actor presupposing that actions function to bring about future goals and that the goals are accomplished by the most efficient action available to the actor within the constraints of situation (Gergely, 2003). Taking this into account, the authors hypothesised that if infants noticed that the demonstrator did not use her hands despite the fact that they were free, they may have inferred that the head action must offer some advantage in turning on the light, and therefore used the same action themselves (Gergely et al., 2002). To test this hypothesis, Gergely and colleagues (2002) introduced two further conditions into the experiment: the “hands occupied” condition (wherein the model pretended to be chilly and wrapped a blanket around her shoulders, holding it with both hands) and the “hands-free” condition (wherein the model pretended to be chilly and wrapped a blanket around her shoulders, but liberated her hands). In both conditions, the model leaned down and illuminated the light box by touching it with her forehead. After one week, only children from the “hands-free” condition used the head action. As the model’s hands were free, the children supposed the head action to be the most efficient and thus that the model had a good reason to use it. They may have thought that they had missed some feature of the situation due to which the head action must have been performed, and thus saw the head action as relevant and part of some new information they should learn. In other words, in the “hands-free” condition, children perceived a mismatch between expectable and actual performed action, leading their attention to focus on the model’s action, which was interpreted as new and relevant information. As a result, both the goal and the means to accomplish it were imitated by the children. However, children viewing the “hands occupied” condition were more likely to use a more efficient way to illuminate the box, i.e. to use their hand. Given the situation and taking the teleological stance into account, children saw the head action as sensible and justified because the model’s hands were occupied, i.e. the head action was cognitively transparent and was not interpreted by the children as part of the new information. Consequently, the children reproduced the novel information (illuminating the box) by more effective means (using their hands). Given their own situation (in which their hands were free to use), they saw it as more effective and sensible to use their hand to illuminate the box. Importantly, whereas all the children in the experiment performed the hand action at least once, children in the "hands-free" condition performed the head action (imitative action) only after they had performed the hand action (emulative action). That is, even after the infants experienced that the effect can be produced by simpler hand action, the majority of participants in the hands-free condition were still motivated to re-enact the model's demonstrated (although less efficient) head action (Gergely & Csibra, 2006), likely for affiliative reasons.

These results suggest that children imitate selectively and that this process is guided and constrained by the evaluation of alternative means available *both* in relation to the model, and in relation to the infant himself (Gergely, 2003). In other words, children are selective in "*what* action to *imitate* to reach a goal, and *what* goal should be *emulated* rather than imitated under certain situational constraints" (Gergely, 2003: 206. Original emphasis). This is in contrast with Tomasello's cognitive transparency criterion, which predicts that children would imitate only new and cognitively transparent actions. In Gergely et al.'s experiment (2002), imitation occurred in a cognitively opaque condition (i.e. the unpredictable head action, when more effective means are at hand) because by creating a mismatch between expectations and actual performance it qualified itself as new and relevant. Children imitated this action even in the absence of cognitive insight – despite not knowing why the head action was performed they still imitated it. Taking into account these results, the authors (Gergely & Csibra, 2005) argue that Meltzoff's theory of children as blind imitators is too broad, because it predicts automatic imitation of any behaviour, and that Tomasello's theory with its cognitive transparency and novel response criteria is too narrow, because a large amount of truly novel and socially important behaviour is, in fact, cognitively opaque and yet children are still motivated to replicate it and learn it successfully.

In general, there are two lines of studies examining what cues trigger imitation and how selectively children imitate modelled behaviour. The first line shows that children are highly selective in imitating the actions of others. For example, Carpenter, Akhtar and Tomasello (1998) demonstrated that children copy only actions that have been previously marked as intentional by the model (saying “There!”) and were less likely to imitate methods and actions that have been marked as accidental by the model (saying “Whoops!”). Meltzoff (1995) showed that when the model tried but failed to provide an action, children did not copy observed actions but rather reproduced the goal behind the action. It was also shown that children choose who to copy by taking into account the model’s age (Seehagen & Herbert, 2010), situational constraints (Gergely, Bekkering, & Király, 2002), the causal relevance of the model’s actions (Brugger, Lariviere, Mumme, & Bushnell, 2007), the model’s reliability (Zmyj, Buttelmann, Carpenter, & Daum, 2010) and the model’s in-group vs. out-group membership (Kinzler, Corriveau, & Harris, 2011). Further, DiYanni and Kelemen (2008) demonstrated that children prefer to use a functionally affordant tool to accomplish the goal and ignore the model’s action when it is performed with a non-affordant tool.

However, the second line of research on children’s social learning demonstrates that children tend to replicate both the model’s causally relevant *and* irrelevant actions (Bauer & Mandler, 1989; Harnick, 1978; Lyons, Young, & Keil, 2007; Meltzoff 1988; Nagell, Olguin, & Tomasello, 1993; Sibulkin & Uzgiris, 1978), in spite of the fact that they are able to distinguish between irrelevant and relevant actions (Flynn & Whiten 2008; Gergely & Csibra 2003; Williamson, Meltzoff, & Markman, 2008). This phenomenon has been termed *overimitation* and it has been shown that children overimitate even in situations, when chimpanzees are capable of the correct identification of irrelevant steps (Horner & Whiten, 2005; Nagell et al., 1993; Want & Harris, 2002). For example, Horner and Whiten (2005) observed that children copied the irrelevant actions even in cognitively transparent conditions, when the irrationality of some of the model's actions should have been clear to them. Nagell and colleagues (1993) demonstrated that children copied the model's behaviour even when there was another more efficient option available. Furthermore, Lyons, Young, and Keil (2007) showed that children copied the model's behaviour even when they were specifically instructed not to do so. To explain overimitation, Whiten, Horner and Marshall-Pescini (2005) argue that overimitation is a strategy for learning causally opaque behaviour – for the sake of certainty and to avoid missing important elements in the behaviour, children overimitate and copy even irrelevant behaviours. The guiding principle seems to be that it is better to know more than to know less; irrelevant behaviours can be parsed out at a later stage through individual learning. Nielsen proposed that children overimitate in order to "satisfy social motivation, to fulfil an interpersonal function of promoting shared experience with others" (2008: 563). Similarly, Uzgiris (1981) argues that the motivation for copying modelled behaviour is that children try to engage socially, suggesting that children are interested in the action itself and not in the rationale behind the action. On the contrary, Lyons et al. (2007, see also Lyons 2009) argue that overimitation has a rational structure and that it "might result from the overextension of a normally adaptive learning process, one in which children use other's actions to imitatively learn about physical causality" (2007: 19751). More precisely, in their study the authors hypothesised that children would automatically encode all of the model's behaviour as causally relevant and interpret model's actions as being somehow connected to the inner workings of the object. Consequently, even though some of the model's action might seem pointless to the eye, there is a possibility that they have something to do with the object's non-visible structure and function. This leads to "distortions in causal beliefs" (Lyons et al., 2007) that are incorporated into children's representations of the object's structure. This, according to Lyons et al. (2007), makes overimitation an unavoidable process.

The *distorted causal belief* hypothesis has been contested by Kenward, Karlsson, and Persson (2011). In their experiment, the researchers asked the overimitating children to explain their actions and found that the majority of children could not explain the performance of unnecessary actions – the subjects were either unsure or did not know why the unnecessary actions should be performed. Kenward et al. (2011) conclude that if the case is that children cannot understand the mechanical causality of an object, overimitation is not an appropriate term to explain this kind of behaviour: "This is because implicit in the definition of the phenomenon of over-imitation is the assumption that the unnecessary action would be clear to the observing child" (Kenward et al. 2011: 1244). They suggest that what has been termed "overimitation" is instead better explained by the concept of "norm learning" (which is likely influenced by social motivations, as proposed in the afore-mentioned studies of Nielsen, 2008; and Uzgiris, 1981). Children might recognise some of the actions as irrelevant, but might see the whole procedure as a conventional practice, i.e. see all elements as obligatory or necessary to perform from a normative standpoint – a theory supported by recent research in developmental psychology (i.e. the theory of two cognitive stances). As some studies of preschool children have revealed, norm following play an important role not only in groups of adults, but also in children's lives. Children's awareness of normative structure and sources of normativity is discussed in the following section. This discussion will fill in the theoretical gaps connecting ritual and normative behaviours in a developmental framework before moving on to a description of how executive function has been measured, trained, and improved in the later sections.

3.3. Children's awareness and learning of norms and normative structure

To a large extent, human social life is organised by rule-governed practices and activities with conventional (i.e. what one typically does) and normative (what one ought to do) structures, including linguistic behaviour, ideologies, or usage of cultural artefacts. In fact, normative conventions are central to the functioning of human societies, as they navigate everyday interactions and guide our judgement and moral behaviour. All the normative conventional structures have some characteristic features (Rakoczy & Schmidt, 2013): (1) normative force and generality – they guide social practice and serve as both reason for acting and grounds for critique; (2) conventionality – as conventional norms are socially constructed and a result of shared acceptance, they are arbitrary (they could have been different); and (3) context sensitivity – apply to specific contexts in which they prescribe what is appropriate. Social norms and conventions are powerful to the extent that individuals either conform to them, or risk being ostracised, ridiculed, or punished. Thus, early on in development children begin to conform to the rules issued by adults.

To become successful members of a society, young children must learn and understand that members of their group do things in a certain way, i.e. that some behaviours and actions have conventional nature and normative quality. As soon as during preschool years, children already understand the difference between norms and conventions (e.g. Schmidt, Rakoczy, & Tomasello, 2012; Smetana & Braeges, 1990; Turiel, 1983), and they assume that unlike idiosyncratic matters (ex. preferring tea over coffee) social conventions are shared across a community (e.g. linguistic knowledge) (Diesendruck & Markson, 2011). Children also distinguish between moral norms, which are applied universally (e.g. one should not steal) and conventional norms, which are valid only in specific contexts (such as norms valid for a specific social group in question, e.g. shaking hands when being introduced to someone) (e.g. Nucci & Nucci, 1982; Turiel, 1983). Children can discriminate between conventional rules (one cannot play in the snow without clothes) and natural contingencies (children cannot fly; Kalish, 1998) and appreciate that rules violations can result in upset (a mother might be sad when her son violates a rule; Keller, Gummerum, Wang, & Lindsey, 2004).

Recent research provides evidence that children as young as 2-3-years old already engage in and have grasp of some conventional and normative practices, namely rule-governed games. Warneken, Chen and Tomasello (2006) (and also Rakoczy 2008; Rakoczy, Warneken, & Tomasello, 2008) demonstrated that even children as young as two years old require others to follow the rules and act according to their roles in a game and they protest when someone is violating these rules and fails to conform to their expectations in terms of required behaviour. Interestingly, Rakoczy et al. (2008) found that when the violator clearly demonstrated that he or she was not going to play the game, children did not protest against this rule-violating behaviour. This result suggests that children did not only understand that the game had a normative structure with rules to be followed, but were also sensitive to situations when that structure was applicable and when it was not. Moreover, action violating the rules of the game are not viewed as based on subjective perspective, but rather as objective mistakes (Rakoczy, 2008). This indicates that from a very young age children are able to distinguish people according to the group membership, which allows them to decide which behaviours to engage in, which people to interact with, and which behaviours and beliefs to learn and follow.

At the age of two, along with the language acquisition, children start to engage in relatively rich array of communicative acts in accordance with conventional and normative rules of the language. Language, besides being a conventional normative system by itself, is also an effective way of expressing norms and conventions, as well as their violations. For example, Ingram and Bering (2010) reported that the majority of speeches describing peers' behaviour concerned norm violations. Developmental research on children's norm acquisition reported that children spontaneously criticised, corrected and objected when an actor violated game rules (Warneken, Chen, & Tomasello, 2006; Rakoczy 2008; Rakoczy, Warneken, & Tomasello, 2008). Importantly, children used objective language. This result suggests that children do not understand normative conventions as just applying when they themselves are affected, but in a more generally applicable way – they understand them as agent-neutral forms of actions and behaviours that should be obeyed by all (Rakoczy & Schmidt, 2013; Schmidt & Tomasello, 2012). This result shows the fact that a child does not follow a personal interest, but an interest as a member of a group. Children's appropriate use of normative vocabulary (right/wrong, must/ought, etc.) also demonstrates at least some understanding of the origins of social norms as agreements of individuals.

A study from Göckeritz, Schmidt and Tomasello (2014) examined 5-year-old children's understanding of normativity and found that children were able to independently (without adults' supervision or guidance) create their own set of social norms and to align their behaviour accordingly. This demonstrates that children at this age already understand that norms are based on agreement. However, when interacting with novices, children did not start a new round of negotiation. Rather, they transmitted the norms in a stipulated way, as objectively valid. Once accepted as a general rule, even maladaptive or less effective norms were transmitted and normative language was used to justify this behaviour. This supports the findings of Kenward, Karlsson and Persson (2011) that overimitation of causally irrelevant actions can be explained by norm learning. Thus, children view following rules of a game not as a personal preference but as something everybody ought to conform to.

Because norms apply to everyone, the most effective way to express them is to use generic normative language (this is how *one must* do it, this is *the way it* has been done, etc.) Generic normative statements "carry special weight and guide learning about the social world, for instance by leading children to make generalizations even in the face of contradictory evidence and also to infer essentialist features for social categories from generic language" (Göckeritz, Schmidt, & Tomasello, 2014: 83). The generic normative statements thus represent a powerful linguistic device to point to and enforce normative conventions, and its use reveals understanding that these rules apply to more than a single individual, and are valid and binding in agent-neutral ways.

Although recent developmental research provides fruitful description on children's capacities for reasoning and behaving normatively, the question of what are the learning mechanisms behind these capacities has not been thoroughly investigated. Learning of norms is undoubtedly a complex learning problem – during the first years of life children have to figure out which of the behaviours and actions they encounter are normative, and which are simply common ways of actions, are affordant or rational (known as the inductive problem in learning of concepts and social categories). Although making an initial normative generalisation might be relatively low cost, it must be abandoned in case of counterevidence: demanding that others behave in a particular way that is not in accordance with an established norm is likely to result in peer rejection, ridicule or even ostracism. Thus, the ability to make generalisations about the world is a critical component of human social life. The question then is, what is necessary for children to recognise action or behaviour as normative? The research on natural pedagogy reveals, that children make generalisations when they recognise ostensive communicative pedagogical cues (e.g. eye gaze) indicating that they are being taught something kind relevant and important (e.g. Csibra, 2010; Futó, Téglás, Csibra, & Gergely, 2010); and also use ostensive pedagogical cues to guide inferences about what consitutes a novel category (Butler & Markman, 2014). Butler, Schmidt, Bürgel and Tomasello (2015) found that pedagogical cues also play role in children's normative reasoning. More specifically, in their research children made stronger normative inferences (i.e. persisted in their normative protest when the actions were changed to bring about the same goal) about novel actions when they saw them pedagogically demonstrated, comparing to the same actions carried out in an intentional but non-pedagogical manner. Although some research shows that children do make normative inferences from watching a confident actor performing an action without pedagogical cues (Schmidt, Rakoczy, & Tomasello, 2011), it seems that pedagogical cues play role in strenghtening the normative inferences about observed action. Although this work provides further insight into our understanding on children's normative reasoning and social learning, it only examines instrumental learning and use of artifacts. More research on learning of conventional behaviours (i.e. rituals) is needed to fully grasp learning processes underlying children's understanding and learning of norms.

The norm psychology which is taken for granted in human groups is an anomaly in animal world. No other species shows any indication of following and enforcing social norms in an agent-neutral way. Tomasello (2009) speculates that the reason for this absence is that normative behaviour, which is a result of shared assignment and acceptance, presupposes capacities for shared intentionality. Recent research suggests that such shared intentionality is uniquely human feature (von Rohr, Burkart, & Schaik, 2011; Tomasello, 2009). Why and how such norm psychology evolved? According to culture-gene coevolution, social norms are adaptive way of achieving cooperation and conformity within a group. As such they enable group coordination, and processes of cultural and genetic group selection (Chudek & Henrich, 2011). Young children quickly learn new norms, reason about them systematically, follow and enforce them in agent-neutral ways. By doing so, they learn how things ought to be done in a certain group and thus contribute to the processes of tradition, which enable stability necessary for cumulative cultural evolution (Tomasello, 1999). Further, unique capacity for creating collective rules constitutes institutional reality – the reality of actions, objects and facts which only exists because humans take it to exist (Searle, 1995). According to Rossano, ritual plays a key role in this process: "the ability to consciously ritualize actions created the necessary conditions for the creation, transmission, and reinforcement of social norms. These necessary conditions are pedagogical and emotional – that is, ritualised actions teach normative content and emotionally bind people to that content. Ritualised actions are effective for this purpose because they signal an intentional state of mind that the observer uses to extract social rules" (2012: 532).

Given the information above, it is clear that the ability to learn normative conventions is a crucial aspect of human social cognition. Furthermore, it also appears to be the case that these cognitive facilities are likely to be executive function demanding. Previous research suggests that although executive function is an ability that is not fully developed until adulthood, it undergoes important structural changes during childhood. The following sections will discuss previous literature on the measurement and training of children's executive function. The research described in these sections was used to design the measures and intervention that are discussed in next chapters of this thesis.

3.4. Measuring children's executive function

When working with samples of children, researchers need to be aware of some specifics that come up when dealing with non-adult participants. Research with children not only presents unique ethical challenges that result from having to take into account children's vulnerability and immaturity, the researchers must also choose and design methods that enable children to express their views and abilities. Because of the variability in attention span, the methods chosen for data collection should be perceived by children as interesting and fun, so that the subjects are motivated to participate without losing interest or being bored, anxious or afraid. Researchers need to engage children's interest by using methods that take into account children's linguistic competence and potential differences in background knowledge. The methods must be designed to minimise the complexity of responses and use basic concepts that children from different backgrounds can be expected to understand. For these reasons, it might not always be a good idea to use the same or slightly modified versions of experiments originally designed for adults (e.g. a stimulus-response compatibility task, go/no-go task, stop signal task, etc.), which has often been the case when researching executive function in children. Such methods might facilitate data collection from adult samples, but children might find them strange or boring. Moreover, "remarkably little is known regarding the extent to which they provide equivalent measures of the underlying constructs in participant of different ages" (McAuley & White, 2011: 454-455).

Over the years of researching children's executive function, many tasks have been used and designed to assess this ability. One of the traditional methods of assessments of behavioural regulation, which is an observable behavioural output of executive function, has been teachers' and parents' reports. Cameron Ponitz and colleagues (2008) pointed out that, although these might be useful for understanding the perception of children's behaviour and identifying individual components of behavioural regulation, they might, on the other hand, be based on (parents' and teachers') perceptions rather than child's actual behaviour, or might be biased. Moreover, such reports may have limitations in relation to cross-cultural comparison because they report on culturally biased teacher and parent expectations of children's conduct (Wanless et al., 2011) and thus cannot be used in comparative or cross-cultural research.

Other tasks developed to measure behavioural self-regulation are often designed for laboratory use or for use with clinical populations. Furthermore, all measures (with one exception – Luria's Hand-Game, in which children are instructed to tap a wooden dowel twice when the experimenter taps once and to tap once when the experimenter taps twice) require specialised materials that are often not available in a normal setting (for example, computer software and expensive tools). Some of them require fine motor coordination, which might cause children to fail in the test not because they have low powers of self-regulation but because they do not have the fine motor coordination to complete the tasks. Furthermore, some of the samples in previous research on children's behavioural regulation did not include sufficiently large numbers of children (for a detailed review of tasks measuring behavioural self-regulation in children, see Table 4).

Task	Recent reference	Age	N	Description	Time and materials required	Scoring
Attention Network Task	Rueda et al. (2005)	6–9	48	A modified flanker task using fish: children are asked to help feed the central fish by pressing a button corresponding to the direction in which the middle fish is swimming.	30 min; computer and software	Reaction time
Bear and Dragon	Carlson et al. (2004)	3–4	49	Children are given commands by a bear and dragon puppet, and told to respond only to the bear's commands.	Several minutes; puppets	0–10
Day–Night Stroop	Berwid et al. (2005)	3,5–7	71	Children are shown 16 cards on which "day" or "night" is pictured; they are instructed to say "day" to the night card and "night" to the day card.	4–5 min; 16 cards, videotape, stopwatch	0–16
Dimensional Change Card Sorting Task	Müller, et al. (2006)	3–5	52	Cards with coloured shapes that can be sorted differently, either by colour or shape. Children are first told to sort by pictures one dimension and then the other.	About 10 min; cards with pictures	0–12
Go/No-Go Task	Simpson and Riggs (2006)	3,5	120	Children must press or refrain from pressing a button when a particular stimulus occurs.	15–20 min; apparatus and/or laptop	0–10
Grass and Snow	Carlson & Moses (2001)	3–5	262	Children must point to a white card when the experimenter says "Grass," and a green card when she says "Snow."	5–10 min; coloured cards	0–16
Luria's Hand-Game	Fahie and Symons (2003)	5–9	26	Children first copy the researcher when he or she knocks on the table or points a finger; children are then instructed to point when the researcher makes a fist and vice versa.	Several minutes	0–2 (pass/fail)
The Matching Familiar Figures Test	Welsh et al. (1991)	3–12	100	Out of six figures, children choose the one that most precisely matches the standard. A speed-accuracy tradeoff typically produces more errors.	Several minutes; pictures for matching	1–4
Self-Ordered Pointing	Hongwanishkul et al. (2005)	3–5	98	Children are presented with a binder composed of pages divided into four sections and are instructed to go through each page and point to a different picture on each page.	15–20 min; binder with pictures	Number of items remembered (until failure)
The Test of Everyday Attention	Manly et al. (2001)	6–16	293	A non-computerised measure that uses game-like tests to assess three different forms of attention. Battery costs $530.	60 min; administration materials, stimulus cards	Standard scores are calculated
Tower	Kochanska et al. (1996)	2–3,5	99	Children are asked to build a tower with an experimenter, and shown how to take turns adding blocks to the tower. Score is based on the number of turns children offer to the experimenter.	20 blocks of varying sizes	0–0,5 (proportion of blocks placed by tester)
Tower of London	Ward et al. (2005)	7–21	90	Children are asked to make their tower match a picture. Then, after the trial run they are asked to make their tower match the picture as quickly as possible, with a restriction on the number of times they can move the balls.	15–20 min; book with tower pictures, ball and peg apparatus, stopwatch	0–27
Working Memory Test Battery for Children	Pickering and Gathercole (2004)	4–15	83	Children are tested individually in three sessions over a 10-day period. Of the 10 tests, nine are working memory subtests. Testing kit costs approximately $260.00	60 min; 20 blocks of varying sizes manual, record form, mazes	Standard are scores calculated with norms

Table 4: Tasks measuring children's behavioural self-regulation (Cameron Ponitz, et al., 2008)

To avoid these problems, in 2007 McClelland and her colleagues developed a direct measure of children's behavioural self-regulation that is easy to administer, does not require the use of special materials, has a game-like format and is easy to use in any environment. They called the game the Head-to-Toes task (HTT) and it has since then been widely used in recent research on children's executive function and behavioural self-regulation abilities (McClelland et al., 2007; Cameron Ponitz et al., 2008; 2009; Tominey & McClelland, 2011; Tominey & McClelland, 2013; Wanless et al., 2011). Because of the previous research on the HTT task and its modifications, which is presented further on, it was chosen to be used as a measure of children's executive function in this study. In this task, children are asked to respond naturally to commands such as "Touch your head!" and "Touch your toes!" As the next step, children are instructed to switch the rules and respond to the commands the opposite way (i.e. to touch their toes when they are asked to touch their head, and to touch their head when they are asked to touch their toes). The HTT task requires children to integrate three executive function skills: (1) attention – children must pay attention to the researcher's instructions and commands; (2) working memory – children must use the working memory to remember the new rule while processing commands; and (3) inhibitory control – children must inhibit their automatic response to a command while responding in the reversed, but correct, way. Blair (2002) reports that integration of these cognitive skills enables children to regulate their behaviour, mentally move forward in time and plan their future actions. Higher scores in the game indicate higher levels of behavioural self-regulation. McClelland et al. (2007) used the HTT task to measure children's behavioural self-regulation and found that this measure was positively and significantly related to gains in emergent literacy, vocabulary and mathematics skills (using the Woodcock-Johnson Psychoeducational Battery III Test of Achievement; Woodcock & Mather, 2000) in middle- and upper-middle-class American preschoolers (N = 310, 4–6-years-old; McClelland et al. 2007: 950). The preliminary validity of the HTT task was determined by comparing scores to other measures of behavioural self-regulation, namely the teacher-rated Social Skills Rating System (Gresham & Eliott, 1990) and the Child Behaviour Rating Scale (CBRS; Bronson, Tivnan, & Seppanen, 1995). Both scales were significantly related to scores in the HTT task (all $p < .01$). The reliability of the HTT task was also assessed, demonstrating variability in scores. Examiners working with the task showed a very high inter-rater reliability (α = .98). The researchers used Hierarchical Linear Modelling (Raudenbush & Bryk, 2002) to examine the influence of growth in behavioural regulation (from autumn to spring) on growth in emergent literacy, vocabulary and mathematics skills. They found that higher behavioural regulation scores in autumn and spring were associated with increased academic outcomes (all $p < .05$). Overall, the HTT measure "reliably captured individual differences and gains in attention, working memory and inhibitory control" (McClelland et al., 2007: 954-955). McClelland and colleagues (2007) argue that as children learn to focus their attention and regulate their automatic behavioural tendencies, they become better able to regulate their behaviour in the classroom (which includes paying attention, completing tasks and remembering instructions), and thus take greater advantage from the educational process, which was reflected in achieving better academic results.

In 2008, Cameron Ponitz and colleagues closely examined construct validity, examiner reliability, sources of variations and background characteristics for the HTT task. To test task reliability, variability and construct validity, the researchers administered the HTT task to 445 American children in the three to six-year age range; the children were recruited through their schools. They also examined the effects of socio-cultural variables (gender, months of prior childcare experience and mother's education) on the HTT scores.

The authors found that variability was present for all ages of children. Analysis of the scores revealed that they differed by age group but not by number of task administrations, suggesting that age group, but not the number of task administrations, was associated with an improvement in the task (Cameron Ponitz et al., 2008). Convergent validity of the HTT task was established by comparing the task scores with the CBRS rating: children who received higher scores in the HTT task were rated higher by the teachers on behavioural regulation items in the CBRS (all $p < .05$). Examiners of the task achieved very high inter-rater reliability ($\alpha = .98$). Overall, the results of Cameron Ponitz et al. (2008) meet generally established reliability levels (Landis & Koch, 1977). The influence of the child's characteristics on the HTT task performance are as follows: boys scored about one point lower than average ($t = - 2.89$, $p < .01$); having a parent with two more years of education than average was associated with scoring 0.5 points higher than average ($t = 2.13$, $p < .05$); and being part of a minority had a negative effect of low significance ($t = - 1.94$, $p < .05$). In sum, except for age (the scores differed for six-month age groups, $F_{(8, 1320)} = 29.55$, $p < .01$), the effects of a child's background characteristics were small: mean scores improved as children became older, but the effects of the parent's education and ethnicity were low. Because 30% of participating (USA) children were non-Caucasian ethnic minority, and the sample also included children from Title One (school systems for students at risk of failure and living at or near poverty), Head Start (early childhood education program for children from low-income families, also providing health, nutrition, social, and other services), and NAEYC-accredited schools (The National Association for the Education of Young Children, which promotes high-quality early learning from birth based on research and practice), the results suggest that the HTT task is a valid method to measure self-regulation in children from diverse backgrounds and, as the authors conclude, means it is a “reliable and valid measure of developing behavioural regulation” (Cameron Ponitz et al., 2008).

In 2009 study, Cameron Ponitz and colleagues drew attention to the fact that there was a ceiling effect pattern for regulatory tasks for five-year-olds (McClelland et al., 2007; Cameron Ponitz et al., 2008). On the basis of these findings, they developed a new version of the HTT task, namely the Head-Toes-Knees-Shoulders task (HTKS). The goal of this development was to increase the task’s complexity and variability, while maintaining the advantages of the HTT task. The HTKS task requires children to remember four rules: “touch your head” is first paired with the “touch your toes” command; then, two more commands are added – “touch your shoulders” is paired with “touch your knees” (for a detailed description, see Appendix 1). Participating children receive 20 commands in randomised order (e.g. Touch your head!, Touch your shoulders!, etc.) and receive 2 points for correct reaction (e.g. touching their feet as a response to “Touch your head” command), 1 point for a self-correcting response (e.g. reaching for their head but then correcting themselves and touching their feet as a response to “Touch your head” command), and 0 points for incorrect response (e.g. touching their head as a response to “Touch your head” command). Thus, the minimum score a child can get is 0, and maximum 40 points.

Cameron Ponitz et al. (2009) examined the psychometric properties of the HTKS task, links to teachers’ and parents’ ratings, and the relation between a subject’s scores in the HTKS task to a subject’s academic achievement (using the Woodcock-Johnson Psychoeducational Battery III Test of Achievement; Woodcock & Mather, 2000) and social behaviour (using the Bronson Social Task and Skill Profile). The authors used the HTKS task as an observational measure of children’s goal-oriented behaviour (N = 343, mean age 5.48) and strategies to regulate their own behaviour in academic and other social situations. The descriptive statistics demonstrated individual variability in the HTKS scores. Construct validity was explored by comparing HTKS scores with parents' ratings of attentional focusing and inhibitory control, as well as the teacher's ratings of behavioural self-regulation. Over time (from autumn to spring), children made significant gains in scores (improving from 27.5 points to 31.3 points, t = - 8.55, p < .01) and, importantly, most children scored within the task range (not at floor or ceiling levels). Higher HTKS scores were positively correlated with both these measures (all p < .01). Children with higher HTKS scores measured achieved higher scores in mathematics (the HTKS score was a significant predictor, d = .26), literacy (the HTKS score was a significant predictor, d = .27), vocabulary (the HTKS score was a significant predictor, d = .19) and achieved higher levels in the teacher-rated behavioural regulation questionnaire (the HTKS score was a significant predictor, d=0.28). Another significant predictor of children's academic achievement was parents' education. However, HTKS did not predict children's interpersonal skills, where older children received higher ratings than younger children (d = .22). In sum, HTKS proved to be appropriate for children over the age of five. It showed adequate reliability and variability, and positively predicted children's academic achievements. Cameron Ponitz et al. (2009) explain the result that HTKS did not predict children's interpersonal skills by the fact that interpersonal skills require the regulation of emotions in social situations. Because it is not a feature of HTKS to modulate emotionality, it is not a reliable measure of children's interpersonal skills[22]. Instead, with four rules to remember, the HTKS "draws heavily on working memory and attentional focusing" (Cameron Ponitz et al., 2009: 614).

[22] This is not to say that executive function is not tied to interpersonal skills, but simply that HTKS is likely not an appropriate task to assess these skills.

Aside from the United States (McClelland et al., 2007; Cameron Ponitz et al., 2008; 2009), which represents the vast majority of developmental research, the HTKS task was also piloted in South Korea, Taiwan, and China in an intercultural study by Wanless and her colleagues (2011). The authors stress the fact that behavioural regulation must be examined in various societies in order to understand its unique properties and meaning. In the sample, consisting of 814 children from the countries mentioned above (the age range was 3.12–6.5 years), the authors showed that higher HTKS scores were significantly related to higher mathematics, vocabulary and literacy skills, beyond the influence of demographic variables. Variability of scores was found in each of the societies. During the research, Wanless et al. (2011) also found some differences between the societies: (1) child and parents' education and child's gender were significantly related to HTKS scores in the United States but not in other societies; and (2) higher HTKS scores were significantly related to higher teacher ratings of behavioural regulations in the United States (r = .29) and South Korea (r = .23) but not in Taiwan (r = .09) and China (r = .12). The authors explain the former variation by postulating that behavioural regulation is promoted more strongly regardless of gender in the Asian societies. The latter variation may be explained by two factors: the low familiarity of the teacher in Taiwan with the children (the data were gathered at the beginning of the school year) and the particularly large class sizes in China. However, HTKS reflected individual variations in all four societies and the scores covered the entire range of possible HTKS scores. This suggests that HTKS was not too easy or too difficult for the children and supports the view that HTKS scores capture variability in children's behavioural regulation (McClelland et al., 2007; Cameron Ponitz et al., 2008; 2009). Wanless et al. (2011) sum up by stating that HTKS scores reflect behavioural regulation in these four societies and that it is therefore an important measure of early academic success.

Since the HTKS task (1) has proved to be valid and reliable measure of children's executive function skills, (2) is adequately easy and fun for children, (3) is widely applicable in diverse environments (by not requiring the use of special equipment), (4) tests executive function components without being tied to interpersonal skills, and (5) was used in cross-cultural research, it was chosen as the measure of children's executive function abilities in this study.

3.5. Training and improving executive function: Intervention studies on the enhancement of self-regulatory skills

Executive function abilities are critical for developing and maintaining skills that are valued in the modern world, such as creativity, discipline, self-control, flexible thinking, and gaining control over what we do and how we behave. These abilities make it possible to mentally play with ideas, adapt to changed circumstances, take the time to consider what to do next, be focused, resist temptations, deal with novel situations, plan, and use feedback to adjust and modify future responses and behaviours (Bryan & Luszcz, 2000; Diamond, 2013; Rabbit, 1997). Importantly, it has been found that executive function early in life predicts lifelong achievements and quality of life, including academic success: children's behavioural self-regulation predicts academic achievement in preschool (McClelland et al., 2007), in elementary school (McClelland et al., 2000), and it predicts high school graduation and college completion (McClelland et al., submitted; Vitaro, Brendgen, Larose, & Tremblay, 2005). Moreover, poorer executive function abilities have been found to be connected to conduct disorders among adolescents, aggressive behaviour and impulsive responses in conflict situations (Gorenstein, Mammato, & Sandy 1989; Moffitt & Henry, 1989; White et al., 1994). Positive correlations between difficulties in executive function and disruptive and problematic behaviour have also been found as early as in preschool age (Cole, Usher, & Cargo, 1993; Speltz, DeKylen, Calderon, Greenberg, & Fisher, 1999). In general, children with difficulties in executive function fail to form inter-personal relationships with their class-mates and teachers, and have lower levels of academic skills, which place them at risk of various negative consequences, such as peer rejection, school dropout, antisocial and aggressive behaviour, etc. (O'Shaughnessy et al., 2003).

Based on previous research it is likely that finding effective ways to improve executive function abilities (especially those in children) will help individuals to make more advantageous decisions, better work toward goals, and to secure a more satisfactory quality of life. Dowsett and Livesey (2000) propose that "experience, conceptualised as repeated exposure to tasks demanding reflection on rules and the deliberate selection of the most appropriate rule, could accelerate the acquisition of rule complexity and reflection, thus increasing control over thought and subsequent action" (2000: 163). There is strong evidence that executive function abilities can indeed be improved. Different approaches have been used and there is now a body of results suggesting that, by carefully designing interventions, executive function can be trained and that this knowledge is transferable to other tasks, as demonstrated through tasks among subjects of various ages (e.g. the study with three–four year-olds by Kloo & Perner, 2003; the study with young adults by Dowsett & Livesey, 2000; the study with older adults by Kramer & Kray, 2006; the research of Karbach and Kray from 2009 with eight–ten, 18–26 and 62–76 year-old age groups).

In the study by Dowsett and Livesey (2000), the effects of intervention on the development of executive control in 160 three–five-year-olds were examined, using the go/no-go task, in which participants are instructed to respond to target stimuli, but to refrain from responding to non-target stimuli. It was shown that parametrically increasing the number of target (go) stimuli preceding a non-target (no-go) stimulus increase the task difficulty – as the number of preceding consecutive go trials increases, people show a greater proportion of false alarms to no-go trials and longer reaction times to go trials, which makes this manipulation particularly sensitive test of developmental changes in attentional control. Using this task, the researchers measured the executive function performance of participating children in the first phase of this experiment and found that in this phase, children exhibited similar levels of inhibitory control. The children were then assigned to three groups: (1) a practice group, where children practised the same go/no-go task; (2) a training group, where children regularly played two games: a modified version of the Wisconsin Card Sorting task[23], and a version of the Stop Signal paradigm (Logan & Burkell, 1986), the so-called Change Task[24]; and (3) a control group – children with no training. The authors showed that the results of performance in the go/no-go task for both the training and practice group had improved significantly, with the training group producing the greatest improvement. The authors explain this effect by the fact that the training task made greater demands on working memory and required more representational flexibility than the practice task. Dowsett and

[23] Participants are required to differentiate between three colours – red, blue, and green, and three shapes – square, triangle, and circle; and are required to “guess” which criterion – colour or shape – they are to use when sorting the cards.

[24] Participants are required to identify coin size – large and small, as well as paper colour – black and white. In the first stage of the task, children are instructed to place coins, one at a time, a cardboard using one criterion – a paper colour, and when the experimenter says “change”, participants are required to alternate response according to the criterion of a different paper colour. In the second stage, participants are required to alternate their response according to two criteria: coin size and paper colour, i.e. black paper – large coins; white paper – small coins.

Livesey thus concluded that “experience with executive skills task could in fact enhance inhibitory control” (2000: 170) and that this ability can be accelerated even in three-year-olds. Similarly, Rueda, Posner and Rothbart (2005) suggest that, although executive control and attention appear to develop with age, they can be improved by means of educational intervention. Their research involved 49 four- and six-year-olds divided into experimental (to be trained) and control (no training) groups. After five days of training, the executive function of the experimental group improved significantly (measured by an attention network test, an Electroencephalogram, and intelligence test scores).

Importantly, for the intervention to enhance the future quality of children’s life, its effects should extend and generalise to unpractised executive function skills. For this reason, computerised training with computer games that increase working memory demands, and aerobic exercises focused on flexibility and creativity, do not appear to be the ideal solution: although both kinds of intervention improve some executive function skills, others remain unaffected (as summarised by Diamond, 2014; and Diamond & Lee, 2011). Means of intervention that have proven to be effective include traditional martial arts training, which incorporates ritualistic aspects that lead students to greater gains in executive function, extending to various cognitive aspects (attention, mindfulness, etc.) and affective aspects (perseverance, discipline, aggressiveness, etc.) In the study conducted by Trulson (1986), martial art students were divided into two groups: one group practised traditional Tae-Kwon-Do, which emphasises the psychological and philosophical aspects of the martial art (respect for others, patience, perseverance, responsibility, and building confidence and self-esteem) and included some ritualistic activities – the students had to sign a pledge to use their skills for certain purposes only (such as self-defence, protection of oneself and of the weak, etc.), and each class started with a period of meditation to focus students’ attention on their practice sessions and to reflect on their positions and goals in life. The other group of students practiced a modern version of the martial art, without emphasising psychological and philosophical aspects, incorporating only fighting techniques and self-defence training. Trulson (1986) found that compared to the students of modern Tae-Kwon-Do, the students who experienced the traditional conditions had below average aggressiveness scores, lower anxiety levels, and increased self-esteem and social adroitness.

In a similar study, Lakes and Hoyt (2004) substituted standard physical education classes of half of their participants (kindergarten through Grade 5) for traditional martial art (Tae-Kwon-Do) classes, which included traditional ritualistic aspects: all the participants wore traditional uniforms, all the classes began and ended with the students lining up in a particular formation and bowing to an instructor, the students spent a few minutes sitting in meditation focusing on their breathing and were then encouraged to ask three questions that promoted self-monitoring, i.e. (1) where am I? (2) what am I doing? (3) what should I be doing? Using self-ratings, teacher ratings, task performance and behavioural observations, Lakes and Hoyt (2004) found that the participants assigned to the martial art group showed greater cognitive, affective and physical self-regulation, and had greater gains in prosocial behaviour than their peers in the control group. Along with Trulson (1986), Lakes and Hoyt (2004) emphasise that to promote these qualities in children, it is important to utilise a *traditional* martial arts programme, which integrates psychological and philosophical training and emphasises character traits such as responsibility, perseverance and respect.

Taking the results of intervention studies and their importance in improving children's academic skills into account, new school curricula and add-ons to classroom curricula (such as *Tools of the Mind*, and *Promoting Alternative Thinking Strategies curriculum – PATHS*) have been developed to enhance children's self-control abilities. Using the Dots task[25] and the Flanker task[26], Diamond and her colleagues (2007a) measured the executive function of 147 children (mean age 5.1 years) divided into two groups, with one group of children assigned to the classroom, where a new curriculum with executive function-promoting activities – Tools of the Mind (Tools) – was used. The other group was assigned to the classroom with a curriculum not addressing executive function development. The Tools curriculum involves 40 activities to facilitate memory and attention and thus promotes the development of executive functions. Diamond et al. (2007b) reported that children from the Tools classroom responded correctly on more tasks in the Dots task than the children from the other classroom, with a statistically significant linear trend of improvement from the first to the second year of participation. In the Flanker task, children from the Tools classroom responded correctly on more trials than children from the other classroom. The experimenters controlled for variables such as family income, children's age and mother's education and the conclusion in this regard was that children in the Tools classrooms did not perform better because of socioeconomic variables – both groups were matched on these. This demonstrates that it was not children's socioeconomic background but rather the targeted intervention on executive function that successfully improved children's behavioural self-regulation and academic achievement.

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[25] In the congruent condition of the task, participants are required to press the button at the same side as the symbol appears on a computer screen; in the incongruent condition participants are required to press the button on the opposite side of the symbol requiring inhibiting the tendency to respond on the side where a stimulus appears.

[26] The task that requires focusing on a central stimulus in the centre – circle or triangle, inhibiting attention to the large shape surrounding it; with the next stage being reversed, i.e. requiring to focus on the outside shape, inhibiting attentional focus on the inside shape. Congruent, e.g., ○ inside ○, and incongruent, e.g., Δ inside ○, trials are used.

To ensure wider accessibility to intervention (many studies are focused either on improvement of executive control in experimental settings or on highly developed schooling programmes), Megan McClelland and her colleagues designed and tested a series of circle time games for easier classroom implementation. The circle time games are adaptations of children's common games (e.g. "Red light, purple light" being an adaptation of "Red light, green light") and they all include music and movement to make them engaging for children. In the games, children are required to listen to and remember instructions, attend to new sets of instructions and flexibly switching between them. The playgroup sessions start with a greeting song and end with a goodbye song to mark the transition from the educational setting to the playgroup environment, and vice versa. As the games progress, additional rules are introduced, thus making greater demands on children's executive function.

Tominey and McClelland (2011; see also Tominey & McClelland, 2013) found that circle time games designed to help children practice attention, working memory, and inhibitory control significantly improved behavioural self-regulation. They tested the improvement of academic outcomes of 65 children using the Woodcock-Johnson Psychoeducational Battery III after the intervention (mean age at the beginning of the study: four and a half years), with self-regulation measured by the previously mentioned HTKS task. During the intervention phase, half of the children were randomly assigned to participate in the intervention treatment group. For over eight weeks, this group was taken out of the classroom twice a week to participate in group circle time game activities, with each session lasting 30 minutes. Each session started with the greeting song to help children with the transition from classroom to the playgroup setting. Similarly, before returning to the classroom, each session ended with the goodbye song. During the session, children played the circle time games, which were designed to practice inhibitory control (starting and stopping in response to different oral and visual cues), attention (performing specific behaviours in response to various cues, and performing the opposite) and working memory (remembering the rules and instructions). Some of the games used were, for example, *Red light, purple light* and *Sleeping, sleeping, all the children are sleeping* (for details see Appendix 3). The results showed that intervention participation significantly predicted HTKS score gains in children with low initial HTKS scores: their HTKS gains over the year were significantly predicted by treatment group attendance and the number of playgroup sessions. The authors conclude that the circle games were indeed related to a significant improvement in self-regulation skills and academic achievements. The intervention helped children from economically disadvantaged families (i.e. with fewer economic and academic resources, more punitive discipline and higher rates of chronic illness), which are likely to accumulate risk factors that affect a child's outcomes, to improve their attention, inhibitory control and memory – skills that have been found to predict academic achievements (Diamond et al., 2007b; Cameron Ponitz et al., 2008; 2009; McClelland, 2007; Tominey & McClelland, 2011; Wanless et al., 2011). Importantly, the teachers of children participating in the study by Tominey and McClelland (2011; see also Tominey & McClelland, 2013) reported that the games were easy to implement in the classroom environment with large groups of children with various levels of self-regulation skills; and were fun and effective in promoting these skills.

Although the correlations between self-control abilities and academic and social success are well documented, we lack any description of the precise and specific causal (cognitive and behavioural) factors and mechanisms that underlie these correlations. The intervention studies mentioned above suggest that the implementation of routinised activities is effective for improving self-control-related cognitive mechanisms: In the circle games, working memory is improved by adding more instructions and rules (adding more procedural steps), which create more processing demands on working memory, because the participant must remember initial instructions while processing the new ones. The child must also pay attention to environmental stimuli and attend to relevant information to carry out more adaptive behaviour; as well as inhibit immediate impulses and inclinations in order to respond in an appropriate way (higher normativity, which includes the following of cognitively opaque rules with non-obvious goals). More procedural steps, higher normativity and rigidity (including deference to socially stipulated normative conventions), and goal demotion are some of the crucial features of ritualised behaviour (Boyer & Liénard, 2006; Legare & Souza, 2012; Legare et al., 2015).

3.6. Method

Given the findings reviewed above, it is predicted that rituals, with their increased demands on working memory, attention and inhibitory control, enhance executive function abilities: the participation in rituals, which consist of adherence to socially stipulated rules and the requirements to precisely replicate these rules in appropriate contexts and ways, requires one to employ executive function abilities in order to comply to different social requirements. It is likely that individuals with better executive function abilities are better in conforming to normative conventions and are consequently better able to enjoy advantages of group membership and peers' acceptance: in order to conform to the social rituals and conventions (norms, beliefs, ideologies, etc.) individuals must inhibit their own immediate impulses, such as calculating efficiency or choosing easier or more available course of actions and control one's own behaviour. Consequently, the attention to details and rigid performance lead to temporary overloading of working memory. Thus, it predicted that intervention which promotes a ritual stance adoption will facilitate executive function.

As shown in previous studies of improvement in executive function, focusing narrowly on executive function improvement does not seem to be as effective in improving executive function as interventions that also address children's social and character development (Diamond, 2014; Diamond & Lee, 2011; Lakes & Hoyt, 2004; Trulson, 1986). This is likely due to the increased cognitive resources necessary to process social interactions as opposed to individual interactions like those reliant on computer-based protocols. As already mentioned, mere expectation of social interaction can alter cognitive processing in a way that information is processed in a more detailed manner and individuals pay more attention (Erber & Fiske, 1984; Devine, Sedikides, & Fuhrman, 1989) requiring higher employment of executive function processes. Moreover, as seen in the studies conducted by Trulson (1986) and Lakes and Hoyt (2004), the framing of the behavioural interactions had lasting psychological effects on participants' executive function. Most interestingly, this supports the idea that it is the psychological framing of and action that has an effect, not the behaviours alone. It is worthy to note that the traditional framing of martial arts is compatible with a ritual frame as the manoeuvres are not associated with their ability to defend oneself or inflict bodily harm on another, rather they are framed as aspects of self-discipline or quasi-religious beliefs such as qi. When presenting martial arts without its traditional frame, it would appear that the actions map well onto the instrumental frame as the actions can be easily interpreted in regards to their ability to engage physically with other individuals in ways that there are clear goals (i.e. to defend one's self or to inflict bodily harm on another).

To ensure executive function training was effective and accessible, an intervention with two experimental manipulations – ritual and instrumental – was designed to assess the first prediction; this method is discussed in detail in the next section. The intervention combined the circle time games proposed by Tominey and McClelland (2011), which are widely accessible in various environments and involve fun and easy, yet challenging activities for children, and ritualistic priming to promote the adoption of a *ritual stance.* In other words, this research used a modified version of the circle time games to activate the ritual and instrumental stances respectively.

However, one could argue that all games have some "ritual" component. Indeed, just like rituals, nearly all games are bound by a set of "normative" rules which are applicable during the time when the game is played. In fact, games are a very common example of activities that assign conventional function to actions and objects. Similarly to tools which have *usage functions* (i.e. causal functions we ascribe to objects as we used them instrumentally), in games objects and activities have *status functions* which are assigned to them as a matter of convention. These are based on constitutive rules (as opposed to their causal properties). In other words, status functions of objects and actions are based on collective agreement (Searle, 1969; 1995). For example, a piece of wood on a chess board is a queen, and can only move in certain ways; a card is the ace of spades and is the highest card in the deck. Consequently, objects and actions are approached in a normative way; that is objects and actions ought to be treated in a certain normative way in a context of a game.

However, it is difficult to draw a clear line between instrumental and conventional activities, especially in regards to games. Although board games are common example of conventional activities, a game like volleyball involves conventional rules (ball cannot be kicked, different balls have different status and are worth different amount of points, positions of players etc.), but is also is to a large extent instrumental. Some instrumental actions (hitting a ball) are bound by natural and physical principles of the world (mass, probability, etc.) and connections between actions and goals are deducible (hitting a ball stronger if one wants it to fly further. To overcome this issue, the present design uses verbal priming, which was designed to provide distinctive frames for how the children should perceive the actions they performed: instrumental and ritual priming were hypothesised to shift participants' attention to usage functions of actions and to status functions of actions respectively. Unlike instrumental priming, the ritual priming was designed to set up a normative framework by using generic normative language (e.g. this is how the game has always been played).

It was expected in this study that Tominey and McClelland's (2011; 2013) finding that the circle-time intervention games improve children's executive functioning would be replicated and extended. Additionally, it was predicted that adopting a *ritual stance* would improve children's executive function abilities to a greater extent than adopting an instrumental stance. As described at length in Chapter 2, to account for possible variations in sensitivity to ritual cues caused by different cultural environments, the data were collected in two cultural contexts: (a) Slovakia, a post-industrial Western culture where child-rearing practices emphasise instrumental learning, and (b) Vanuatu, a traditionalist Melanesian culture where adherence to ritual scripts and normative conventions are more highly prized in child development (Miles, 1998). The next section introduces the methodology and statistical analyses used to test the hypothesis above.

3.6.1. Study design

To assess the predictions of this thesis, two datasets were collected across two fieldsites (Slovakia and Vanuatu): The datasets collected information on (1) the participant's executive function and (2) their ability to delay gratification. Participants were assigned to one of two intervention groups or a control group (as described below). The collected data were used for the analyses presented in chapters 3, 4, and 5.

Before conducting the fieldwork, ethical approval was granted by the Central University Research Ethics Committee at the University of Oxford (forms CUREC 1 and 1a). Because the research involved vulnerable participants (children) additional approval (form CUREC 2) was needed and subsequently granted by the Committee.

In case of Vanuatu, upon arrival it was necessary to obtain a research visa. These are granted based on a permission from The Vanuatu Cultural Centre (VCC) to conduct research. The VCC was established to regulate the research activity on the islands and only research conducted with the approval of the VCC is legal. The VCC monitors all the research in the area (all the information about the research must be provided by a researcher, including methodology and places where one plans to conduct fieldwork) and limited number of research visa per year is granted to control the flux of researchers. Without proper research visa, no research or fieldwork can be conducted on the islands and breaking this law can result in a monetary fine and deportation. No similar institution exists in Slovakia and no visa was required for either travel – because the researcher is a Slovak national – or for conducting research.

After arriving to the field sites, approval was sought and granted by The Ministry of Education, Science, Research and Sport of the Slovak Republic, and by the Ministry of Education and Training in Vanuatu. Local authorities (mayors at Slovak field sites, chiefs at Vanuatu field sites) were informed about the research and also granted their approval. School headmasters and teachers were also given information about the research and agreed with schools' participation.

Informed consent was obtained from parents and legal guardians. The consent form included the information that sweets will be used as a part of the research (i.e. the delay of gratification experiment); no allergies were reported and all the parents granted their consent. All children assented to participate and were informed that they could end their participation if and whenever they wished to.

The same materials were used at both field sites. All the materials used to gather the data were translated and back-translated into the local languages (Slovak language for Slovak participants and Bislama for Vanuatu participants) to ensure correct translation of the material. The translations were carried out by local bilingual individuals (Slovak/English and Bislama/English respectively). Back-translations were carried out by a separate set of bilingual individuals[27]. Before conducting the studies, familiarity with the stimuli (the animals, colours, etc. used in the intervention games; the body parts mentioned in the HTKS task) were checked with teachers and participating children. All the research activities took place in the local schools.

The research was divided into three phases:

1. Pre-test: The measure of executive function and the ability to delay gratification was administered individually in a quiet room with minimal distractions.

2. Intervention: Based on previous research the intervention phase lasted for three months[28]. Children were randomly assigned to one of three groups: *ritual*, *instrumental*, or *control*. Those assigned to the *ritual* and *instrumental* groups were taken out of the classroom twice a week (as in Tominey and McClelland study, 2011), in groups of eight to ten, to participate in group 'circle time' games (see Appendix 3 for detailed games description). These games, which require inhibitory control, attention and working memory, were designed by Tominey and McClelland (2011) to improve children's executive function. Inspired by the Tominey and McClelland's study (2011), children played five circle time games in each session, which lasted 30 to 45 minutes. These sessions were routinised: they always took

[27] Attention was paid to ensure that the research protocol was as clear and direct as possible. For example, in Bislama personal pronouns encode the clusivity distinction. The word 'yumi' (Eng. 'we') is the inclusive 1st person plural, and includes the speaker and the addressees, or the speaker, the addressees and others who are not present. This form of the pronoun was used in the protocols because the instructions included everyone present. The alternative is exclusive 'mifala', which includes the speaker and other individuals, but not the *addressees*. This form would be inappropriate for the research protocol.

[28] There is no research that has examined an optimal time-period and dose of an intervention to improve executive function with lasting effects. The length of intervention and its frequency in the previous studies varies from five days in succession (Dowsett & Livesey, 2000) to twice a week for six months (Trulson, 1986). In this study the intervention period lasted three months to allow sufficient time for executive function to be manipulated. Additionally, because the presented research was designed to take place in schools during the school year, the three-month period was chosen to allow working with children without holiday interruptions.

place on the same day of the week and at the same time of day, and games were played in an invariant order (the exact order in which games were played is described in Appendix 3). Children assigned to the control group played none of these games and stayed in the classroom with their teacher.

3. Post-test: The pre-test measure of executive function and the ability to delay gratification was re-administered.

To avoid confounding the effect of the pre-test with the effect of the intervention (also referred to as 'treatment'), the Solomon four-group design (SFGD; Solomon, 1949) was used. Various combinations of pre-tested groups and groups with treatment in this design allowed the researcher to ensure that the results were not attributable to the influence of the pre-test. The SFGD is an experimental design that assesses the possibility of pre-test sensitisation, in which case "exposure to the pre-test increases the subjects' sensitivity to the experimental treatment, thus preventing generalization of results from the pretested sample to an unpretested population" (Huck & Sandler 1973: 54). In the SFGD, subjects are randomly assigned to four groups (see Table 5): (1) pre-test and treatment; (2) pre-test with no treatment; (3) no pre-test and treatment; (4) no pre-test and no treatment. All the subjects from all the groups are post-tested:

Group description	**Pre-test**	**Intervention**	**Post-test**
Group 1: Pre-tested participants from the experimental (ritual and instrumental) groups	✓	✓	✓
Group 2: Pre-tested participants from the control group	✓		✓
Group 3: Non-pre-tested participants from the experimental (ritual and instrumental) groups		✓	✓
Group 4: Non-pre-tested participants from the control group			✓

Table 5: Solomon four-group design

Group 1 and group 2 in the SFGD are interpreted as per a pre-test/post-test design. Comparing the results of groups 1 and 2 with the results of groups 3 and 4 allows one to determine if the pre-test itself influenced the results. The comparison between groups 1 and 3 allows one to determine the effect (if any) of the pre-test upon the treatment. Finally, comparing the results of groups 2 and 4 shows the possible effect of the pre-test, independently of the treatment. As can be seen in Table 5, the SFGD requires twice as many groups as the classic pre-test/post-test design. This, however, does not mean that it requires twice the number of subjects. Braver and Braver showed that when the original number of subjects is simply split in half, “there is no loss of power for the Solomon design analysed meta-analytically as compared to the use of posttest-only design (in fact, there generally is a slight gain in power)” (1988: 153).

Braver and Braver (1988) offer a meta-analytic solution for this rather complicated design, which combines the effect of treatment and pre-test on the post-test scores of all groups (pre- and post-tested groups, and post-tested only groups). The initial phase of the Solomon meta-analysis is conducted to determine whether evidence of pre-test sensitisation exists (i.e. the treatment is only effective in combination with the pre-test). This is assessed by a 2x2 between-group ANOVA on post-test scores, in which the presence of intervention (present vs. absent) and pre-test (present vs. absent) are factors and post-test scores are the dependent variable. As the subjects are randomly assigned to the groups, it is not necessary to include pre-test scores in the analysis. Evidence for pre-test sensitisation (i.e. the pre-test might be one of the factors influencing the post-test scores) occurs when the interaction between intervention and pre-test proves to be significant. If there is a significant simple effect of treatment on the on the post-test scores of the two pre-tested groups, but not on the on the post-test scores of the two pre-tested groups two, “the analysis terminates with the conclusion that there is evidence of a treatment effect, but it occurs only for pre-tested groups; there is thus pretest sensitization" (Braver & Braver 1988: 151). If the simple main effect of treatment is also significant among the two non-pre-tested groups, pre-test sensitisation "merely enhances the effect of treatment, which is detectable as well even in unpretested sample" (Braver & Braver 1988: 151). If the interaction of treatment and pre-test proves to be non-significant, it can be concluded that there is no evidence of pre-test sensitisation. The next step in the meta-analysis is to check for the simple main effect of the treatment. If the simple main treatment effect is significant, there is evidence of the treatment effect. For greater clarity, the complete meta-analysis is presented in Figure 1 (Braver & Braver 1988: 152).

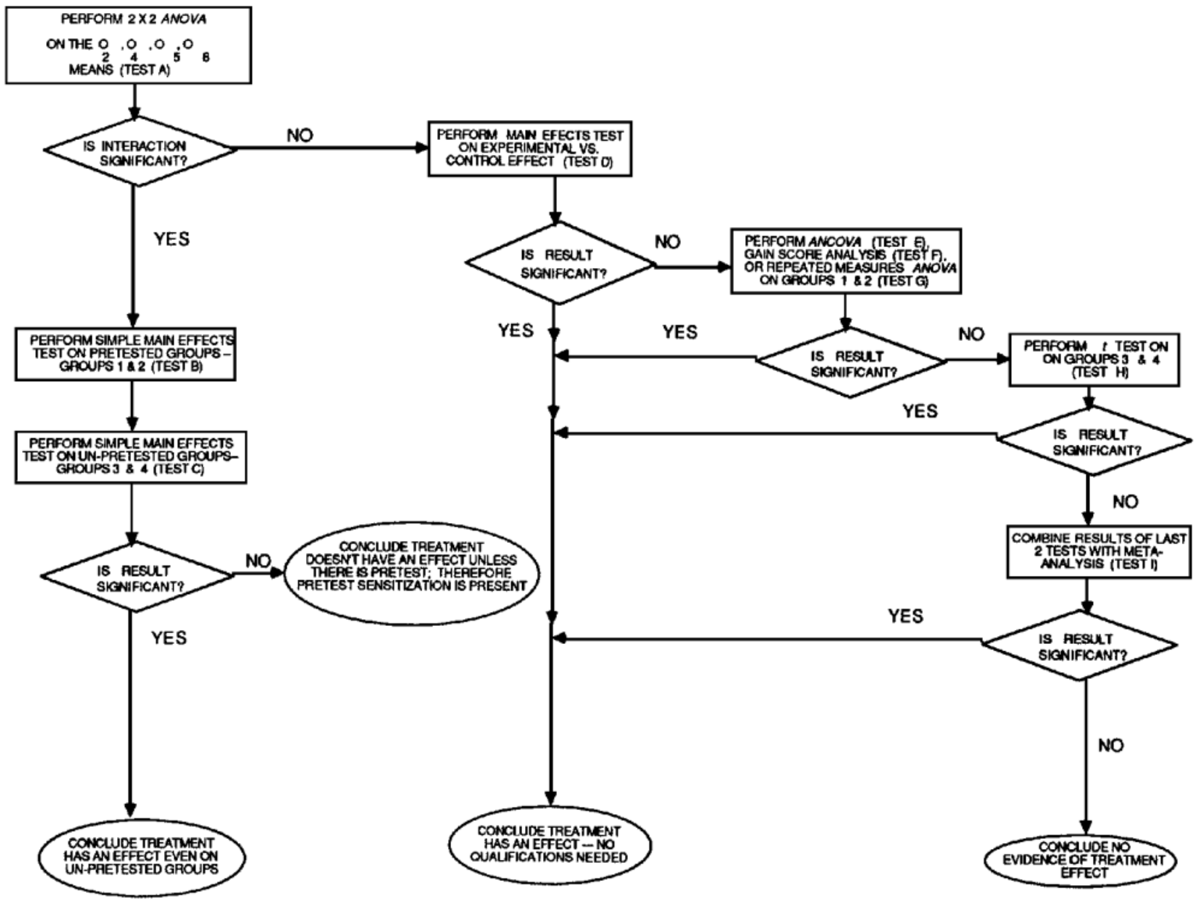

Figure 1: Meta-analytic approach of the Solomon four-group design (Braver & Braver 1988: 152)

(O = outcome measure)

Despite its complexity, which is, as Braver and Braver point out, "certainly not a scientifically justifiable reason to fail to conduct it" (1988: 150), the SFGD provides a solution for pre-test/post-test designs with adequate statistical power. As it guards against mistaking pre-test sensitisation (in which the scores from pre-test to post-test would change even without the treatment) for a treatment effect, it improves the validity of the analysis by facilitating conclusions that are not contaminated by extraneous factors and confounding variables.

3.6.2. Participants

In total, 110 participants were recruited from one school in Slovakia and 105 participants from two schools in Vanuatu. All three schools were chosen due to their willingness to participate in the research and their sufficient size; the researcher had a pre-existing research relationship with the school in Slovakia, the relationship with the schools in Vanuatu were established when the research was initiated. All of the participating schools were public, opened to all members of the public in the surrounding areas. The locations of the schools were in average socioeconomic areas for their respective countries. No participants were recruited from programs for gifted children or children with special needs. According to ethical standards when working with vulnerable participants, all of the data were anonymised and all the identifying information was removed so that the participants' identity cannot be traced.

Attrition rate was low, with only five children dropping out, three (2 Slovakia; 1 Vanuatu) of whom did so due to prolonged illness during the pre-test phase before any data was collected. One child dropped out after the first intervention session (Slovakia), and one child was dropped after the intervention phase as she only attended 23% of the sessions. After attrition, the final sample consisted of 107 children in Slovakia (48 girls, 59 boys; M_{age} = 7.82 years, *SD* = 1.85) and 103 in Vanuatu (56 girls, 47 boys; M_{age} = 7.73 years, *SD* = .95), totalling 210 participants in the age range from 6.01 to 8.77 years-old (104 girls, 106 boys; M_{age} = 7.78 years, *SD* = 1.47). The two cultural groups did not differ in age [$t_{(208)} = .44$, $p = .59$] or sex [$\chi^2_{(1.\ N)} = 201) = 1.89$, $p = .17$]. Participants were from mixed socioeconomic backgrounds relative to their countries expected socioeconomic levels. In Slovakia, all the children were native Slovak speakers. In Vanuatu children's first language was an island specific local vernacular language, however as Bislama is used as a vernacular and educational language, all the children were fluent Bislama speakers. Additionally, children in Vanuatu understood basics of English language. The difference in pre-test executive function was marginal, $t_{(122)} = 3.49$, $p = .053$; Slovakian children (*M* = 27.62, *SD* = 8.39) performed slightly better than Vanuatuan children (*M* = 22.18, *SD* = .69).

3.6.3. Measures

In this study, the HTKS task is used to measure executive function and a variation on the "marshmallow task" is used to measure the ability to delay gratification. The administration and analysis of both measures is explained below.

Executive function: Following previous research, a recently developed version of the Head-To-Toes task (McClelland et al., 2007; Cameron Ponitz et al., 2008; Cameron Ponitz et al., 2009) – the Head-Toes-Knees-Shoulders task (HTKS; Cameron Ponitz et al., 2009) – was used to measure children's executive function. The task was administered individually in a quiet room with minimal distractions. The performance of the task requires children to physically respond to a set of directions provided by an experimenter. For example, children were initially asked to respond naturally to two pairs of commands: (1) "Touch your head!" and "Touch your toes!"; (2) "Touch your knees!" and "Touch your shoulders!". Participating children were then invited to play a game that involved responding in a stipulated fashion contrary to these commands; that is to touch their toes when they were commanded to touch their head, and vice versa; and to touch their shoulders when commanded to touch their knees, and vice versa. The HTKS task included 20 such incongruent items in total. Sessions were recorded as digital video to be coded later. During data coding, each action was scored with a value of 0, 1, or 2 for each prompt. Children received 2 points for a correct response without a prior movement toward the incorrect response; 1 point for a "self-correcting response", defined as any motion toward the incorrect response, followed by the child stopping and responding correctly; and 0 points for an incorrect response. The score for each action was recorded and the total sum of all scores represented a participant's overall score; therefore, total scores ranged from 0 to 40. Higher scores in the task were taken to indicate higher levels of executive function. A full description of all action prompts is included in Appendix 1.

Delay of gratification: Following Mischel and colleagues (e.g., Mischel & Ebbsen, 1970; Mischel & Moore, 1973), each child was presented with a sweet and was given two options: (1) they could eat the sweet while they waited for the experimenter to return; or (2) they could refrain from eating, touching or smelling the sweet until the experimenter returned. Any manipulation, such as touching or smelling was considered sufficient to end the session because tasting or touching the sweet without fully ingesting it may trigger gratification on the part of the participant. Therefore, any manipulation of a sweet on the part of the child was considered sufficient to end a session. If a child refrained from manipulating the sweet until the experimenter returned they would receive two sweets. Local sweets that children were familiar with were used to prevent confounding effects, such as aversion --to or curiosity about--unfamiliar sweets. Due to high temperature in Vanuatu, the rooms the experiment took place in had to be well ventilated (e.g. by opening doors and windows as there is no electricity on most of the islands) to prevent melting of the sweets used for the experiment. Rooms also had to be well cleaned for the sweets to not attract insects such as flies and ants. Following previous research, the delay was not open-ended. A predetermined criterion time of 15 minutes was used. The participants were not informed of what the delay would be. The immediate reward (one sweet) was placed on the table in full view and within reach of participants while they waited. Sessions were video-recorded to verify the exact amount of time that each child was able to delay gratification. If the child wanted to stop the experiment or wanted to eat the sweet, he or she had a chance to indicate that by calling out the experimenter. As soon as a child touched, smelled, or tasted the sweet, or otherwise indicated that he or she no longer wanted to wait (called for help, tried to leave the room, etc.), the session ended and the time elapsed to that point (in minutes) was recorded (see Appendix 2 for full task description).

Inter-rater reliability: All sessions of the study were video-recorded to enable two independent blind coders to provide HTKS scores.

3.6.4. Intervention and experimental manipulation

As described above, the intervention period lasted three months, with children randomly assigned to one of three groups: *ritual* (N = 71), *instrumental* (N = 69), or *control* (N = 70). Those assigned to the *ritual* and *instrumental* groups were taken out of the classroom twice a week, in groups of eight to ten, resulting in 7 groups per condition, to participate in group 'circle time' games. Each participant's intervention group (ritual, instrumental, or control) was recorded for later analysis. The circle time games were performed in groups in order to efficiently administer the intervention to the appropriate sample. These games, which require inhibitory control, attention, and working memory, were designed by Tominey and McClelland (2011) to improve behavioural self-regulation. Following Tominey and McClelland's procedure (2011), these games became increasingly complicated and new rules were added as each intervention session progressed. These games were chosen because they employ multiple aspects of executive function and require no special materials to administer. As such, they are well suited to be administered in fieldsites such as Vanuatu, where schools lack basic teaching materials and premises. Children played six circle time games in each session, which lasted 30 to 45 minutes. All sessions were led by the same researcher in both countries, with the help of a local substitute teacher. The substitute teacher was hypothesis blind. However, given that there are different verbal cues (described below) it was not possible for the experimenters to be condition blind. This is compensated for by strictly following the rules of the games and verbal prompts during intervention administration in order to mediate the potential effects of experimenter bias. The game sessions were routinised: they always took place on the same day of the week and at the same time of day, and games were played in an invariant order. Games in the *ritual* condition incorporated a ritual priming manipulation designed to promote adoption of a *ritual stance*. In the *ritual* condition, no rationale or explanation was provided for the actions in the games, and no goal was specified. Moreover, instructions were accompanied by assertions using generic normative language such as "it has always been done this way", or "those are the rules and they must be followed", to encourage interpretation of the actions as conventional rather than instrumental. In contrast, games in the *instrumental* condition incorporated an instrumental priming manipulation designed to promote adoption of an *instrumental stance*. In this condition, instructions were accompanied by more idiosyncratic explanations such as "if we do it this way, we will learn how to dance", or "if we do it this way, we will learn about different animals". This verbal prime serves to evoke an interpretation of the actions as having instrumental value. Children assigned to the control group played none of these games and stayed in the classroom with their teacher (see Appendix 3 for details of games, including the details of experimental manipulations).

3.7. Results

For the analysis presented in this chapter, only the dataset for participant's executive function and participant's intervention group assignment were used (the dataset for participant's ability to delay gratification was not used at this point). Descriptive statistics for the executive function scores are included in Table 6 below.

Executive function scores	Pre-test	Post-test
Mean	23.36	25.69
Std. Error of Mean	1.100	.762
Median	28.00	30.00
Mode	30	31
Std. Deviation	12.253	11.014
Variance	150.136	121.313
Skewness	-.739	-.926
Std. Error of Skewness	.217	.168
Kurtosis	-.808	-.197
Std. Error of Kurtosis	.431	.335
Range	39	40
Minimum	0	0
Maximum	39	40

Table 6: Descriptive statistics for executive function scores

3.7.1. Inter-rater reliability and pre-test comparisons

Inter-rater reliability was excellent for the HTKS task (*Cohen's* $\kappa = .99$; $N = 107$).

Participants in the two experimental conditions did not differ in age, $t_{(207)} = 1.7631$, $p = .17$, sex, $\chi^2_{(2,\ N\ =\ 210)} = 5.25$, $p = .07$, or pre-test executive function [$F_{(2,\ 123)} = 1.35$, $p = .26$] scores. All the participating children attended at least 97% of the intervention. A Mann-Whitney U test revealed that there were no significant differences in executive function between countries at time 1 ($U = 1397.5$, $p < .001$) or time 2 ($U = 3673$, $p < .001$). These results are reported in Table 7 below with the upper and lower level 95% significance bounds as calculated by means of a 10,000 sample monte-carlo simulation. This allows for the participants from the two cultures to be pooled into a single sample for further analyses.

	U-test	*p-value*	*Lower Bound*	*Upper Bound*
Executive Function Score Time 1	1397.5	<.001	<.001	<.001
Executive Function Score Time 2	3673	<.001	<.001	<.001

Table 7: Results of Mann-Whitney U test

3.7.2. Latent structure of executive function

A confirmatory factor analysis (CFA) was performed using SPSS in order to discern the number of potential factors underlying the measurement of executive function. This serves two purposes. Primarily, this serves to show that the measure being used (the HTKS task) is being used in a way which is theoretically continuous with previous research. That is to say, previous research (Cameron Ponitz et al., 2008; Cameron Ponitz et al., 2009; Wanless et al., 2011) has found that the HTKS task is an appropriate measure for executive function which is assumed to be comprised of three factors. Should the CFA reveal that more or fewer factors are observed in the current data than in past studies, it is possible that a different (or additional) task may be more appropriate to measure executive function. The secondary function of the CFA is to replicate earlier findings. Researchers have debated the extent to which executive function can be considered a single construct, or consisting of multiple underlying factors. Recent research has shown that it has as many as three components, however, as discussed in Chapter 1, it appears that younger children have not yet developed an executive function that maps onto three components. By attempting to replicate the results with this sample population, it allows one to interpret the results in comparison with other studies that demonstrated the executive function to be separable into three components.

Furthermore, this research seeks to investigate the extent to which these results are cross-culturally replicable.

Factor analyses were used to test one-, two-, three-, and four-factor models of executive function. To identify how many factors or components explain variability in the executive function task used in this study, an exploratory factor analysis was performed using the data collected by participants' responses during the HTKS task. This analysis requires that the score for each individual sub-action in the HTKS task to be left with their original scoring 0, 1, or 2 (not summed into a single score, which would be representative of their HTKS score generally). The information for each item from all participants is stored as a 2x2 matrix where each action is recorded for each participant; that is to say the axis of the matrix are action x participant. This allows for the relevant factors to be drawn from the entire dataset.

Since the HTKS tasks are expected to load on common factors and share executive demands, oblique rotation that allows for correlated factors (instead of *varimax* rotation, which best fits uncorrelated solutions) was used. To compare the validity of various structures, confirmatory factor analyses, which provided multiple indices of fit that could be used for different model evaluations, were used. The models were created and tested in order of increasing complexity (i.e. CFAs were created targeting executive function as composed of 1, 2, 3, and then 4-factors). The fits of each model was compared using χ^2 difference tests (subtracting the χ^2 value of the fuller model from the χ^2 value of the simpler model). For additional model evaluations, two fit indices were used: (1) root mean square error approximation (*RMSEA*) – the adjusted fit index, with *RMSEA* value < .08 indicating good fit; and (2) comparative fit index (*CFI*) – relative fit index which compares each model to the baseline model, with *CFI* values .09 – .095 indicating good model fit (Browne & Cudeck 1993; Hu & Bentler 1999; Yu 2002). The preliminary checks on data were carried out revealing that the correlations in the data set are appropriate for a factor analysis. Kaiser-Meyer-Olkin Measure of Sampling Adequacy revealed high adequacy (*KMO* = .92). Bartlett's Test of Sphericity was also significant ($X^2_{(190)}$ = 2560.958, $p < .001$). Lastly, all communalities were above .45 confirming that each item shared some common variance with other items. Given these results, factor analysis was conducted with the HTKS scores drawn from all participants (n = 210) as no outliers were found during preliminary data screening. The first model, where all tasks are loaded on a single factor (also known as a unitary model), was not found to be sufficient to explain the data (χ^2 = 679.69, *RMSEA* = .12, *CFI* = 0.79) (also see Tables 1a and 1b in Appendix 4). This suggests that executive function is not a unitary construct but rather a set of different cognitive processes.

The two-factor model (χ^2 = 454.09, *RMSEA* = .091, *CFI* = .88) (also see Tables 2a and 2b in Appendix 4) had a significantly better fit ($\Delta\chi^2_{(1)}$ = 225.59, $p < .001$) than the unitary model.

The three-factor model further improved the accuracy of the model (χ^2 = 370.62, *RMSEA* = .078, *CFI* = .92; also see Tables 3a and 3b in Appendix 4). The three-factor model was found to have a significantly better fit ($\Delta\chi^2_{(2)}$ = 83.47, $p < .001$) than the two-factor solution.

Finally, a four-factor model was tested to rule out the possibilities that: (1) children's executive function can be separated into more than three cognitive processes; and (2) that the three-factor model is insufficient to explain its latent structure. Compared to the three-factor solution, the four-factor model (χ^2 = 418.59, *RMSEA* = .09, *CFI* = 0.89) had a significantly worse fit ($\Delta\chi^2_{(1)}$ = –47.96, $p < .001$) and did not account for the variation in the data significantly better than the three factor model (also see Tables 4a and 4b in Appendix 4).

The analysis showed that there was no significant difference between the observed data and the hypothesized three-factor model. As revealed by significant χ^2 differences, the unitary and two-factor models were not sufficient to account for the variation in the data. Furthermore, no explanatory power was gained when executive function was separated into four processes. Thus, the three-factor model was retained, this is consistent with the hypothesis that executive function is an ability that can be separated into three correlated but relatively independent cognitive processes (attention, working memory, inhibitory control). The model explained 57.26% of overall results variability in the executive function task. Each subscale corresponding to its latent factors was reliable (*Cronbach's* $\alpha_{(factor\ 1)}$ = .88, *Cronbach's* $\alpha_{(factor\ 2)}$ = .91, *Cronbach's* $\alpha_{(factor\ 3)}$ = .88) and had unique and adequate explanatory power.

3.7.3. Testing assumptions of ANOVA

Before moving on to the data analyses, non-robust methods for testing assumptions of ANOVA (i.e. normality, homogeneity of error variances and presence of outliers) and linear regression (i.e. normality of errors, homogeneity of errors, linearity and independence of errors) were implemented, using IBM SPSS version 21. The results of the assumptions tests are presented in tables 8 and 9 (yes = assumption satisfied, no = assumption not satisfied, HTKS1 = pre-test executive function scores, HTKS2 = post-test executive function scores).

GROUP	ANALYSIS	LINEARITY	NORMALITY OF ERRORS	HOMOSCEDAS-TICITY	INDEPENDENCE OF ERRORS
all	regression	**yes**	**no**	**no**	**yes**

Table 8: Assumptions tests 1 for the executive function scores

GROUP	ANALYSIS	NORMALITY		HOMOGENEITY OF ERROR VARIANCE	OUTLIERS	
		HTKS1	HTKS2	HTKS2	HTKS1	HTKS2
pre-tested	one-way ANOVA intervention	no	**no**	**no**	**yes**	**no**
non-pre-tested	one-way ANOVA intervention	N/A	**no**	**no**	N/A	**yes**
all	2 x 2 ANOVA	N/A	**no**	**no**	N/A	**no**
	one-way ANOVA intervention	N/A	**no**	**no**	N/A	**no**

Table 9: Assumptions tests 2 for the executive function scores

For classic parametric tests to produce accurate results the assumptions must be met; however, in this case the assumptions were not met in several tests, as can be seen in tables 8 and 9. It has been shown that these assumptions are rarely met when real data are analysed: Micceri (1989) examined 440 large data sets from the educational and psychological literature and found that none of these data were normally distributed. Erceg-Hurn and Mirosevich (2008) examined 28 studies from experimental psychology and found that the homoscedasticity assumption was often violated. Violation of assumptions can lead to severely biased results, such as "miscomputation of *p* values, inaccurate effect sizes and confidence intervals", which can further lead to "substantive errors in the interpretation of data" (Erceg-Hurn & Mirosevich 2008: 591). Moreover, the violation of assumptions of normality and homoscedasticity can influence rates of Type I error (which refers to falsely rejecting the null hypothesis, i.e. concluding that the effect exists even though it in fact does not), rates of Type II error (which refers to not rejecting the null hypothesis even though it is false), and can generally lower the power of classic parametric tests: thus, "arbitrarily small departures from normality can result in low power; even when distributions are normal, heteroscedasticity can seriously lower the power of standard ANOVA and regression methods" (Wilcox 1998a: 300). Therefore, to analyse the data robust statistical procedures, which produce more accurate results and reduce the occurrence of Type I error, were used. The term 'robust statistical procedures' refers to "procedures that are able to maintain the Type I error rate of a test at its nominal level and also maintain the power of the test, even when data are nonnormal and heteroscedastic" (Erceg-Hurn & Mirosevich 2008: 593).

3.7.4. Effects of circle time games intervention and ritual manipulation on children's executive function

The intervention games used in this study were designed by Tominey and McClelland (2011) to improve executive function by boosting children's attention, working memory and inhibitory control. Along with previous executive function research it was argued that engagement in the treatment groups (whether ritual or instrumental) would significantly improve children's executive function, which would be reflected in increased scores on the HTKS task. It was further predicted that there would be a significant difference between the two kinds of intervention. Specifically, it was predicted that, compared to instrumental priming, ritual priming would result in a significantly larger improvement in terms of executive function. These predictions were tested using robust ANOVAs with 20% trimmed means (Welch-type), and by analysing linear contrasts between groups. The analyses were performed using *R* version 3.0.1 with package WRS (Wilcox Robust Statistics), based on Wilcox (2012), testing the effect of a three-level factor (no intervention vs. instrumental intervention vs. ritual intervention) on children's performance on an executive function task.

To provide input for the analyses, the scores for each action item in the HTKS task were summed in order to create a single score for each participant. As noted above, this score can range from 0-40, with higher scores representing better performance on the task. The participant's condition group, which was randomly assigned, was given a designation of 0 for the control condition, 1 for the instrumental condition, or 2 for the ritual condition. Each participant was also coded for her pre-test group: 0 if a participant did not undergo pre-testing and 1 if a pre-test was administered. This allows for an analysis of the data to show if there are significant differences in the overall HTKS score between conditions.

First, a meta-analysis as suggested by Braver and Braver (1988) was performed (see Figure 1: Page 180). This statistical treatment combines analysis of the effect of the intervention and pre-test sensitisation to test whether the intervention alone has a significant effect on the measured scale, even without its interaction with the pre-test.[29] One by one, the effect of intervention, pre-test, and the interaction of the two on the post-test executive function scale (HTKS2 scale) were tested. Using a 2 (intervention: present vs. absent) x 2 (pre-test: present vs. absent) robust ANOVA (20% trimmed means method), a significant effect of intervention on the post-test executive function measure (HTKS2) ($F_{(1, 206)} = 60.18$, $p < .001$) was found. The effects of the interaction of intervention and pre-test ($F_{(1, 206)} = 23.78$, $p < .001$), and pre-test alone ($F_{(1, 206)} = 20.23$, $p < .001$), were likewise significant (see Table 10).

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[29] This analysis is not performed to test the hypotheses of the research, *per se*. Rather, this analysis aims to investigate the results in line with the Solomon Four Group design as described above.

HTKS2	*F*	*df*	*p-value*
Pre-test	20.23304	206	<.001
Intervention	60.18143	206	<.001
Pre-test*Intervention	23.7756	206	<.001

Table 10: 2 x 2 ANOVA, all children, executive function scores

It was therefore necessary to analyse pre-tested and non-pre-tested children separately to rule out the possibility that the intervention only had an effect in combination with the pre-test (i.e. that the pre-test sensitisation caused the intervention to only be effective in combination with the pre-test). The analyses showed that the effect of the interventions on HTKS2 scores for pre-tested children was significant ($F_{(1,\ 38.06)} = 4.64$[30], $p < .05$, $\xi = 0.33$[31]; see Table 11). However, a significant intervention effect on the executive function measure (HTKS2) was also found in the group of non-pre-tested children ($F_{(1,\ 30.94)}$[32] $= 72.19$, $p < .001$, $\xi = .81$; see Table 11). This demonstrated that the intervention had a significant effect on executive function improvement even without the pre-test.

HTKS2	*F*	*df*	*p-value*	*Variance explained*	*Effect Size*
Pre-tested children	4.6412	38.063	.037	.106	.326
Non-pre-tested children	72.195	30.936	< .001	.661	.813

Table 11: One-way ANOVA, executive function scores for pre-tested and non-pre-tested children

[30] The degrees of freedom were adjusted because of trimming.

[31] Robust explanatory measure of effect size: negligible $\xi < .15$, small from $\xi = .15$ to $\xi = .3$, medium from $\xi = .3$ to $\xi = .5$, large $\xi > .5$.

[32] See footnote 22.

Next, a robust 3 (condition: *ritual* v. *instrumental* v. *control*; between-subjects) × 2 (HTKS task administration: pre-test v. post-test; within-subjects) mixed design ANOVA was performed. This revealed a main effect of HTKS task administration, indicating that scores on the executive function measure improved after the intervention. This was qualified by an interaction between the HTKS task administration factor and condition, indicating differences in the improvement of executive function between children from the *control*, *instrumental* and *ritual* groups, $F_{(1,121)} = 12.16$, $p < .001$, $\eta^2 = .39$ (also see Table 5a in Appendix 4). A record of the means for each condition by time period can be found in Table 12 below. A follow-up one-way robust ANOVA on the post-test HTKS scores revealed large differences in post-test executive function between the *control* and intervention (*ritual* and *instrumental*) groups ($F_{(1,54.05)} = 30.22$, $p < .001$, $\eta^2 = .39$; also see Table 5b in Appendix 4). Children assigned to the *instrumental* group scored higher on the executive function task than children assigned to the *control* group ($p < .001$, $\eta^2 = .21$; also see Table 5c in Appendix 4). The largest improvement in executive function was recorded among children in the *ritual* group, who scored higher than their peers from both the *control* ($p < .001$, $\eta^2 = .56$; see Table 5c in Appendix 4) and *instrumental* groups ($p < .002$, $\eta^2 = .24$; also see Table 5c in Appendix 4). The impact of different types of intervention explained 37% of the variance in post-test executive function.[33]

[33] In addition to testing the assumptions of the Solomon's four-group design, a linear regression was used to investigate whether the ritual intervention or pre-test had a greater effect on the post-test executive function scores. It was found that the ritual intervention had a greater effect ($\beta = .301$, $p < .00001$) on the post-test executive function scores than pre-test ($\beta = .15$, $p = .023$). If this were not the case, and the effect of pre-test scores on post-test executive function were greater than the effect of intervention, this may suggest that the repetitive nature of ritual actions, rather than their cognitive demands, play the more important role in training executive function.

		Ritual Intervention Condition		
		None	*Instrumental*	*Ritual*
Executive Function Score	*Pre-test*	35	38	39
	Post-test	22	25	31

Table 12: Executive function score averages by ritual intervention condition

To sum up, the first prediction of the present thesis was confirmed: the intervention games improved children's performance on an executive function task, with games that incorporated a *ritual stance* having the largest effect on this improvement when compared to both control and instrumental groups.

3.8. Discussion: Routines, rituals and executive function

It was proposed in this study that rituals enhance executive function by making humans more sensitive to the details of their performance, which is driven by the social motivations (i.e. social bonding and HPS activation) involved in performing normative conventions. The fidelity and precision with which children copy ritualistic conventions (Herrmann et al., 2013; Legare et al., 2015; Watson-Jones et al., 2014) implies that, all else being equal, the learning and practise of such conventions makes greater demands on executive function, which comprises attention, memory, and inhibitory control, than instrumental learning (e.g., Friedman et al., 2007; Hull, Martin, Beier, Lane, & Hamilton, 2008; Miyake, Friedman, Emerson, Witzki, & Howerter, 2000). Because both ritualised behaviour and executive function undergo pivotal changes in the same developmental period (around six years of age), and activate similar neural processes, it is possible that they are reliant on the same psychological mechanisms and influence each other.

Before assessing the prediction that ritualised normative conventions make heavy demands on executive function and that adopting the *ritual stance* in an intervention programme over time promotes executive function abilities, preliminary analyses were conducted using confirmatory factor analysis (CFA) to establish the latent structure of executive function, and to test assumptions of ANOVA and linear regression. The CFA revealed that the three-factor model was the most suitable to account for the measured executive function data, with each of the three subscales having adequate explanatory power. The analyses support the view that from around six to seven years of age executive function has a tripartite structure, with three interrelated but relatively independent cognitive abilities (e.g. Huizinga, Dolan, & van der Molen, 2006; Lehto, Juujärvi, Kooistra, & Pulkkinen, 2003; Wiebe et al., 2011). Thus, using a task that integrates and focuses on improving three cognitive abilities related to executive function – attention, working memory and inhibitory control – i.e. the HTKS task (Cameron Ponitz et al., 2009), was well justified for measuring, and was a reliable way to measure, children's executive function and its potential improvement as a result of the intervention. As the assumptions of ANOVA and linear regression were not met in several tests (as is often the case in experimental psychology; Erceg-Hurn & Mirosevich, 2008; Micceri, 1989), robust statistical methods, which maintain the power of the test even when the assumptions are violated, were used to analyse the data.

The meta-analyses of the data drawn from the intervention, which was administered using a Solomon's Four-Group Design, demonstrated that the intervention used in this study had a significant effect on executive function improvement, even without its interaction with the pre-test, supporting the hypothesis that children's executive function would improve after the intervention: large differences in post-test executive function between the *control* and intervention (*ritual* and *instrumental*) groups were found. The largest improvement in executive function was recorded among children in the *ritual* group, who significantly outperformed their peers from both the *control* and *instrumental* groups in the HTKS task during the post-test. These results confirm the prediction that normative conventions (teleologically and causally opaque ritualised behaviours, such as social norms and rules) promote the adoption of a *ritual stance*.

The methods employed in this research utilized a subtle prime in order to frame the actions of the participant in either a ritual or instrumental way. In line with the definitions presented above, children in the instrumental condition were told that the actions they were performing served an end purpose (e.g., how to dance or learn about different animals). On the other hand, children in the ritual stance were not given any such explanation, but were told that the activity is performed that way because it is conventional to do so. Moreover, ritual priming used generic normative language leading children to believe that they are learning a normative convention. This subtle frame primes the participant to adopt either an *instrumental* or *ritual* stance to their actions. When ritual stance is adopted, actions are interpreted as conventional and it is assumed that they are executed in a certain way simply because this is demanded by a convention, with unclear causal relevance (unlike in the case of adoption of an *instrumental stance*, where the actions are interpreted as instrumental, and a causal structure that could account for the actions as the means to achieve a goal is assumed). Because the conventional actions must be performed in a precise, socially accepted (proper) and established manner, individuals are more attentive to the way they execute the actions and must inhibit the use of individual innovative, different or even more effective ways. In such situations, different environmental and social cues must be integrated with existing cognitive information (experience, beliefs, norms, etc.), leading to increased employment of working memory. Thus, as children (and indeed, all humans) become more sensitive to learning and to replicating normative conventions, and to possible consequences of failure to replicate them or making mistakes (being ridiculed, judged, ostracised, etc.), more demands are placed on executive function – an ability that enables the monitoring of complex actions and the control of behaviour in the light of different needs and situational constraints. Moreover, the use of normative generic language in the ritual priming likely led children to believe that a normative convention is being transmitted. Such language suggests an agent-neutral way of behaviour and actions, and increases normative pressure – this is simply the way it must be done. As it was shown by previous research, children have a relatively sophisticated understanding of normativity (Rakoczy, Schmidt, Tomasello and colleagues), and that children do not just respond to social norms, but they seek them out to find out how to behave and what to do in unfamiliar situations (Kalish & Cornelius, 2007). It is thus likely that ritual priming indicated that a generally applicable knowledge is being transferred, and thus required greater engagement of executive function. On the other hand, the use of “you” (as opposed to generic language) in the instrumental condition suggested that rather than a prescriptive norm, more idiosyncratic information is being transferred. This result demonstrates that children do not only adopt ritual stance when witnessing ritualised actions (as shown by Legare et. al., 2015), but also when specific verbal cues, leading them to believe that an action that follows is a widely applicable normative convention, are present.

Along with previous studies (summarised by Diamond & Lee, 2011), the results of the present study showed that activities that challenge executive functioning also improve it, with the intervention having similar effect in both Slovakia and Vanuatu. Moreover, as predicted, recurrent activation of a ritual stance cultivated executive functioning to a greater extent than instrumental stance activation. This result shows how fundamental normative conventions are by imposing themselves on young children and influencing the ways children learn.

As noted above, Vanuatu and Slovakia differ on a number of crucial cultural aspects that would lead one to posit differences between the two groups. Namely, the more ritualised daily activities in Vanuatu should cause children to be more attentive to ritual cues. As such, the *effect* of the intervention should be greater in Vanuatu and there should be significant differences between Slovak and ni-Vanuatu children. In other words, the children in Vanuatu should have significantly greater executive function at post-test if they started from a place of non-significant differences at pre-test. However, the analysis revealed no significant differences at pre-test, nor were there significant differences between the two groups found at post-test. Therefore, one can conclude that the two groups were similarly affected by the intervention. This unexpected result may be due to the fact that executive function operates similarity regardless of cultural context. This general cognitive facility (i.e. executive function) may not be manipulated by cultural context to the extent that was previously hypothesised. The results here suggest that executive function can be trained but, as a cognitive system, it is not entrained. That is to say, it is a cross-culturally recurrent cognitive system that operates via similar mechanisms in individuals cross-culturally; however, its performance can be manipulated by administering specific interventions such as those presented here.

The fact that no differences in the effect of the intervention on post-test executive function were not found in the analysis presented above may be due to the fact that executive function was measured as a single construct. It is possible that the life histories of individuals in different cultural contexts affect the components of executive function unequally.

One could argue that the way the participating children were invited to attend the HTKS task (i.e. "We are going to play a game.") implied that there was a subsequent instrumental end (i.e. to win) in both ritual and instrumental condition. Indeed, there is a difference between the English words “game” (e.g. a game of cards which has a winner in the end,) and “play” (e.g. playing a family where there is no winner in the end). However, no such difference is present in either of the languages used during the fieldwork: Slovak language uses the word “hra” and Bislama uses the word “plei plei” to describe both game and play. Therefore, no competition was implied at the introduction of the HTKS task.

Although there were no possible contamination effects between groups, there could – in principle – have been order effects in the study design because the order of the tasks was not counterbalanced. However, the Solomon’s four-group design allows for assessment of entrainment-based order effects. That is to say, because one of the groups in the study will not receive the pre-test, if an order effect is present, it should reveal itself as significant differences between the group that received the pre-test and those who did not. As discussed in the previous sections, no such significant differences were revealed in the analysis.

The extent to which the children were aiming to please the experimenter should also be discussed. Although pleasing the experimenter may explain the differences between the intervention and control condition, it fails to explain why the children from ritual condition showed a greater executive function improvement than the children from instrumental condition. One might still argue that children might have been primed to seek approval, which as a result would have been reflected in HTKS task performance. More precisely, the approval seeking effect would be stronger in children who have undergone intervention, because the experimenter would be part of their ‘ritual group’. On the other hand, participants from the control group might have been less motivated because they were not previously selected by the experimenter to participate on the intervention sessions. However if it were the case that children from the control group had lower post-test HTKS scores than children from the experimental groups because they were less motivated to seek experimenter’s approval, then, given the study results, it would need to be demonstrated that children - for whatever reason - were *more* motivated to please the experimenter in the ritual intervention condition than they were in the instrumental intervention condition since the analysis revealed that children from the ritual intervention group had higher post-test HTKS scores than the children from the instrumental intervention group. Additionally, developmental research shows that young children have quite sophisticated understanding of normative conventions: children are identified with their group's social norms beyond their own interest, intervene normatively when rules are being violated, and enforce the rules on third parties in an agent-neutral way. Thus, generic normative language used in ritual priming was more likely to elicit respect for social norms rather than an attempt to please the experimenter. Nevertheless, given that conforming to a social norm might occur for different reasons, including to please an adult, it would be an interesting topic for the future research to address how perceived social status or prestige (and approval seeking) affect a child's performance on executive function tasks.

One possible alternative explanation for the presented results is that a "policing" mechanism was active in children in the ritual intervention condition, and it was this policing mechanism that increased the cognitive load on children's executive function. This effect could help explain the observed patterns if the ritual priming activated this hypothetical policing mechanism to a greater extent than the instrumental prime. However, more data would be required to show that this "policing" mechanism is not some form of – or a part of – executive function; unless that could be demonstrated, it is possible that the effects are accounted for in the study as it currently stands. More precisely, the "policing" mechanism might just be a sort of inhibitory control, which is the cognitive ability to inhibit prepotent or maladaptive responses. In such a case, this interpretation of the data is largely subsumed by the theories presented above. Nonetheless, the relationship between the policing of behavioural norms and executive function is a potential avenue for the further research, which might address the extent to which cognitive vigilance for behavioural deviations can be manipulated by adopting a ritual or instrumental stance.

An issue with the presented approach might be that ritual priming does not necessarily rule out instrumental interpretation, and vice versa; ex. this is the proper way to perform the game *in order to* learn how to dance. However, in the case of ritual priming, no end goal was mentioned to the participating children, thus giving them no reason to connect performed activities to an instrumental goal (e.g. to learn how to dance, to learn about animals, etc.) In the case of instrumental priming the instrumental rationale might have been interpreted as a ritual (this is the proper way to reach this goal, it has always been done this way to reach this goal, etc.) Again, if this were the case the analysis should reveal the differences between control and experimental groups (i.e. ritual *and* instrumental), but there would be no differences found between the two experimental groups. However, the fact that significant differences were found in the post-test executive function between participants from ritual group and their peers from the instrumental group suggests that the verbal primes used in this research cued children to adopt different cognitive stances, which caused the observed differences in children’s post-test executive function abilities.

A possible limitation of the presented results might be that there were no manipulation checks concerning whether or not the instrumental condition incited normative responses. Although the ritual and instrumental condition differed in the use of generic and specific language respectively, to ensure that ritual condition points to a normative convention, future research should include tests to ensure that verbal instructions or the tasks to be learnt in the instrumental condition do not evoke a normative response.

Questions may also remain concerning the extent to which the social aspect of the intervention may have had some unintended effect on the study results. It would be difficult to state that the social nature of the intervention had a confounding effect because both ritual and instrumental intervention were administered socially, with significant differences observed between the two intervention groups. In other words, if the fact that intervention was administered socially was an important factor, no significant differences would be found between the instrumental and ritual groups.

In any case, it is possible that there may be differences between measurements if individually and socially administered tasks were compared. However, as both social and individual intervention would be – in principle – activating the same mechanisms this effect would not call into question the results of the research on its own. Furthermore, the fact that many actions – both ritual and instrumental – are performed in social contexts may call into question the ecological validity of an individually administered intervention as opposed to a socially administered intervention. Moreover, the adapted intervention games used in this research were designed by Tominey and McClelland (2011) to be administered in groups, i.e. socially. To replicate the results from the previous studies, the intervention used in this research must have stayed as close to the previous administrations as possible.

It is plausible that a set of cognitive abilities that are involved in executive functioning enables humans to control maladaptive and prepotent responses, and helps to override impulses by consciously controlling thoughts and actions. This allows humans to adopt more adaptive or advantageous behaviours that are necessary for pursuing various different goals (e.g. pursuing academic studies, quitting smoking, losing weight, exercising regularly). It is further predicted in this thesis, that, as such, executive function is a crucial component in the ability to delay gratification – i.e., the ability to resist the temptation of a smaller but more immediate reward in order to receive a larger or more enduring reward later. Therefore, additional analyses are required to demonstrate a relationship between executive function and the ability to delay gratification. Specifically, better executive function abilities should correlate with a greater ability to delay gratification. This effect should be present in all participants. The second analysis (presented in the next chapter) examines the prediction that executive function and the ability to delay gratification are significantly positively correlated processes.

4. Executive function and the ability to delay gratification

This chapter examines the proposal that executive function is a crucial component in children's ability to delay gratification. Because it is argued in the thesis that the effect of ritual on the ability to delay gratification is mediated by improvement in executive function, this study aimed to show that executive function and the ability to delay gratification are indeed correlated, and that improvement of the former leads to improvement of the latter. The study was designed to assess the prediction that

(2) Participants' executive function and their ability to delay gratification will be significantly positively correlated: children with better executive function abilities will be able to delay gratification longer than children with lower executive function abilities.

Research on the ability to delay gratification has shown that this ability is positively correlated with achievements in schooling (e.g. Kirby et al., 2002; Reyes-García et al., 2007), better abilities to cope with stressful situations (e.g. Mischel, Shoda, & Rodriguez, 1989: 933; Shoda, Mischel, & Peake, 1990), and with resisting behavioural tendencies that lead to unhealthy or chronic lifestyles, such as substance abuse, depression, anxiety, and anger (e.g. Bickel & Marsch, 2001; Kirby, Petry, & Bickel, 1999). Because executive function is crucial in regulating behaviour in situations which require impulsivity to be overridden, it is likely that delaying gratification requires executive function: executive function enables maladaptive and prepotent responses and urges to be overridden, in order to employ those more adaptive or advantageous behaviours that are necessary for pursuing goals that are temporally distant or that have delayed payoffs, as opposed to goals that are immediately salient. Moreover, the research suggests that both executive function and the ability to delay gratification follow a similar course of development. Although until four years of age it is almost impossible to delay gratification, the ability to delay becomes increasingly available as children age. This change takes place at the same time as children's executive function develops into a more structured ability and gains in efficiency (as discussed in the previous chapter). Taking these results into account, it is predicted that improvement of children's executive function will in turn enhance their ability to delay gratification. The fact that executive function and the ability to delay gratification have been shown to be important predictive factors of early academic achievement as well as social and cognitive functioning during adulthood (e.g. Duckworth & Seligman, 2005, Eigsti et al., 2006), calls for an improved understanding of these two cognitive abilities, the relationship between the two, and their possible improvement. This chapter will continue by first explicating the hypothesised relationship between executive function and the ability to delay gratification. It will then present an analysis that will address the nature of the relationship between executive function and the ability to delay gratification.

4.1. Connecting executive function and the ability to delay gratification

In their longitudinal study, Eigsti et al. (2006) predicted that the ability to delay gratification might be a developmental precursor for cognitive control, which was measured by an inhibitory task ten years later. The authors defined cognitive control as the ability to "suppress attention and responses to irrelevant information, even when the information is highly salient" (Eigsti et al., 2006: 478). Cognitive control increases through development and is marked by a "decrease in individual's susceptibility to interference from competing information" (Eigsti et al., 2006: 478). In both a delay of gratification task and a go/no-go task, performance requires controlling a prepotent response: behavioural response in the go/no-go task and resisting temptations in the delay of gratification task. Eigsti and colleagues examined whether the proportion of time preschoolers (four years old) spent delaying rewards would predict their performance in the go/no-go task in adolescence (14 years old). Although the authors did not find significant correlations between delay time and the performance in the go/no-go task, they found that children who were, as four-year-olds successful in directing their attention away from the tempting features of the reward, were faster and better (made fewer errors) in performing the go/no-go task ten years later. Eigsti et al. (2006) explain the failure to find a correlation between the number of seconds of waiting time and performance in the go/no-go task by the fact that the delay time variable was characterised by a very high proportion of scores at ceiling.

However, the relationship between an individual's executive control and their ability to delay gratification might run the other way: the enhancement of an individual's abilities in cognitive self-control (the executive function) might enhance one's ability to delay gratification. It is proposed in this study that the executive function, which involves the ability to plan, consider choices and control one's behaviour, allows the coordination of activities involved in the delay of gratification situations, and thus could be a predictor of an individual's ability to delay gratification. To our knowledge, no study has linked these two abilities in children, and this attempt has only been made in a single study with university students by Weatherly and Ferraro (2011), who found that the measure of the executive function was a significant predictor of the ability to delay gratification. This result shows the possibility that improving the executive function could lead to enhancing the delay ability.

Another indication that executive function and the ability to delay gratification might be linked comes from the study of Shamosh et al. (2008). The authors predicted that individual differences in working memory will account for differences in intelligence and the ability to delay gratification. Brain regions involved in working memory, defined as the "ability to maintain active representations of goal-relevant information despite interference from competing or irrelevant information" (Shamosh et al., 2008: 904), overlap with those that support the ability to reason and solve problems (fluid intelligence). Since the ability to delay gratification requires one to maintain in mind the values of the rewards, and to mentally manipulate different information and alternatives, the authors predicted that working memory-related brain activity would be related to delayed reward preference. Using fMRI, the authors found that working memory-related activity was observable in the areas of the prefrontal cortex (left anterior prefrontal cortex and lateral frontopolar cortex), and that this activity was associated with higher intelligence and greater resistance to tempting immediate rewards. Moreover, the left anterior prefrontal cortex, which was found to be activated during performance of the working memory task, is the region "principal role [of which] is to integrate the products of multiple, concurrent subtasks promoting a superordinate behavioural goal, especially when these products are abstract or complex" (Shamosh et al. 2008: 909–910). Such abilities are necessary when we face the choice between immediate rewards and more time-distant ones. This brain region is also associated with episodic memory, which has been proved to have an important role in delaying gratification (see section 1.6.2). Given that this brain region is activated to a higher degree during performance in working memory tasks, and is integrated when we need to mentally manipulate (evaluate and hold in mind) abstract components (future selves, delay periods, delayed rewards, future consequences and goals), it seems probable that the ability to delay gratification is partially related to working memory.

In general, activity in the prefrontal cortex has been connected to cognitive processes involved in the delay of gratification situations. Fuster has suggested that the prefrontal cortex "allows the organism to reconcile *sensations and acts that are mutually contingent but temporally separate from one another*" (Fuster, 1990: 320. Original emphasis), as is the case in delayed gratification. Thus, one of the roles of the prefrontal cortex is to mediate actions that are temporally split and to connect them in a logical manner, such as bridging the gap between the behaviours required to reach a goal and the goals of these behaviours. For example, in the delay of gratification experiment used in this study, there is a temporal delay between sensory information (immediately available cues) and a response (goal) to this information, and the cross-temporal contingencies between the two have to be mediated (Fuster, 1990). In this case, the goal is not immediate or salient and is attributable to the future self. The actions, then, must be designed to bring about the future goal (ex. two sweets for the future self) at the expense of the immediate one (ex. the pleasure of having one sweet now for the present self; Kanfer, Elfriede, & Morris 1981; Moore & Macgillivray, 2004): if the goal is to receive two sweets instead of one, the participant has to wait and not eat the one sweet that is available immediately. The logic of cross-temporal contingencies in this case is *if now A, then later B+; if earlier A, then now B*; that is to say if I eat the sweet now, I will not receive the additional one later; because I did not eat the sweet earlier, I will get two sweets now. Fuster (1990) has shown that large numbers of cells in the dorsolateral prefrontal cortex are activated during such temporally separate but contingent events, suggesting that these cells play a role in the representation of the events and the inter-connections between them. Fuster's result was confirmed by the more recent study of Lebreton and colleagues (2013), which showed that the dorsal prefrontal cortex, together with the hippocampus, was involved in preventing impulsivity during choice situations.

Theory of mind (ToM), “a system involving mental state categories, such as beliefs, desires, and intentions” (Moore & Macgillivray, 2004: 53) is likely to play an important role in this process. As our actions are to a substantial extent guided by postulating mental states, and by our ability to predict and explain behaviours by attributing mental states to others and to ourselves, it is plausible that the ability to represent an individual’s own mental state across time (the feelings brought about by the result of a successful action) will help to overcome the temptation to obtain an immediate reward and, instead, to persist in an effort to bring about a desired goal. In other words, one needs to separate current temptations and a temporally distant state of affairs. The ability to mentally represent the state of the future self, which is distinct from the current experience, is enabled by the ToM, allowing one to compare current and future states, and to act to overcome the temptations of current states of affairs to reach more advantageous or rewarding options.

Moore and Macgillivray (2004) propose that imagining future mental states of self can produce emphatic reaction, which serves as a powerful motivation to act. Thus, in the delay of gratification situations, individuals might give up their immediate gratification because they are in conflict with their future interest. However, humans cannot directly observe the outcomes of most of their inter-temporal choices (losing weight, finishing studies, having a satisfying relationship, etc.), they can only mentally manipulate elements from episodic memory and use them to guide decisions, while considering the consequences of these decisions. As it has been shown that past and recent personal events bring greater vividness to episodic future thinking and improve the delay ability to a greater extent than non-personal episodic thinking (Daniel et al., 2013), it is likely that combining executive function related abilities, ToM (imagining future self; Kanfer et al., 1981; Moore & Macgillivray, 2004) and episodic future thinking (imagining future scenarios in as much detail as possible, as discussed in section 1.6.2; Daniel et al., 2013; Lebreton et al., 2013; Peters & Büchel, 2010), provides motivation to resist consummatory qualities of immediate rewards (Boyer, 2008; Rick & Loewenstein, 2008). The impulsive decisions are thus reduced and greater consideration of delayed outcomes takes place.

Based on presented literature, it is proposed that the ability to delay gratification is likely to be linked to other important self-regulatory mechanisms, such as inhibitory control, working memory and attention – the target components of executive function, defined as the cognitive ability to control our behaviour. If this was the case, interventions effective in improving executive functioning would also lead to the improvement of the ability to delay gratification. The next section introduces participants and methodology to examine this proposal.

4.2. Method

4.2.1. Study design

As described in the previous chapter (section *3.6.1. Study design*), the study design was divided into three phases. During the first (pre-test) phase, the measures of executive function and delay of gratification were administered. During the second phase the participants underwent the intervention manipulation. During the third phase, the measures of executive function and delay of gratification were re-administered.

4.2.2. Participants

The details about participating children, as well as the attrition rates and between-culture differences are described above in section 3.6.2.

4.2.3. Measures

The measures are described above in section 3.6.3. For the present analysis, only the dataset for the participant's executive function and their ability to delay gratification were used (participation group assignment was not a factor).

4.3. Results

For the analysis presented in this chapter, the dataset for participant's executive function and the ability to delay gratification were used. Participant's intervention group assignment was not used. Descriptive statistics for the executive function scores are included in Table 6 in section 3.7. Descriptive statistics for the ability to delay gratification scores are included in Table 13 below.

Delay of gratification scores	**Pre-test**	**Post-test**
Mean	8.919	10.10
Std. Error of Mean	.4917	0.35
Median	10.192	11.68

Mode	15.0	15.00
Std. Deviation	5.4757	5.08
Variance	29.983	25.841
Skewness	-.323	-.713
Std. Error of Skewness	.217	.168
Kurtosis	-1.384	-.856
Std. Error of Kurtosis	.431	.335
Range	15.0	15.00
Minimum	.0	0.00
Maximum	15.0	15.00

Table 13: Descriptive statistics for the ability to delay gratification scores

4.3.1. Inter-rater reliability and pre-test comparisons

Inter-rater reliability was excellent for both the HTKS task (*Cohen's κ* = .99; *n* = 103) and the delay of gratification task (*Cohen's κ* = .96; *n* = 107).

Experimental conditions did not differ in age, $t_{(207)} = 1.7631$, $p = .17$, or sex, $\chi^2_{(2, N = 210)} = 5.25$, $p = .07$. Nor did they differ in pre-test executive function [$F_{(2, 123)} = 1.35$, $p = .26$] and delay of gratification scores [$F_{(2, 123)} = 1.97$, $p = .14$]. There were no significant differences in delay of gratification scores between the Slovak and Vanuatu sample (see Table 14 below). All the children attended at least 97% of intervention. Furthermore, it was found that most (*n* = 138) children were unable to delay gratification for the entire experimental period of 15 minutes; suggesting that there is sufficient variance to proceed with an analysis of variance (ANOVA) if the statistical assumptions are satisfied, as discussed below.

	t-test	***p-value***	***Lower CI***	***Upper CI***
Delay of Gratification Score Time 1	1.793	.075	-.183	3.717
Delay of Gratification Score Time 2	.081	.936	-1.513	1.642

Table 14: Results of testing for significant differences between Slovak and Vanuatu sample (confidence intervals calculated using 1,000 bootstrapped samples).

4.3.2. Testing assumptions of ANOVA

Before moving on to the data analyses, non-robust methods for testing assumptions of ANOVA (normality, homogeneity of error variances, and presence of outliers) and linear regression (normality of errors, homogeneity of errors, linearity, and independence of errors) were implemented, using IBM SPSS version 21. The results of the assumptions tests are presented in tables 15 and 16 (yes = assumption satisfied, no = assumption not satisfied; HTKS1 = pre-test executive function scores, HTKS2 = post-test executive function scores, DG1 = pre-test delay of gratification scores, DG2 = post-test delay of gratification scores).

GROUP	ANALYSIS	LINEARITY	NORMALITY OF ERRORS	HOMOSCEDAS-TICITY	INDEPENDENCE OF ERRORS
all	regression	**yes**	**no**	**no**	**yes**

Table 15: Assumptions tests 1 for the executive function and delayed gratification scores

GROUP	ANALYSIS	NORMALITY				HOMOGENEITY OF ERROR VARIANCE		OUTLIERS			
		HTKS1	HTKS2	DG1	DG2	HTKS2	DG2	HTKS1	HTKS2	DG1	DG2
pre-tested	one-way ANOVA intervention	no	**no**	no	**no**	**no**	**yes**	**yes**	**no**	**yes**	**no**
non-pre-tested	one-way ANOVA intervention	N/A	**no**	N/A	**no**	**no**	**no**	N/A	**yes**	N/A	**yes**
all	2 x 2 ANOVA	N/A	**no**	N/A	**no**	**no**	**no**	N/A	**no**	N/A	**no**
	one-way ANOVA intervention	N/A	**no**	N/A	**no**	**no**	**no**	N/A	**no**	N/A	**no**

Table 16: Assumptions tests 2 for the executive function and delayed gratification scores

For classic parametric tests to produce accurate results the assumptions must be met; however, in this case the assumptions were not met in several tests, as can be seen in tables 15and 16. It has been shown that these assumptions are rarely met when real data are analysed, as discussed in section 3.7.3. Therefore, to analyse the data robust statistical procedures which are suitable to analyse nonnormal and heteroscedastic data while maintaining the power of the test, were used.

4.3.3. Relationship between executive function and delayed gratification

It was predicted that the children with higher scores in the HTKS task would be more successful in the delay of gratification experiment; that is, they will be able to sustain longer waiting periods than the children with lower levels of executive function. To test whether children's executive function predicted their ability to delay gratification, a robust[34] (percentile bootstrap) regression analysis with the Theil-Sen estimator[35] (Wilcox, 1998) was performed. The input for analysis was each participant's HTKS score (measured as the sum of each item score, as described above in section 3.6.3); and each participant's delayed gratification score, as measured by the time in minutes that they were able to delay gratification on the marshmallow test. In order to test the hypothesis that higher executive function scores will predict longer waiting periods on the delay of gratification task, a

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[34] As the data violated several assumptions of analysis of variance (ANOVA) and regression (for details), robust statistical methods to test the prediction was used (see section *2.8.3. Testing assumptions of ANOVA* for a detailed description of assumption tests and their results).

[35] A method of slope estimation insensitive to outliers and heteroscedasticity, based on Kendall's correlation tau.

regression analysis was used. Consistent with our prediction, higher scores on the executive function measure (the HTKS task) predicted longer waiting periods on the delay of gratification task (β = .26, p < .001, R^2 = .26; also see Table 6 in Appendix 4).

It could be concluded that, consistent with the prediction, executive function and the ability to delay gratification were significantly positively correlated: children with better executive function abilities were able to delay gratification for longer than children with lower executive function abilities. The fact that these results were observed for both pre-test and post-test scores suggest that the effect of interventions designed to improve executive function can be transferred to the ability to delay gratification; in other words, executive function improvement may, in turn, enhance the ability to delay gratification.

4.4. Discussion: The role of executive function in the ability to delay gratification

The previous studies and theoretical frameworks suggest that some of the key components of executive function – working memory, attention and inhibitory control – are crucial for a successful ability to delay gratification:

- Working memory serves to maintain active representations of goal-relevant information and manipulate abstract components involved in the delay situations (future selves and the consequences of our present behaviours, delayed rewards, etc.) It becomes essential in connecting temporally separate sensations and behaviours, and goals. More precisely, when the actions and goals need to be mentally linked in a sequential (rather than simultaneous) manner, working memory connects the information across time, and bridges temporal gaps between immediately available cues and goals we want to achieve (Fuster, 1990).

- Attention is crucial in order to focus on goal-relevant stimuli, instead of focusing on cues that signal indulgence and immediate gratification. When attention shifts from cues signalling long-term advantages towards cues signalling gratification, the individual fails to exert self-control and surrenders to the tempting, gratifying stimuli of immediate rewards. In these situations, individuals are “less attentive to cognitive and affective signals indicating a conflict or discrepancy between desired and current states and attend to cues associated with reward and gratification” (Inzlicht and Schmeichel, 2012: 452). Additionally, when attention shifts to the possibility of immediate reward, people fail to notice that certain behaviours should be inhibited and they react impulsively – they abandon their long-term goals in order to satisfy momentary desires. Similar results were found in the study of Eigsti et al. (2006, mentioned earlier): children who were successful in directing their attention away from the tempting features of the reward were faster and better in performing the executive function task. Thus, it can be argued that the attention shifts lead to inhibitory control, the ability that suppresses automatic prepotent response, being undermined, which in turn compromises our long-term goals.
- Inhibitory control suppresses impulsive behaviours related to more available or pleasing immediate rewards. In situations in which a goal is not perceptually present (finishing studies, losing weight, receiving a larger reward later, having a successful relationship, etc.) in the time when an action is supposed to be made (studying for exams, eating a salad instead of pizza, not eating one sweet now in order to receive two sweets later, resisting the urge to fight with a partner, etc.), individuals must be

attentive to the cues that are relevant to the desired goal, and inhibit impulsive, counter-productive, or intrusive thoughts and behaviours.

Thus, it seems logical to predict that enhancing one's executive function abilities (inhibitory control, working memory and attention) in turn enhances one's ability to control one's desires, immediate impulses and mechanisms, which helps to sustain longer waiting periods, and consequently delay gratification. Moreover, the choice to delay becomes more available after children reach a milestone in their executive function development: children's executive function undergoes important developmental and structural changes between five and six years of age, which is the period when children start to comprehend the advantages of the choice to give up immediate gratification in order to receive greater or more enduring rewards later (Mischel & Ayduk, 2004). The reviewed literature and the results of the present study confirm the prediction that executive function is indeed an important ingredient in the ability to delay gratification. The presented analyses revealed that children who scored higher in the executive function task (HTKS) were able to delay gratification longer. Therefore, it can be concluded that executive function (which, develops along with the ToM) plays an important role in allowing participants behavioural change to implement behaviours and actions that are necessary in order to satisfy future (mentally represented) interests and to attain long-term positive benefits at the cost of giving up immediate pleasures or tolerating unpleasant, tedious or harsh circumstances and situations.

However, two caveats must be discussed in relation to this conclusion: one more theoretical, one methodological. First, the analysis presented above cannot rule out the possibility the relationship between an individual's executive function and their ability to delay gratification might run the other way: the enhancement of an individual's abilities to delay gratification might enhance their executive function. However, it is proposed in this study that executive function, which involves the ability to plan, consider choices and control one's behaviour, allows the coordination of activities involved in the delay of gratification situations, and thus could be a predictor of an individual's ability to delay gratification. The following chapters (particularly section 5.4) will address this issue with more precision and further analysis.

Second, some might question the extent to which the participants were responding to the prompt in order to please the experimenter in the delay of gratification task. When measuring the ability to delay gratification, the protocol made sure that the participants understood how they may be rewarded for delaying gratification by being asked if they understood what kind of reward would they get if they waited for the experimenter. The participants were primed with the question "And which one will you get if you wait *for me*?" One might posit that this evoked a response rooted in the desire to please the experimenter, and therefore the relationship should be between executive function and an approval seeking motivation (pleasing an experimenter). If a child's motivation was to please the experimenter instead of receiving a larger reward (i.e. two pieces of sweets) then their gratification would be derived from pleasing the experimenter. However, most (n = 138) of the children eventually manipulated the sweet during the experiment. This shows that most of the children "failed" to please the experimenter because they failed to reach the 15-minutes threshold for the task. This shows that in any case, the children were still delaying gratification – however in this interpretation, it was not the gratification of receiving a larger reward but a gratification of receiving the experimenter's approval. Therefore, regardless of whether the gratification is in seeking the additional piece of sweet, or pleasing the experimenter (with sweets being only a means to do so), the data collected still reflect the children's ability to delay gratification.

Importantly, the results of the studies presented in this thesis so far suggest that interventions that enhance executive function abilities can in turn improve the ability to delay gratification. The next chapter examines this claim in more detail, assessing the overarching proposal of this thesis: namely that exposure to an intervention that activates a *ritual stance* (such as ritual participation) increases children's ability to delay gratification. It is proposed that the effect of intervention, and specifically ritualised intervention, is mediated by improvement in executive function. It analyses ritual intervention, executive function, and delayed gratification as part of a single cognitive system using structural equation modelling. This can allow for statistical testing of the complex relationships beyond the mediation analysis presented here and help elucidate the effects of ritual intervention between pre-test and post-test.

5. The impact of ritual on the ability to delay gratification

Recent research in developmental psychology has revealed that children are able to use the presence or absence of different cues in their environment to flexibly coordinate their learning strategies when observing a modelled behaviour (Legare et al., 2015; Hermann et al., 2013). Utilising these cues, children are able to recognise whether modelled actions are amenable to physical-causal reasoning, or whether they are based on social conventions. Different interpretive modes (or cognitive stances) are employed accordingly. As discussed in the earlier chapters, when modelled actions are inexplicable in physical-causal terms and rationales are causally opaque, lack end states, or include conventional verbal priming (Herrmann et al., 2013), children are prompted to adopt a *ritual stance* – an interpretive mode which supports the learning of normative cultural conventions. On the other hand, when modelled actions have physical/causal outcomes, and the rationale for these actions can be based on physical-causal reasoning, children adopt an *instrumental stance* – an interpretive mode supporting the learning of instrumental skills. The two stances differ in the levels of rigidity they encourage in reproducing modelled actions. Whereas causal transparency of instrumental behaviours (prompting adoption of an *instrumental stance*) allows for personal innovations, calculations of effectiveness and modifications to bring about a desired goal, cognitively opaque ritualised normative conventions such as social norms, rules, ideologies, etc. (prompting adoption of a *ritual stance*) call for rigid learning strategies because children are not able to explain why particular procedures rather than any others are carried out – no coherent causal structure that could account for the actions instrumentally is assumed when adopting a *ritual stance*. Rather, it is assumed that the actions are executed in a certain way simply because it is demanded by convention. Consequently, there is no better or worse, or more or less, effective way of performing the action sequence – conventions must be executed in a socially stipulated and proper way, which does not allow for personal innovations. Such normative conventions often include very subtle behaviours and actions (such as facial expressions, postures, etc.) that are often inaccessible to the conscious awareness of the practitioners (and are therefore hard or even impossible to articulate). Learning of these subtle behaviours and being able to replicate them in appropriate ways and contexts is related to the amount of time spent within a group, and as such functions as a reliable indicator of authentic group membership and identity (Heyes, 2013).

To overcome the potential threat of violation of such social conventions (contamination, illnesses, attacks, etc.) different rules and prohibitions (i.e. normative conventions) designed to deal with these threats are applied to social life. These include prescriptions about social life, morality and fairness, human relations and rights, etc. (Turiel, 1983). When these rules and prescriptions are violated, individuals are deprived of the feeling of stable community and the violators are judged, ridiculed, punished or ostracised (Baumeister & Leary, 1995; Haidt & Graham, 2009). This underlies the importance of rigid, imitative learning of rituals, and the competence of reproducing them in a proper prescribed and socially stipulated manner, in appropriate contexts and situations. Such demands place increased requirements on employing executive function skills: inhibiting individual impulses and inclinations (seeking and calculating more effective behaviours and actions) and instead adhering to a convention; paying attention to social categories and details of our performance (performing appropriate actions according to different situational demands); and employing working memory (manipulating the knowledge and information we hold in mind, and integrating it with situational demands).

Indeed, the analyses that have been described previously (presented in Chapters 3 and 4) have shown that (1) ritual is executive function-demanding and ritual participation improves children's the executive function, and (2) executive function and the ability to delay gratification are significantly positively correlated – higher scores in the executive function task predict longer waiting periods among study participants.

To follow, this study examines the proposal that ritual participation (in contrast to participation in instrumental activities) improves children's ability to delay gratification, i.e. the ability to forego a smaller but more immediate reward in order to receive a larger or more enduring reward later. As a first step, delay ability requires an individual to consider the available options and make a decision, and consequently sustain the delay – which often proves to be more difficult and frustrating than initially anticipated. It is proposed in this study that the capacity to sustain the delay of gratification can be facilitated by ritual participation. It was thus predicted in the present study that an intervention imbued with ritual cues would improve children's ability to delay gratification to a greater extent than an instrumental intervention. Furthermore, a mediation model, such that the effect of ritualised intervention games on children's ability to delay gratification is mediated by improvements in executive function, was proposed.

The methods of this study were designed to assess these predictions step by step:

(3) Rule-based intervention games will improve children's ability to delay gratification, with games that incorporate a 'ritual stance' having the largest effect on this improvement.

(4) *The effect of rule-based intervention games on children's ability to delay gratification will be significantly mediated by executive function.*

(5) *The effect of a ritual stance on children's ability to delay gratification will be significantly mediated by executive function.*

As some of the recent studies have shown that ritual participation promotes cooperation and charitable and prosocial behaviour (that is, voluntary behaviour that intentionally benefits others; Brooks, 2003; Ginges et al., 2009; Sosis and Ruffle, 2003; van Baaren et al., 2004; Wiltermuth and Heath, 2009), which requires organising individual's actions to bring about a goal that is in the interest of others at the expense of his/ her own immediate gratification, it is possible that ritual also promotes delaying gratification as an action toward the interests of the individual's future self. Following the theoretical approaches discussed in previous chapters (e.g., rituals and normative conventions, executive function, the ability to delay gratification), the next section describes the methods used to examine the study's predictions.

5.1. How does ritual promote the ability to delay gratification?

According to the "zero contribution thesis", a rational individual will not act in order to achieve group interest – instead, he or she will act in order to achieve selfish gain providing individual satisfaction (Olson, 1965: 2). Generally, unless there is a special device to motivate individuals to contribute to public good, individuals will act in order to achieve their own immediate self-interests. However, if the personal benefit of collective action is larger than the personal cost of delaying or suspending immediate gratification, people become more motivated to cooperate: e.g. the famous example of the prisoner's dilemma (Tucker, 1983) shows that when people cooperate instead of betraying their partners, they receive greater future payoffs. Thus, individuals who act altruistically or in order to benefit another, and forego immediate gratification (keeping the resources, saving time and energy, etc.), often do so to receive a larger future benefit – the benefit of collective group action.

Norm following is but one example of giving up immediate individual gratification for the 'greater good' and pleasing our social partners – for example, instead of skipping the queue, we patiently wait for our turn; instead of keeping the money, we pay taxes each year; instead of saying whatever is on our mind, we must often hold back in order to be considered polite and well-behaved.

Another example of giving up immediate individual gratification is altruistic and charitable behaviour: instead of keeping the resources for themselves (e.g. money, crops, energy), people often donate to charity or help out others. Along with some previous studies, we argue that if ritual attendance promotes social cohesion (e.g. Henrich, 2009; Whitehouse, 2012), it in turn promotes individual investments (even within large-scale societies), that would otherwise be impossible. Indeed, it was shown that the frequency of ritual attendance (not only religious, but also secular) is positively correlated with cooperative behaviour and norm following (Brooks, 2003; Sosis & Ruffle, 2003; Wiltermuth & Heath, 2009): some recent studies demonstrated that ritual engagement reduces selfish behaviour and promotes cooperation (Ginges et al., 2009; see also Sosis & Ruffle, 2003; Wiltermuth & Heath, 2009) and charitable behaviour (Brooks, 2003), and that it is ritual participation – not a personal devotion – that significantly predicts greater positive regard for parochial altruism (Ginges et al., 2009).

This effect might be connected to how social rituals are learnt and transmitted by means of rigid imitative learning, which was shown to increase liking and cooperative tendencies among participants. Some studies argue that engaging in imitative actions promotes affiliation and liking (van Baaren et al., 2004; Wiltermuth & Heath, 2009), with even unintentional mimicking of simple actions (foot shaking, face touching), termed as the *chameleon effect*, increased the liking between the social partners; participants mimicked by their confederates reported higher liking of interaction partners and perceived their mutual interaction as more pleasant and smooth, as opposed to the control (not-mimicked) participants (Chartrand & Bargh, 1999). Also, participants primed with affiliation expressions, such as “friend”, “together”, “cooperation”, mimicked their confederates significantly more than participants primed with neutral words and expressions. This phenomenon seems to emerge relatively early in development. Fawcett and Liszkowski (2012) found that 18-moths-old infants are more likely to invite an adult to join their game after they have been previously mimicked by the adult. Besides increased affiliation, research participants engaged in ritualised behaviours also manifested increased prosocial orientation (van Baaren et al., 2004; Wiltermuth & Heath, 2009).

As ritual promotes the ability to organise actions and behaviours toward the interest of others (prosocial orientation), it is likely that it will also promote individuals to organise actions toward the interest of the future self, i.e. with respect to individuals’ own future goals and interests. The results of the present study are consistent with this hypothesis, showing that children’s performance in a delay of gratification task improved in a condition where activities were framed as prescribed conventions, i.e. among the children assigned to the *ritual* intervention group: when the intervention games were primed by ritualistic words and reasons (it has to be done this way, it has always been done this way, it is necessary we do it this way) children's actions were driven by social motivations and conventions, which require higher levels of imitative rigidity, and consequently place greater demands on executive function. Executive function improvement in turn enhanced children's ability to delay gratification. Although children from the *instrumental* group evidenced better ability to delay gratification than their peers from the *control* group, they were significantly outperformed by the children from the *ritual* group, whose ability to delay gratification was better than that of children assigned both to the *instrumental* and *control* groups.

Moore and Macgillivray propose that there is similarity between altruism (acting in interests attributable to another person) and prudence (acting in the interest of the future self): "in both cases, the actor must imagine and empathise with a noncurrent state of affairs – the other person's in the case of altruism and one's own future in the case of prudence" (2004: 52). Indeed, in an empirical study conducted by Thompson, Barresi and Moore (1997), children who chose to share obtained rewards with others were also more likely to delay gratification. Both of these processes require attributing mental states to another, suggesting the employment of ToM in the process: Moore, Barresi and Thompson (1998) showed that the performance on the ToM task was significantly correlated with children's (four-years-old) tendency to share and delay gratification, indicating that ToM capacity may be related to the ability to give up immediate rewards when they are conflicting with the interests of someone else or, in the case of delayed gratification, the future self. Future prospective thinking or imagination is utilised in the ToM processes to mentally represent states of affairs that are not salient and are different from ones currently experienced (because they belong to either another person or the future self).

Because ToM follows a similar developmental path as executive function and parallels children's understanding of diverse mental states (Moore, Barresi, & Thompson, 1998; Moore & Macgillivray, 2004); and episodic future thinking is one of the crucial processes governed by the cognitive abilities involved in executive function (i.e. mentally manipulating and recomposing ideas in working memory), it was likely that the effect of intervention, as well as the effect of ritual intervention, on children's ability to delay gratification was mediated by executive function improvement, as further predicted in the presented research.

5.2. Method

5.2.1. Study design

As described in the previous chapter (section *3.6.1. Study design*), the study design was divided into three phases. During the first (pre-test) phase, the measures of executive function and delay of gratification were administered. During the second phase the participants underwent the intervention manipulation. During the third phase, the measures of executive function and delay of gratification were re-administered.

5.2.2. Participants

The details about participating children, as well as the attrition rates and between-culture differences are described above in section 3.8.2.

5.2.3. Measures

The measures are described above in section 3.6.3.

5.2.4. Intervention and experimental manipulation

The intervention and experimental manipulation is described in section 3.6.4. To summarise, the intervention period lasted three months, with participating children randomly assigned to one of three groups: *ritual* (N = 71), *instrumental* (N = 69), or *control* (N = 70). Those assigned to the *ritual* and *instrumental* groups were taken out of the classroom twice a week, in groups of eight to ten, to participate in group 'circle time' games (Tominey & McClelland, 2011) to improve behavioural self-regulation. Six circle time games were played in each session, which lasted 30 to 45 minutes. Games in the *ritual* condition incorporated a ritual priming manipulation designed to promote adoption of a ritual stance: generic normative language was used, no rationale or explanation was provided for the actions in the games, and no goal was specified, and the instructions were accompanied by assertions such as "it has always been done this way", to encourage interpretation of the actions as conventional rather than instrumental. In contrast, games in the *instrumental* condition incorporated an instrumental priming manipulation designed to promote adoption of an *instrumental stance*: instructions were accompanied by explanations such as "if we do it this way, we will learn about different animals", to encourage interpretation of the actions as having instrumental value and a goal. Children assigned to the control group played none of these games and stayed in the classroom with their teacher.

5.3. Results

For the present analysis, all participant data were used in the analysis. The descriptive statistics for the executive function scores are included in Table 6 in section 3.7 and the descriptive statistics for the ability to delay gratification scores are included in Table 13 in section 4.3.

5.3.1. Inter-rater reliability and pre-test comparisons

Inter-rater reliability was excellent for both the HTKS task (*Cohen's* κ = .99; N = 103) and the delay of gratification task (*Cohen's* κ = .96; N = 107).

Experimental conditions did not differ in age, $t_{(207)} = 1.7631$, $p = .17$, or sex, $\chi^2_{(2,\ N = 210)} = 5.25$, $p = .07$. Nor did they differ in pre-test executive function [$F_{(2,\ 123)} = 1.35$, $p = .26$] and delay of gratification scores [$F_{(2,\ 123)} = 1.97$, $p = .14$].

All the children attended at least 97% of intervention.

5.3.2. Testing assumptions of ANOVA

Before moving on to the data analyses, non-robust methods for testing assumptions of ANOVA (i.e. normality, homogeneity of error variances and presence of outliers) and linear regression (i.e. normality of errors, homogeneity of errors, linearity and independence of errors) were implemented, using IBM SPSS version 21. The results of the assumptions tests are presented in tables 15 and 16, pp. 215. As the assumptions were not met in several cases, robust statistical procedures were used to analyse the data.

5.3.3. Multilevel analyses

To test for potential differences in the effect of ritualised intervention on the ability to delay gratification between the two cultures, multilevel analyses were performed, with delay of gratification scores (delay time was measured in minutes) as an outcome variable, and participants' nationality (Slovak vs. Vanuatu coded as 1 and 2 respectively) as a random effect (i.e. nationality is a factor that is not manipulated by the experimenter).

In this study, the ability to delay gratification was predicted to be significantly improved by attendance in the ritual treatment group, with the effect of ritual priming being significantly mediated by children's executive function (as described in the predictions, section 0.1). However, when analysing the data, some differences might be expected to be found between subjects from different countries; that is to say, children from Vanuatu might, for the reasons described above (*kastom* lifestyle, presence of imagistic rituals, traditional schooling), respond differently to Slovak children. The cultural environment is a factor that must be taken into account when data from cross-cultural studies are analysed. However, this factor is qualitatively different to the control vs. experimental group attendance: the parameters vary at more than one level – the data have a hierarchical structure, or, in other words, are nested (i.e. experimental and control groups are embedded within the two countries).

To account for possible variations caused by the different cultural environments, and to determine variation and patterns in the data, children's nationality was introduced as a random effect (nationality is a source of random variation, and is not manipulated by an experimenter), given that the results within experimental and control groups might vary according to the subjects' nationality. Moreover, the fact that half of the children in each treatment group come from the same cultural environment might cause dependency (i.e. violation of the independence of errors assumption), and therefore high and significant intra-class correlation. To ensure that this was not the case and to check whether the data should be (a) analysed separately for each country, or (b) merged and analysed as a whole, multilevel analyses were performed using the *NLME* package in *R*. Various models were created, and each of the newly-created models was compared to the previous one, which was the same in all but one parameter (new fixed and random variables were added, to test for potential improvement) by testing the difference in the log likelihood ratio (*-2LL*) in two models (also known as the likelihood ratio test). This difference was used to evaluate whether random effects must be considered and to assess the overall fit of the models.

First, the null model, with no predictors and post-test delay of gratification scores (DG2) as an outcome variable, was created. Since there were no predictors or effects set, only the intercept in this model was estimated. The value of *-2LL* of the null model was 1274.7 (a table describing all values can be found in Appendix 4 Table 7). To provide a comparison to the null model, the new model (Model 1, see Table 8a, 8b, and 8c in Appendix 4), with intervention as a fixed effect (independent variable) and DG2 scores as an outcome (dependent) variable, was created. It was predicted in this thesis that the type of intervention would significantly predict children's ability to delay gratification. More precisely, the ritual intervention was predicted to improve children's ability to delay gratification to a significantly greater extent than the instrumental intervention. Therefore, introducing the type of intervention as a fixed factor (predictor of DG2) should significantly improve the model. The *-2LL* value of the first model was 1232.93. A Chi-square test of the difference between *-2LL* of the null and the new model with intervention as a fixed effect was highly significant ($p < .0001$), with intervention being a significant explanatory factor of children's post-test delay of gratification scores. It can thus be concluded that introducing intervention into the model as a fixed factor very significantly improves the fit of the model.

A second multilevel model with intervention as a fixed effect and nationality (Slovak vs. Vanuatu) as a random effect was created (presented in Table 9 in Appendix 4). In other words, it was assumed in this case that the variance of post-test delay of gratification scores might be affected by children's nationality. Attendance in the experimental groups (instrumental and ritual) and control group was nested within children's nationality, which might have affected the post-test delay of gratification scores within these groups. More precisely, the hypothesis that the post-test delay of gratification scores within the groups would vary according to subjects' country of origin (for example, Vanuatu children might have higher or lower scores than children from Slovakia) was tested. The *-2LL* value of this model was 1232.76. A Chi-square test of the difference between the *-2LL* of the first (with intervention as a fixed effect and post-test delay of gratification scores as an outcome variable) and second model was negligible and not significant (p = .96) (see Table 9b in Appendix 4).

This model could not be accepted and therefore it could be concluded that children's nationality (as a random effect) was found to explain very little variance in the post-test delay of gratification scores: only less than .7% of the variance in DG2 scores was explained by the random effect, i.e. the children's nationality (*ICC* = .007, also see Table 10 in Appendix 4).

In other words, no evidence has been found in this thesis to support the hypothesis that there would be a difference in the effect of the intervention between participants from Slovakia and Vanuatu. This might perhaps be a result of the fact that the learning of normative conventions is equally important in all societies, regardless of their structure, size or belief system. As such, learning of normative conventions might be primarily supported by neurophysiological structures in our cognitive architecture, rather than influenced by various cultural traits (or alternatively, it may be influenced in a way that was not accounted for in this thesis). It was thus concluded that the intervention had a similar effect on the children from both countries. Therefore, subsequent analyses will pool the two samples as a single dataset.

5.3.4. Effects of circle time games intervention on delayed gratification

This study investigated whether the circle time games intervention improved children's ability to delay gratification, especially when coupled with ritual priming. The participant's intervention condition (control, ritual, or instrumental) was coded as a nominal variable of 0, 1, or 2. Delay of gratification was coded as the time in minutes that a participant was able to delay gratification on the marshmallow test. This data can be employed in an ANOVA to statistically test for significant differences on the ability to delay gratification between the intervention groups.

It was predicted that, compared to the children assigned to the control group, the post-test delay of gratification scores (DG2) would be significantly improved among children assigned to the experimental groups (ritual or instrumental). It was further predicted that ritual priming (the independent variable) will cause a significantly larger improvement in children's ability to delay gratification (the dependent variable) than instrumental priming. These predictions were tested using robust ANOVAs with 20% trimmed means (Welch-type), and by analysing linear contrasts between groups. The analyses were performed using *R* version 3.0.1 with package WRS (Wilcox Robust Statistics), based on Wilcox (2012), and tested the effect of a three-level factor (no intervention vs. instrumental intervention vs. ritual intervention) on children's performance in the delay of gratification experiment.

Again, the meta-analysis designed by Braver and Braver (1988) was first performed. Because an evidence for pre-test sensitisation (i.e., the pre-test might be one of the factors influencing the post-test scores) occurred in the post-test delay of gratification scores ($F_{(1, 206)} = 12.4$, $p < .001$; see Table 11 in Appendix 4), the possibility that the intervention only had an effect in combination with the pre-test needed to be ruled out.

Thus, the data of pre-tested and non-pre-tested children were analysed separately. Significant effects of the intervention for both pre-tested ($F_{(1, 33.73)}$[36] $= 5.35$, $p < .03$, $\xi = .38$[37])

[36] The degrees of freedom were adjusted because of trimming.

[37] Robust explanatory measure of effect size: negligible $\xi < .15$, small from $\xi = .15$ to $\xi = .3$, medium from $\xi = .3$ to $\xi = .5$, large $\xi > .5$.

and non-pre-tested children ($F_{(1,\ 51.99)}$[38] = 49.63, p < .001, ξ = .68) were found, demonstrating that the intervention was effective in improving the ability to delay gratification even in the absence of the pre-test (further information can be found in Tables 12 and 13 of Appendix 4).

Next, a robust 3 (condition) × 2 (delayed gratification task administration: pre-test v. post-test; within-subjects) mixed design ANOVA was performed (mean scores are reported in Table 17). This revealed a main effect of delayed gratification task administration, indicating that scores on the delay of gratification measure improved after the intervention. This was qualified by an interaction between the delayed gratification task administration factor and condition, indicating differences in the improvement of the ability to delay gratification between children from the *control*, *instrumental* and *ritual* groups, $F_{(1,121)}$ = 8.78, p < .001, η^2 = .34 (also see Table 14 in Appendix 4). A follow-up one-way robust ANOVA on the post-test delayed gratification scores revealed large differences in the ability to delay gratification at post-test between the *control* and intervention (*ritual* and *instrumental*) groups ($F_{(2,\ 72.5)}$ = 31.1, p < .001, η^2= .53; also see Table 15a in Appendix 4). These differences explained 28% of the variance in post-test delay of gratification scores. At post-test, children from the *instrumental* group evinced better ability to delay gratification than their peers from the *control* group (p < .001, η^2 = .17; also see Table 15b in Appendix 4). However, the largest improvement was recorded among children from the *ritual* group, whose ability to delay gratification was better than that of children assigned both to the *instrumental* (p < .002, η^2 = .16) and *control* groups (p < .001, η^2 = .49; also see Table 15b in Appendix 4), thus confirming the prediction that the intervention games incorporating a *ritual stance* would have the largest effect on the improvement of children's ability to delay gratification.

[38] See footnote 27.

		Ritual Intervention Condition		
		None	*Instrumental*	*Ritual*
Delay of Gratification Score	*Pre-test*	6.232843137255	8.042949	12.154487
	Post-test	11.091870	10.865854	12.264286

Table 17: Average delay of gratification scores by ritual intervention condition

As predicted, the intervention games improved children's ability to delay gratification. Moreover, the intervention games that incorporated the ritual priming and activated a *ritual stance* were found to have the largest effect on this improvement.

5.3.5. Mediation analysis 1: The effect of intervention on the ability to delay gratification

As discussed earlier, for children to be able to overcome longer waiting periods, it is necessary to employ abilities such as inhibitory control, attention and working memory. These are all parts of what is defined as executive function. It was argued that executive function and the ability to delay gratification were correlated (as demonstrated in Chapter 4). Moreover, it was argued that the intervention (i.e. the independent variable) would have a significant effect (with executive function as the mediating variable) on children's ability to delay gratification (i.e. the dependent variable), as measured by a participants' post-test delay of graditifcation scores. This effect would be mediated by the improvement of executive function (independent variable 2). In other words, intervention will directly improve children's executive function, which would in turn directly improve their ability to delay gratification and sustain longer waiting periods. To test this prediction, robust mediation analysis was conducted, using the Zu-Yuan method (with Huber-type M-estimator, used in conjunction with a percentile bootstrap method),[39] as described in Zu and Yuan (2010) and in Wilcox (2012). The participant's intervention condition (no intervention recieved vs intervention recieved) was coded as a nominal variable of 0 (no intervention recieved) or 1 (intervention recieved). Executive function was measured as the sum of a participant's scores for each item on the HTKS task. Delay of gratification was coded as the time in minutes that a participant was able to delay gratification on the marshmallow test. This analysis confirmed the proposed mediation model that the effect of intervention on the ability to delay gratification was significantly mediated by executive function (β = 2.28, p < .001, also see Tables 16a, 16b, and 16c in Appendix 4).

In addition to the robust mediation analysis, a path analysis (using AMOS 19) was performed to determine the contribution of the indirect effect of intervention condition (relative to the direct effect of executive function) to the total effect. In this case, the indirect effect of intervention on children's delayed gratification scores was tested for. The indirect effect was defined by the path '*intervention→ executive function→delay of gratification'* (executive function being the mediator between intervention and the ability to delay gratification) and the direct effect by the path '*intervention→delay of gratification'*. The sum of the indirect and direct effects comprises the total effect. The model with executive function as a mediator was found to have a good fit ($\chi^2_{(1)}$ = 1.83, p = .18, CFI = .99, see Table 18 below), with the standardised total effect being .3, of which .21 was contributed by the standardised indirect effect of intervention condition on post-test delayed gratification scores.

[39] Method of slope estimation insensitive to outliers and heteroscedasticity, used to eliminate the problem with the Theil-Sen estimator (in various situations the actual level of the test can drop well below the nominal level, which could result in very low statistical power).

Standardized Total Effects (ALL - Default model)		
	Intervention	HTKS2
HTKS2	.434	0
DG2	.301	.473
Standardized Indirect Effects (ALL - Default model)		
	Intervention	HTKS2
HTKS2	0	0
DG2	.205	0

Table 18: Path analyses, control vs. experimental groups

Thus, the analyses confirmed the prediction that the effect of rule-based intervention games on children's ability to delay gratification was significantly mediated by executive function.

5.3.6. Mediation analysis 2: The effect of ritual on the ability to delay gratification

Robust statistical analyses indicated that rule-based intervention games incorporating a ritual priming manipulation led to a greater improvement in the ability to delay gratification than games incorporating an instrumental priming manipulation. To test the prediction that the effect of ritualistic intervention games (i.e. independent variable 1) on children's ability to delay gratification (i.e. the dependent variable) would be significantly mediated by executive function (i.e. independent variable 2), a robust mediation analysis was conducted using the Zu-Yuan method with Huber-type M-estimator as above. The participant's intervention condition (control, ritual, or instrumental) was coded as a nominal variable of 0 (control), 1 (instrumental) or 2 (ritual). Executive function was measured as the sum of a participant's scores for each item on the HTKS task. Delay of gratification was coded as the time in minutes that a participant was able to delay gratification on the marshmallow test. In other words, it was predicted that the intervention imbued with ritual cues would directly improve children's executive function, which will in turn directly improve their ability to delay gratification. The indirect effect was defined by the path '*ritual intervention→ executive function→delay of gratification'* (with executive function being the mediating variable). The direct effect was defined by the path '*ritual intervention→ delay of gratification'*. Finally, an additional path analysis (using AMOS 19) was conducted to determine the contribution of the indirect effect of ritual priming (relative to the direct effect of executive function) to the total effect. This analysis indicated that the model had a good fit ($\chi^2_{(1)}$ = .17, p = .68, CFI = 1.00, also see Tables 17a, 17b, and 17c in Appendix 4), with a standardised total effect of .48, of which the standardised indirect effect of ritual on post-test delay of gratification was .28 (see Table 19 below). This result confirmed that the effect of the *ritual* condition on children's ability to delay gratification was significantly mediated by their executive function.

Standardized Total Effects (ALL - Default model)		
	Intervention	HTKS2
HTKS2	. 523	0
DG2	.475	.532
Standardized Indirect Effects (ALL- Default model)		
	Intervention	HTKS2
HTKS2	0	0
DG2	.278	0

Table 19: Path analyses, control vs. ritual group

In sum then, it could be concluded that last prediction was confirmed: The effect of a *ritual stance* on children's ability to delay gratification was significantly mediated by executive function. That is to say, there is a significant statistical relationship between the ritual intervention and the improvement in delaying gratification and that this relationship is partially mediated by executive function abilities.

5.4. Can the ability to delay gratification mediate the executive function improvement?

Based on the results reported in this thesis, it has been demonstrated that ritual participation is associated with the improvement of children's ability to delay gratification. This seems reasonable to hypothesise: The reward for participating in conventional actions is often not immediate. For example, when greeting a fellow group member appropriately, or when preparing a meal a specific way to share with a neighbour or friend, it is unlikely that one will be compensated immediately for their action. However, it will signal that everyone has the same group membership and therefore the individual will be more likely to benefit from the actions of the other people in the future. Furthermore, the causal opacity of ritual actions cause the actors to delay any immediate gratification as rituals do not seem to function to promote immediate benefits to an individual. That is not to say it does not have benefits to the participants; for example, a ritual can serve to solidify social ties may allow an individual to receive aid in the future. Some scholars of religion, such as Stark and Bainbridge (1987) have noted that many religious groups in western cultures are largely premised on the proposal that by participating and sacrificing time for the group now, they will be rewarded in the afterlife; in this way they frame entire religious systems as delayed gratification systems.

However, given the experimental design presented in this thesis, it is necessary to test and discuss an alternative model. More specifically, given that the executive function and the ability to delay gratification were measured at the same time, there is a possibility that the relationship between the two is inverse from the one presented here: the ability to delay gratification might be the mediating mechanism between ritual participation and executive function. i.e. ritual participation improves children's ability to delay gratification, which in turn improves their executive function. The relationship between executive function and the ability to delay gratification is critical to understand as neither of these variables was explicitly manipulated (only measured) in the presented design. Therefore, each could – at least mathematically speaking – serve as the mediating variable in a statistical analysis of the data in this study. It is therefore crucial to discern which of these variables is – theoretically speaking – exerting the mediating force (m) on the dependent (y) variable.

Given that ritual actions are conventional and rigid, it is likely that working memory, attention and executive function are crucial for carrying out actions that require adherence to past experiences as well as coordination with other individuals in their environment. The relationship between ritual participation and executive function thus appears to be a reasonable proposition (furthermore, given that ritual participation was manipulated in the presented design, it allows for the inference of some directionality, i.e. that ritual participation "causes" an increase in executive function).

Thus, the possibility that the improvement of the ability to delay gratification mediated the executive function enhancement was tested. Using the PROCESS macro for IBM's SPSS software, which can be used for robust bootstrapped analyses, the analyses did not reveal a positive effect (the results are presented below in Table 20). Although it was revealed that the ability to delay gratification does have a significant mediating effect, this significant effect was found to be negative (Sobel's test for indirect effects: *Effect* = -.5787; *SE* = .0424; $p < .001$; 95% *CI* [-.6536 - -.5010]), i.e. the variance that the ability to delay gratification explains in the model is negative. Even though the executive function is still improved from pre-test to post-test (*Effect* = .0895; *SE* = .0196; $p < .001$; 95% *CI* [.0510 - .1281]), this appears to be driven by the direct effect relationship between the two time periods (*Effect* = .6682; *SE* .0424; $p < .001$; 95% *CI* [.5847 - .7518]), which given earlier analyses appears to be the effect of intervention. To conclude, the hypothesised model with the ability to delay gratification being a mediator between ritual and executive function could not be accepted as the alternative model provides a more parsimonious explanation.

	Effect	SE	P	Lower CI	Upper CI
Indirect Effect	-.5787	.0424	<.001	-.6536	-.5010
Direct Effect	.6682	.0424	<.001	.5847	.7518
Total Effect	.0895	.0196	<.001	.0510	.1281

Table 20: Effects, SE, P-values, and 95% CIs of Mediation Model

5.5. Pre-test – post-test structural equation modelling

In addition to other robust statistical methods, Structural Equation Modelling (SEM) analyses were performed as part of the data analyses. One of the key advantages of SEM is the facility to construct latent variables and take into account their scores instead of the scores of measured variables, i.e. SEM enables one to test complex patterns (e.g. relationships between different conditions, groups, variables, etc.) and facilitates working with latent variables and constructs that cannot be directly observed. The latent variables are constructed from different measured variables, which are predicted to tap the latent variables. This allows one to estimate the fit (i.e. reliability) of the constructed models. SEM also incorporates relations among measurement errors into the model, thus providing more reliable conclusions than other statistical models. In this study, three different models were created in AMOS 19 and tested for how they fit the data. The model parameters were estimated using multi-group analyses.

5.5.1. SEM model 1: Effects of intervention

The first SEM model was created to test for the effects of the intervention on the ablity to delay gratification. The intervention was tested as a two-group comparison (intervention vs. no intervention). The subjects tested were pre-tested children from both countries (N = 124). Multi-group comparison was based on assigning children to the control group (N = 41) vs. the experimental (*ritual* or *instrumental*) groups (N = 83). This model used latent SEM, which generalises the traditional analysis of covariance techniques by incorporating latent variables and auto-correlated residuals (as originally suggested by Sörbom, 1978; and presented by Arbuckle, 2012: 241-262; see Figures 2 and 3 below).

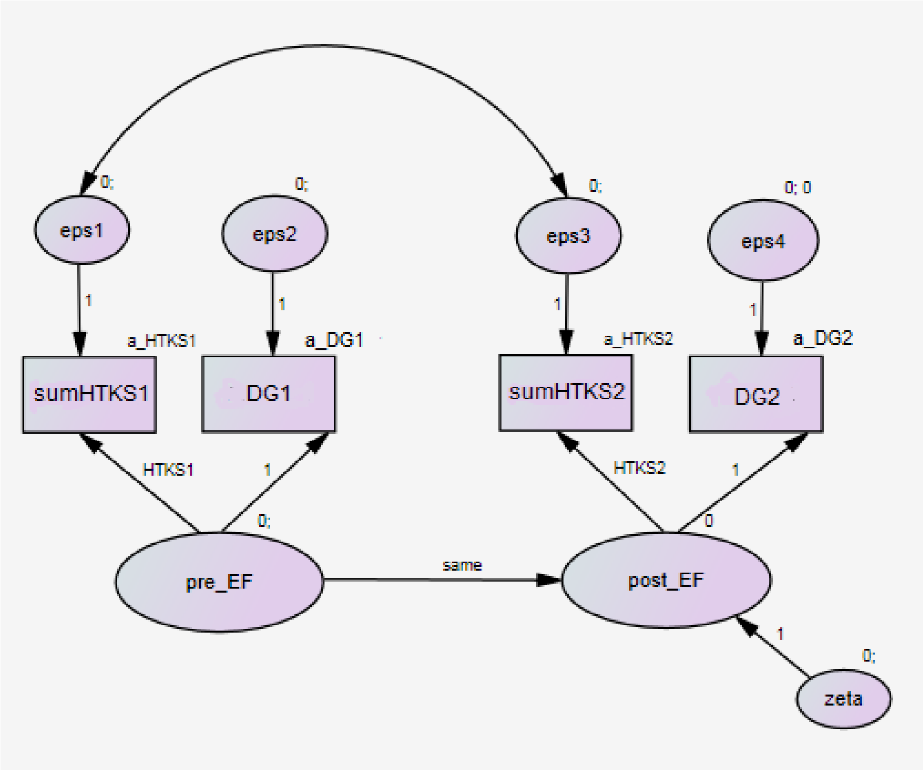

Figure 2: SEM, The path diagram for the control group

Measurement model:

- "sumHTKS1", "DG1" – indicators of the latent variable "pre_EF" (pre- executive function, i.e. the executive function ability measured during the pre-test phase);
- "sumHTKS2", "DG2" – indicators of the latent variable "post_EF" (post- executive function, i.e. executive function ability measured during the post-test phase).

Structural model:

- "post_EF" linearly depended on "pre_EF"

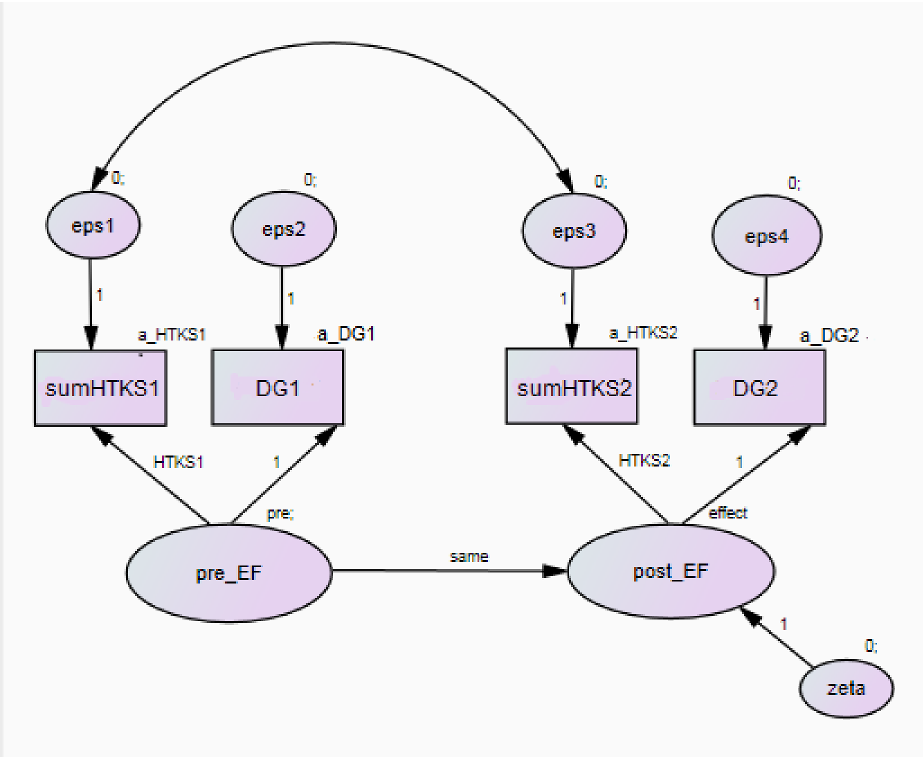

Figure 3: SEM, The path diagram for the experimental group

Measurement model:

- "sumHTKS1", "DG1" – indicators of the latent variable "pre_EF" (pre-executive function, i.e. executive function ability measured during the pre-test phase);
- "sumHTKS2", "DG2" – indicators of the latent variable "post_EF" (post-the executive function, i.e. executive function ability measured during the post-test phase).

Structural model:

"post_EF" linearly depended on "pre_EF"

For the control subjects, the mean of "pre_EF" and the intercept of "post_EF" were fixed at 0, thus establishing the control group as the reference group for the multi-group comparison of latent scores. This enabled to identify the latent variable means and intercepts. For the experimental subjects, the mean and intercept parameters of the latent factors were allowed to be non-zero. The latent variable mean labelled "pre" represented the difference in executive function ability prior to intervention, and the intercept labelled "effect" represented the potential performance improvement of the experimental groups relative to the control group.

The original model has been modified by using modification indices, suggesting the addition of a covariance between "eps1" and "eps3" in the experimental group (or, in other words, to free autocorrelation of their residuals): because "eps1" and "eps3" both represented the variation in the HTKS scores obtained by administering the same test at two different times, it was reasonable to assume that "eps1" and "eps3" might have been positively correlated. The path diagrams are presented in Figures 2 and 3; the results for the model are presented in Figures 4 and 5.

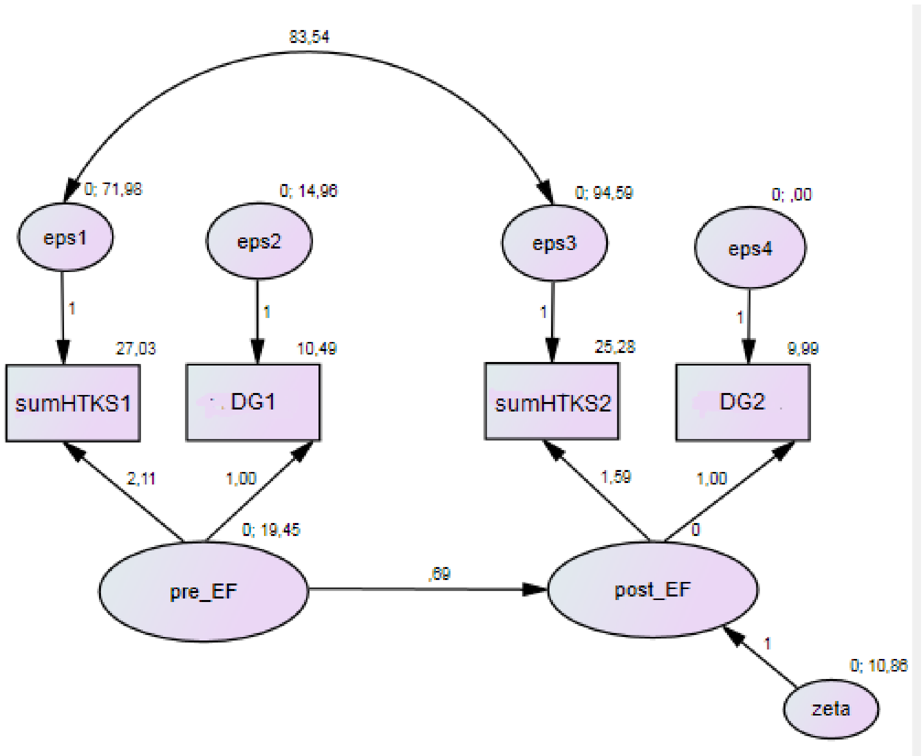

Figure 4: SEM, The parameter estimates for the 41 control subjects

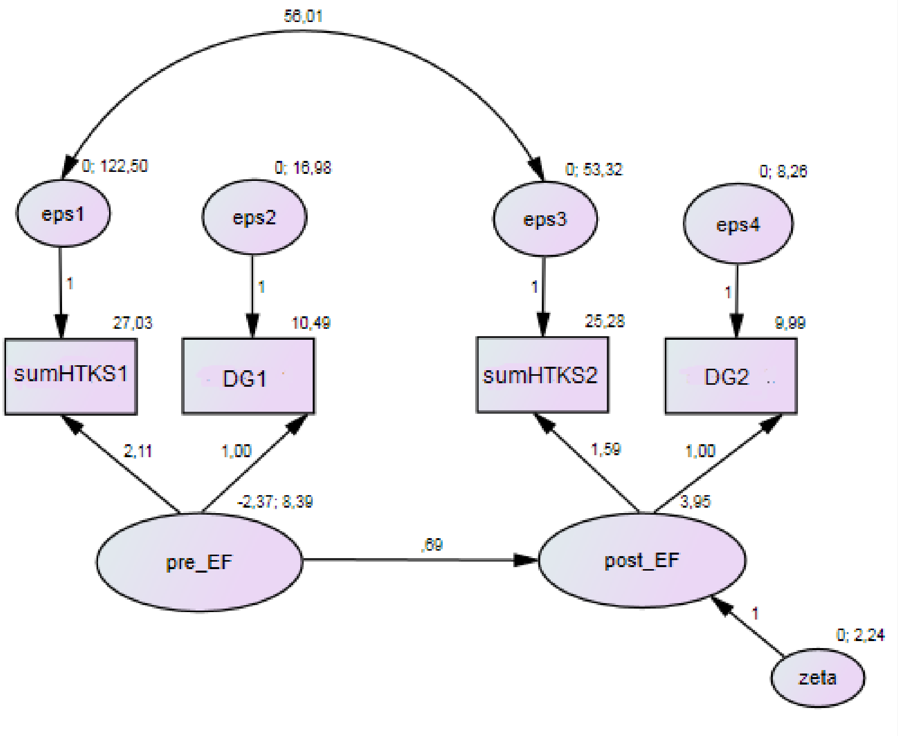

Figure 5: SEM, The parameter estimates for the 83 experimental subjects

The results showed that the model had a very good fit ($\chi^2_{(6)}$ = 11.6, *p* = 0.072, *CFI* = .96); all regression weights, variances and covariances were positive. The intercept for the experimental group was estimated as 3.95, with critical ratio 5.445, *p* < .001 (i.e. the probability of getting a critical ratio as large as 5.445 in absolute value was less than .001). In other words, the intercept in the equation for predicting “post_EF” was significantly different from zero at the .001 level (two-tailed; more information is included in tables 18a, 18b, 18c, and 18d in Appendix 4). It could be concluded that the intervention did indeed have a significant effect on performance in the delay of gratification task for children from the experimental groups (both *ritual* and *instrumental*), relative to the control participants.

However, one could argue that the differences between the two groups (experimental and control) already existed at the time of the pre-test. To rule this out, an alternative model with the additional constraint that the intercepts be equal across groups was created. In other words, it was assumed that the differences in the post-test scores between control vs. experimental groups were caused by differences existing at the pre-test. Thus the intercepts for both control and experimental group were set to 0.

The chi-square value of the model increased significantly (from 11.596 to 38.537), and *CFI* dropped from .967 to .813. The results suggested that this model cannot be accepted at any conventional significance level (see Table 21 below). Because the fit of this model was significantly worse than that of the previous model, the hypothesis of equal intercepts had to be rejected. In other words, the control and experimental groups were shown to differ at the time of the post-test in a way that couldn't be accounted for by differences that existed at the time of the pre-test.

Model	NPAR	CMIN	DF	P	CMIN/DF	NFI Delta1	RFI rho1	IFI Delta2	TLI rho2	CFI
Default model	21	38.537	7	< .001	5.505	.787	.634	.818	.680	.813
Saturated model	28	.000	0			1.000		1.000		1.000
Independence model	16	180.735	12	< .001	15.061	.000	.000	.000	.000	.000

Table 21: SEM Model 1- Effects of intervention, pre-test differences only

5.5.2. SEM model 2: Effects of ritual and instrumental intervention

The second model was constructed to test for the effect of the *ritual* and *instrumental* interventions. 124 pre-tested children from both countries were tested (N = 124). Multi-group comparison was based on assigning children to the control group (N = 41) vs. the *instrumental* group (n=41) vs. the *ritual* group (N = 42) (intervention as a three-group comparison).

The effects of the *ritual* and *instrumental* intervention were tested by creating a three-group model (control vs. *instrumental* vs. *ritual* group).[40] The model fitted the data very well, the path results for instrumentally primed subjects are presented in Figure 6, while the results for ritually primed subjects appear in Figure 7.

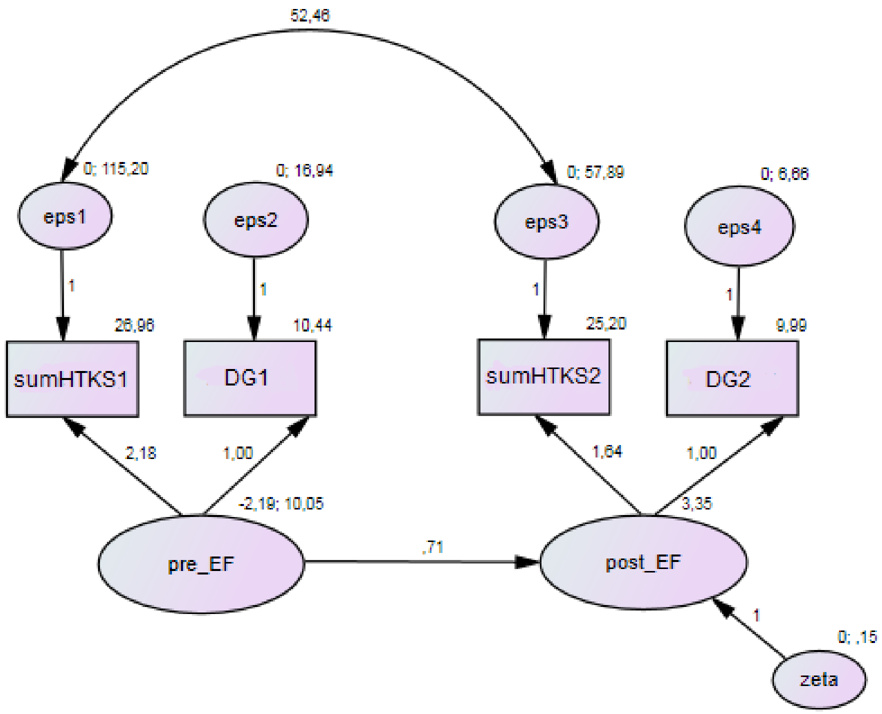

Figure 6: SEM, The parameter estimates for the 41 instrumentally primed subjects

[40] To test the effects of the ritual and instrumental treatment the first model with some labelling modifications (the labels for means and intercepts in the ritual group have to be renamed, otherwise the same estimates would be provided), could be used – the model was generalised from testing the effect of treatment vs. non-treatment to test non-treatment vs. ritual treatment vs. instrumental treatment. Because the path diagram (and the parameter estimates) for the control group were the same, only the parameter estimates for the two intervention groups were reproduced in diagrams.

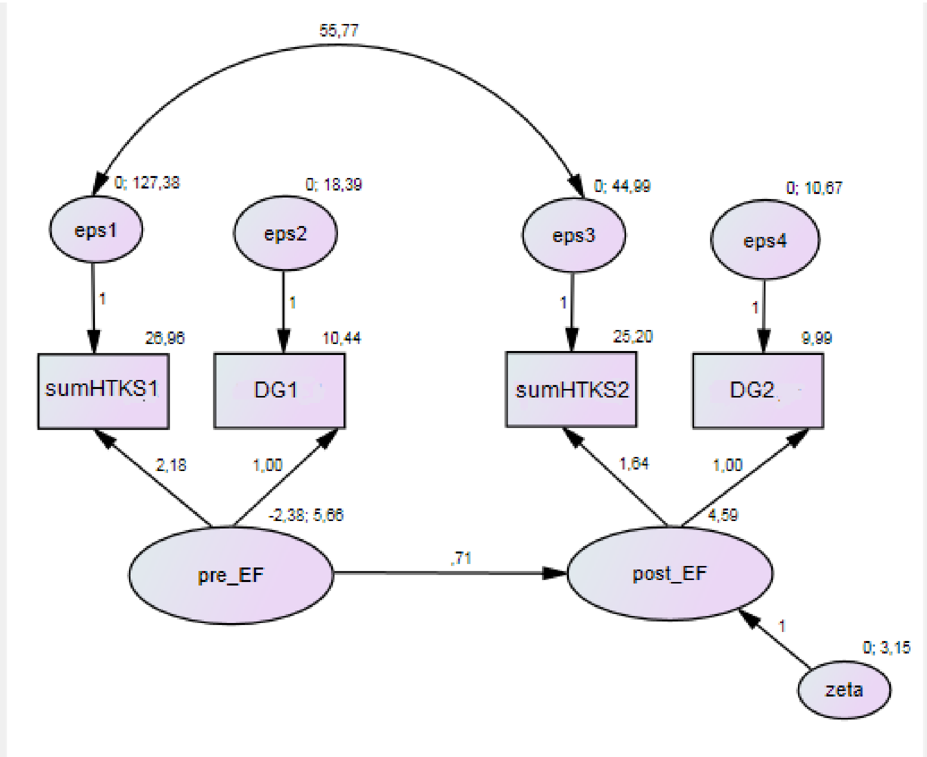

Figure 7: SEM, The parameter estimates for the 42 ritually primed subjects

The intercepts for the treatment groups were estimated as 3.345 (*instrumental*) and 4.585 (*ritual*), their critical ratios were 4.535 and 5.538 respectively, $p < .001$ in both cases. Put in other words, the intercepts in the structural equations for predicting "post_EF" were significantly different from zero at the .001 level (two-tailed) (for more information see Tables 19a, 19b, 19c, 19d, and 19e in Appendix 4).

Because of its higher complexity (i.e. more parameters and paths) comparing to the previous model the chi-square value of this model increased (from 11.596, $df = 6$ to 14.762, $df = 11$). It could be concluded that both *instrumental* priming *and ritual* priming had significant effects on children's post-test scores. Again, it could be argued that the differences between the groups (i.e. control vs. *instrumental* vs. *ritual*) already existed at the time of the pre-test. To rule this possibility out, the stability of the effect was tested by setting the intercepts to 0 in the instrumental and ritual groups. In both cases the model could not be accepted at any significance level. It could be concluded that the differences between the control, *instrumental* and *ritual* groups (with children assigned to the *instrumental* and *ritual* treatment groups having better scores in both the executive function and delay of gratification measures) were caused by the intervention and the type of the intervention, and that these differences were significant and not present at the time of pre-test.

5.5.3. SEM model 3: Effects of ritual vs. instrumental intervention

The previous three-group model clearly showed the significant effect of a *ritual* stance, but an objection could be raised that all it had demonstrated was the combined effect of adopting an instrumental *and* a ritual stance. The question then became: would the *ritual* priming still display its power when tested against the *instrumental* priming group (without the control group)? The issue was resolved by specifying two groups only: the *instrumental* group and the *ritual* group, using the *instrumental* group as a control group against the *ritual* group (uniquely in the case of a ritual–instrumental comparison, the instrumental group can be considered a control group). If *ritual* priming had its effect only in combination with the *instrumental* priming, or only because of features it shared with the *instrumental* priming, the results of this test would be non-significant. Thus, the third model tested for the difference between *ritual* and *instrumental* intervention. It was predicted that there would be a significant difference between the two types of intervention. This model used 83 pre-tested participants assigned to *ritual* and *instrumental* intervention groups. Multi-group comparison was based on assigning children to the *instrumental* group (N = 41) vs. the *ritual* group (N =

42) (intervention as a two-group comparison). The results for instrumentally primed subjects are presented in Figure 8 and for ritually primed subjects in Figure 9.

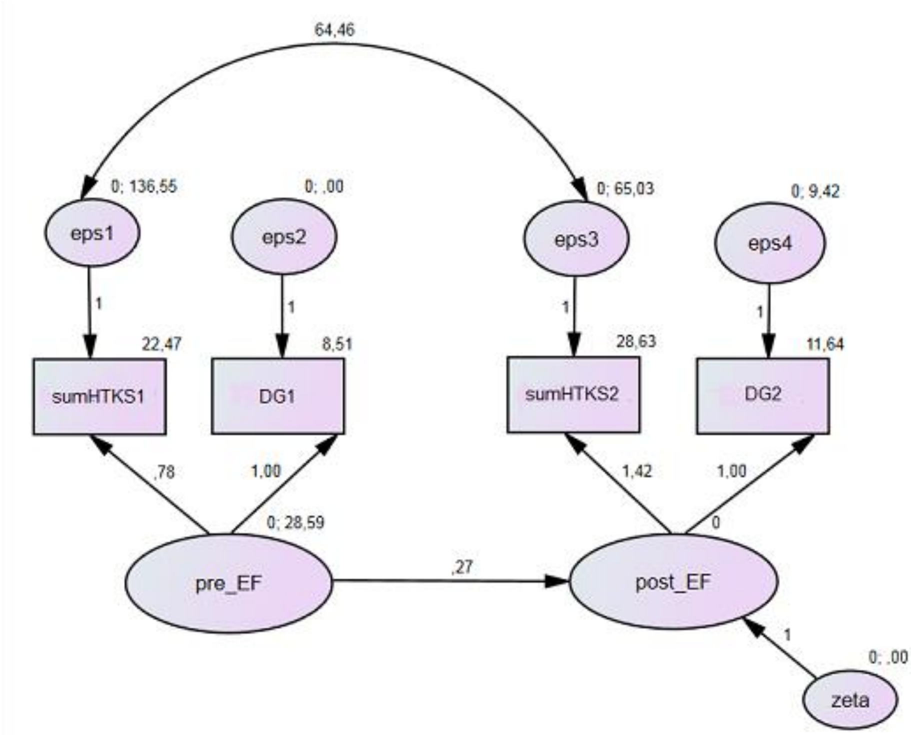

Figure 8: SEM, The parameter estimates for the 41 instrumentally primed subjects

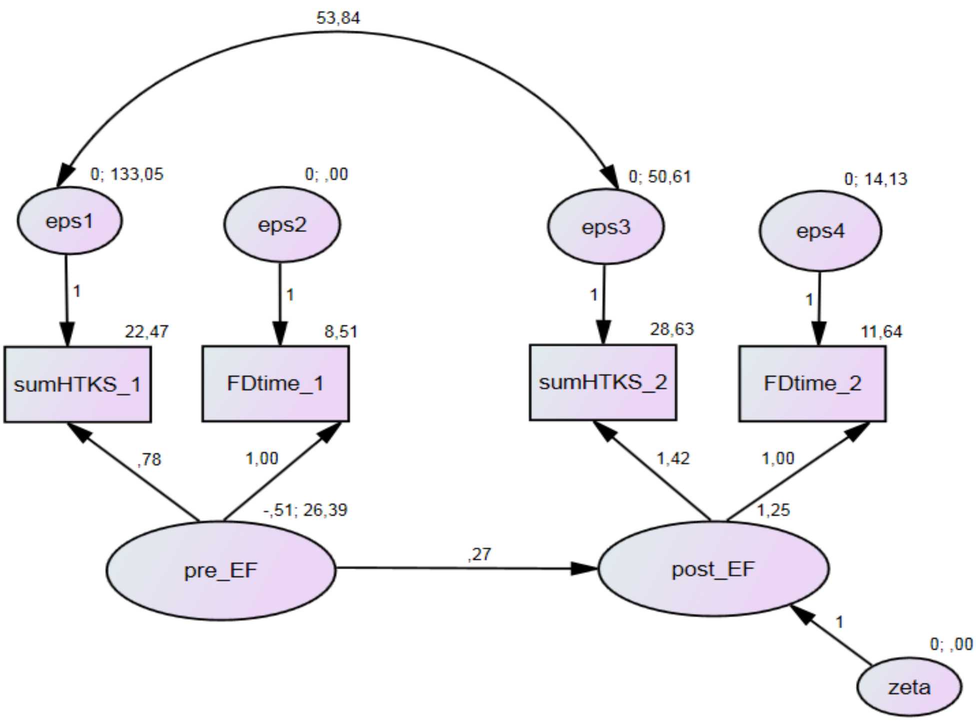

Figure 9: SEM, The parameter estimates for the 42 ritually primed subjects

The intercept for the ritual group was estimated as 1.252, with a critical ratio of 2.003, *p* = 0.045 (see Tables 22).

	Estimate	S.E.	C.R.	P	Label
post_EF	1.252	.625	2.003	.045	effect_r
sumHTKS_1	22.469	1.446	15.535	<.001	a_HTKS1
DG_1	8.511	.845	10.066	<.001	a_DG1
sumHTKS_2	28.631	1.042	27.483	<.001	a_HTKS2
DG_2	11.636	.503	23.121	<.001	a_DG2

CMIN

Model	NPAR	CMIN	DF	P	CMIN/DF
Default model	19	7.974	9	.537	.886
Saturated model	28	.000	0		
Independence model	16	80.788	12	<.001	6.732

Baseline Comparisons

Model	NFI Delta1	RFI rho1	IFI Delta2	TLI rho2	CFI
Default model	.901	.868	1.014	1.020	1.000
Saturated model	1.000		1.000		1.000
Independence model	.000	.000	.000	.000	.000

RMSEA

Model	RMSEA	LO 90	HI 90	PCLOSE
Default model	.000	.000	.115	.680
Independence model	.266	.213	.322	.000

Table 22: SEM Model 3: Effects of ritual vs. instrumental intervention

The analyses showed that the intercept for the ritual group was significantly different from the intercept for the instrumental group. It could be concluded that a *ritual stance* had a significant effect on children's performance, not only in comparison with the control group but also in comparison with the instrumental group. The children assigned to the ritual intervention group achieved significantly better scores on both executive function and delay of gratification measures than children assigned to *instrumental* intervention group. Ritual, with its specific demands on executive functioning, thus improved children's executive function and the ability to delay gratification. Although the instrumental treatment was found to have an effect (relative to the control group with no intervention at all), the last model clearly confirmed a significant difference between the *ritual* intervention and the *instrumental* intervention, with the former being more effective in improving children's ability to delay gratification. Structural Equation Modelling, a more powerful alternative to the general linear analysis of covariance (ANCOVA), reveals a pattern of statistical relationships that supported the prediction that a *ritual stance*, by enhancing executive function, significantly improves children's ability to delay gratification.

5.6. Discussion: Rituals improve the ability to delay gratification

The results above reveal a pattern of statistical relationships consistent with the prediction that the effect of *ritual stance* on children's ability to delay gratification is mediated by executive function. Structural equation modelling confirmed the results of previous statistical analyses and revealed that (1) the intervention was effective in improving children's executive function and the ability to delay gratification, (2) there was a significant difference between the two kinds of intervention, with the *ritual* intervention leading to significantly greater improvements than the *instrumental* intervention, and that (3) the between-group differences were not attributable to the differences at the time of the pre-test, thus providing support for the prediction that a *ritual* stance, by enhancing executive function, significantly improves children's ability to delay gratification.

Chapter 3 assessed and confirmed the prediction that rituals are executive function demanding. In line with previous research on enhancing children's executive function, it was argued that executive function can be improved by carefully designed interventions. The present study used a series of intervention games designed by Tominey and McClelland (2011), designed to improve children's executive function skills. It was expected to replicate and extend Tominey and McClelland's (2011) finding that these games improve children's executive functioning, as measured via the HTKS (Head-Toes-Knees-Shoulders) task, a direct measure of the relevant aspects of behavioural regulation (viz., inhibitory control, attention, and working memory; Cameron Ponitz et al., 2009). Additionally, it was predicted that when intervention is primed by ritual cues, children's executive function would improve to greater extent, compared to conditions when intervention was primed by instrumental cues. The analyses confirmed these predictions and revealed that scores on the executive function measure improved after the intervention. Moreover, the post-test HTKS scores revealed large differences in post-test executive function between the control and intervention (ritual and instrumental) groups: children assigned to the *instrumental* group scored higher on the executive function task than children assigned to the control group, and the largest improvement was recorded among children in the *ritual* group, who scored higher than their peers from both the control and *instrumental* groups. The presented effects seem to be due to the adoption of the ritual stance, which would have an increased burden on executive function and therefore may entrain the processes of executive function. As many real-world rituals are repeated actions that one may participate in multiple times throughout one's life, it is likely that ritual participation would successfully have the subsequent efficient of increasing the executive function of individuals in many real-world contexts. Cultures and religions throughout the ethnographic and historical record are reported to have rituals which could serve just such a purpose.

These results are consistent with the study of Pietrefesa and Evans (2007) who found that among children over the age of six years, those who engaged in more ritualised or 'just right' behaviours demonstrated greater inhibitory control. Thus, based on the study results it can be assumed that engagement in ritualised behaviours (and consequently adopting a *ritual* stance) improves children's executive function, because rituals (comparing to instrumental actions) require greater behavioural self-regulation.

As the set of cognitive abilities involved in executive functioning enables humans to control and override maladaptive, prepotent or impulsive responses by consciously controlling thoughts and actions, and consequently allow individuals to employ more adaptive or advantageous actions in order to pursue our goals (e.g. quit smoking, losing weight, exercising regularly), it was predicted in Chapter 4 that executive function would be one of the crucial components in the ability to delay gratification. Consistent with the prediction, it was found that higher scores on the executive function measure (the HTKS task) predicted longer waiting periods on the delay of gratification task; suggesting that these abilities were linked. Indeed, delay situations are likely to put higher demands on individual's executive function and require focusing on goal relevant stimuli (employing attention), manipulating abstract components involved in the delay situations and mentally connecting them (employing working memory), and finally, supressing impulsive behaviours or intrusive thoughts and behaviours related to more immediate rewards (employing inhibitory control). In short, executive function enables humans to implement actions and behaviours that are consistent with their goals. The study results are supported by some previous research on engagement in ritualistic activities in order to improve self-control. These studies showed that participants who practiced martial arts with ritualistic aspects (greeting rituals, wearing traditional uniforms, signing pledges, etc.) improved in cognitive, affective and physical self-regulation, had greater gains prosocial behaviour measures (Lakes & Hoyt, 2004), expressed lower aggressiveness and anxiety, increased self-esteem, and increased social adroitness (Trulson, 1986).

Putting the results together, participation in ritualistic, conventional activities taps executive function and consequently improves it; and executive function was found to be significantly correlated with children's ability to delay gratification. Thus, it was predicted that ritual participation would improve children's ability to delay gratification. Additionally, it was predicted that the effect of ritual on delayed gratification would be mediated by improvements in executive function. As described in the literature review on ritual and ritualised behaviour, engaging in costly social rituals and thereby providing signals of commitment to group beliefs and ideologies facilitates trust, cooperation and bonding with in-group members. Communicating commitment to a group often requires individuals to suspend or delay their own immediate interests in order to conform to in-group norms and ideologies and enjoy the benefits of successful collective actions later – i.e. to delay gratification.

Thus, it could be that the ritual context cued social support and belonging, which ultimately enabled participants to better tolerate the distress of delaying gratification. As noted earlier in the thesis, rituals may also serve to bond individuals in a social group. If these mechanisms were activated in the protocol above, ritual participation may have cued social support and feelings of belonging which enabled participants to better tolerate the distress of delaying gratification. However, if this is the case, it remains to be seen why it is that adopting an instrumental stance also had a significant effect in increasing executive function. Perhaps it is not ritual *per se* that elicits social bonding mechanisms, but any collective action; this may explain why participants in both the ritual and instrumental conditions performed better than the control group. If this is the case, it would still appear that the ritual stance has an *increased* effect on executive function. Further experimentation would be needed to untangle the extent to which the mechanism is entrainment or some other cognitive mechanism. However, given that there was no pre-test effect, it seems unlikely that entrainment is the underlying mechanism. If it were the case that entrainment was the underlying mechanism behind executive function improvement, those children who were pre-tested should have exhibited a greater effect than those who were not. Regardless, any future research should be careful to account for significant differences that appear to be the result of framing an action within a ritual stance.

Additionally, there may be a question concerning the extent to which the adaptation of the Mischel's marshmallow task is actually measuring a participant's boredom threshold as opposed to the ability to delay gratification. As covered in the earlier sections of the thesis, this task has been shown to address many behavioural outcomes, including but not limited to early sexual debut, early pregnancy, lower financial status, lower levels of academic performance, etc. (Ariaga & Rusbult, 1998; Ayduk et al., 2000; Ayduk & Kross, 2008; Bickel & Marsch, 2001; Diller et al., 2008; Gross, 1998; Hoerger et al., 2011; Hanoch et al., 2013; Kirby et al., 1999; 2005). Therefore, if this task was related to a boredom threshold, it would also need to show how delayed gratification tasks measured boredom but not delayed gratification. That is to say, it would have to be posited that behavioural motivations were rooted in boredom and separate from the pursuit of gratification. Moreover, the proposal would appear to be spurious given the longitudinal data on the subject. While it may be the case that some participants react to the task at hand due to a sense of boredom and the need to have something happen, this appears to fail as an explanation for why participants in other experiments, which have used other measures for the ability to delay gratification, would exhibit so many other concurrent features.

More specific to this research however, the interpretation of the marshmallow task as one which measures boredom would appear to suggest that participants in the ritual condition were more bored overall and therefore their boredom threshold was raised through the games, which in turn would presumably enhance their performance on the delayed gratification task. However, regarding the actual actions that the children performed during the intervention, there was no difference between the ritual and instrumental tasks; the only difference was the way in which the tasks were framed in different experimental conditions. Assuming this, how it is that the ritual condition significantly decreased boredom, resulting in a higher boredom threshold at a later period of time than the instrumental condition, remains unclear. As such, it appears that interpreting the delayed gratification task within the traditional framework seems more parsimonious given the significant differences revealed between the two intervention conditions.

Furthermore, one might venture that the children experience a form of gratification from the correct performance of social actions. If indeed the children experienced gratification from the correct performance of an action, then it would be expected that there would be significant differences between the intervention and control conditions, but not between the two intervention conditions (ritual and instrumental). This is because the two intervention conditions consisted of identical behaviours and their only difference was a verbal prime used to frame the understanding of the action as instrumental or ritual; meanwhile the control participants were not required to perform the social actions of the circle-time games. However, if the intervention is not based in the gratification experienced from the correct performance of an action, but is based in the cognitive framing of an action – as proposed by this thesis – then one should expect to see significant differences not only between the control and intervention groups but also between the two intervention groups.

It could be posited that social gratification – as opposed to some material gratification – may have been a confound for this research insofar as it was present during the intervention but had no significant effect on the measurements of executive function or the ability to delay gratification. Addressing this requires some additional expansion. In the instrumental stance, actions are framed in reference to their outcome, which is linked to the actions performed during the games. In this way, it is possible for the individual to have received some sort of gratification for correctly performing the action, as evidenced by their attainment of the tasks' goals (ex. if the task was framed as performed in order to increase the participant's ability to learn the names of animals, and the child subsequently is more knowledgeable about the names of animals, they may be gratified by this). However, in the ritual stance, there is no such “goal post” whereby one can measure their success with any certainty. Instead, completing a ritual task does not evoke gratification internally but relies instead upon external reinforcement in order to achieve any form of gratification. For example, the performance of a ritual will have no known or causally discernible outcome – by definition – so no child would be able to tell if the ritual was performed correctly without some sort of feedback provided by a member of their social group. Should an authoritative member of their social group praise them for the successful completion of a ritual, it could afford the occasion for gratification. However, in lieu of such social reinforcement for the action, the means by which someone would achieve gratification remains to be seen. Furthermore, personal gratification in ritual has been posited to arise from the successful completion of rituals which are aimed to reduce the anxiety of some perceived threat in the environment (Woody & Szechtman, 2011). To review, Woody & Szechtman propose that rituals arise from perceived threats in our environment and participating in structured ritual actions can help us to mentally feel as if the threat has been mediated. This feeling of completion – that the threat has been neutralized in some way – is referred to as “yedasentience”. However, this interpretation of the research does not appear to be applicable because 1) the actions performed during the interventions were not related to perceived threats in the environment, and 2) the actions were already structured prior to any participant’s enacting them, so any perceived yedasentience should be equal for all participants.

Future research can address some of the potential limitations of the presented research. As noted in the earlier chapters, executive function has three factors. The measure of executive function used here measures all three factors. However, it is possible that these factors are not all contributing to the observed effect (i.e. increase in delayed gratification) equally; it is possible that one or two of the factors may be driving these observations. In order to investigate this potential possibility, measurements of each individual component of executive function could be obtained. Then, the SEM presented above could be amended so that the executive function variable is the result of measuring all three executive function measurements. These measurements could then be used to inform a model which breaks executive function down into these three measurements and factor loadings could be calculated within the new SEM. This would allow future studies to both replicate the overall findings of this research, but with greater clarity in regards to what aspect of executive function might be driving the observed effects.

6. General discussion

6.1. Summary and results

The overarching goal of this thesis was to examine the effects of ritual participation on children's ability to delay gratification in order to provide us with a better understanding of how different types of actions – and their understandings – can help us to improve aspects of interactive institutions such as schools. The research sought to examine the proposal that adopting a *ritual stance* would improve children's ability to delay gratification, defined as the ability to prefer a delayed reward in preference to a smaller, immediate reward. It was further proposed that the effect of adopting a ritual stance would be mediated by improvements in executive function. This proposal was situated in a broader literature relating to ritualised behaviour, delayed gratification, and executive function. The aim has been to provide a plausible account of how *ritual stance* activation increases demands on and employment of executive function and in turn result in an increased preference for larger delayed rewards. To examine the effect of ritual cross-culturally, the study included two contrasting samples: Slovakia (Western) and Vanuatu (non-Western, Melanesian). To assess the predictions a Solomon four-group design (pre-test/post-test design allowing the researcher to ensure that the results were not attributable to the influence of the pre-test) was used. Results were analysed using advanced structural equation and mediation models in order to test the hypotheses both individually and as a single system.

Overall, the results supported the prediction that ritual participation (i.e. intervention imbued with ritual cues and consequently promoting a *ritual stance* adoption) improved children’s executive function and in turn their ability to delay gratification. Mediation and structural equation models revealed that the effect of ritual on children’s ability to delay gratification was significantly mediated by improvement in the executive function. Importantly, these effects were found to be equally strong in both Western and Pacific Island populations, suggesting that the effects of ritual participation may be equally effective in widely differing cultural environments.

A casual observer might assume that ritual participation is simply a matter of mindless conformism and slavish copying. But the findings presented in this thesis suggest that rituals actually improve our capacities for critical computation, reflection, inventiveness and flexible thinking. Adopting a *ritual stance* may place more demands on executive function (encompassing abilities such as attention, working memory and inhibitory control) than adopting an *instrumental stance*. Rituals are defined in this thesis as conventional, rigid, causally opaque and goal-demoted behaviours, and as such require rigorous computation of arbitrary detail and avoidance of deviation from the normatively prescribed scripts and socially stipulated rules. When performing rituals – actions which implicitly require close adherence to procedural rules – attentional focus is narrowed to single gestures instead of end-goals. This requires fine-grained performance, precision, and concentration in order to prevent incompatible or improper actions (Zacks, Tversky, & Iyer, 2001; see also Boyer & Liénard, 2006; Keren et al., 2010; Liénard & Boyer, 2006; Norman & Shallice, 1986). Because learning and repetition of rituals are socially motivated (communicating likeness to social partners to provide reliable signs of group membership), and their misuse or misconduct can lead to ridicule, ostracism and social exclusion (Boyer & Liénard, 2006; Liénard &Boyer, 2006; Whitehouse, 2012), the requirements of rituals call for a greater understanding of social categories, greater self-awareness and voluntary behavioural self-control to avoid implied threats to social standing (Over & Carpenter, 2009; Mehta & Zhu, 2009; Friedman & Forster, 2010). It would follow from this that rituals require higher levels of executive function.

It has long been appreciated that activities that challenge executive functioning also improve it (Diamond and Lee (2011). Indeed, in line with previous research on improving executive function (Kloo & Perner, 2003; Dowsett & Livesey, 2000; Kramer & Kray, 2006; Karbach & Kray, 2009), this thesis shows that executive function abilities significantly improved after attending carefully designed intervention sessions ($F_{(1, 54.05)} = 30.22$, $p < .001$, $\xi = .63$). Moreover, when compared with an instrumental intervention, a ritual intervention appeared to challenge children's attention, working memory and inhibitory control to a greater extent, and consequently led to greater executive function improvement. Although these components of executive function were not directly measured, the results presented throughout this thesis appear to support this theoretical interpretation (as outlined in the first chapter). Children undergoing the ritual treatment scored significantly higher on the executive function measure than children in the *control* ($p < .001$, $\chi = .46$) and *instrumental* conditions ($p < .001$, $\chi = .75$).

It was further predicted that executive function abilities will be positively correlated with the ability to delay gratification. This is because executive function involves cognitive processes that are crucial for the ability to delay gratification, namely mental manipulation of elements involved in delay situations (alternative choices, future consequences, imagining and manipulating possible future scenarios, focusing on goal-relevant stimuli, suppressing impulsive and maladaptive behaviours etc.), and enables one to deliberately control one's actions and behaviours. Because the appraisal of a potential threat to one's social standing involves not only the evaluation of stimuli, but also a consideration of the current situation ("context") and future scenarios ("plans") (Woody & Szechtman, 2011: 1026), it was reasonable to predict such a correlation. Consistent with the prediction, the analyses showed that children who scored higher in the executive function task were also able to delay gratification for longer than children with lower executive function scores (β = .26, p < .001, R^2 = .26).

As the adoption of a ritual stance promotes executive function, and executive function and the ability to delay gratification were found to be significantly positively correlated, the last study assessed the over-arching prediction of this thesis, namely that ritual attendance improves the ability to delay gratification. The effect of ritual on children's ability to delay gratification was predicted to be mediated by executive function improvement. The prediction was supported by the fact that around the age of six years old children become increasingly sophisticated in social and moral norms, and more sensitive to situations that require conformity and deference (Espy, 2004; Wiebe et al., 2011). Children start to understand group goals, and some of these goals require self-imposed control of behaviour, with greater tolerance for the individuals they interact with (school-mates, teachers, friends, siblings, parents, etc.) This developmental change likely promotes greater employment – and in turn the improvement – of executive function skills.

Executive function further enables children to employ effective strategies to pursue temporarily distant goals, and activities that challenge children's persistence and immediate desires, i.e. situations that require gratification to be delayed. Thus, the more an individual is engaged in activities that are causally opaque, with outcomes that cannot be inferred by physical-causal mechanisms, and that demand deference and rigidity of performance (i.e. rituals), the more her executive function is challenged. This is a result of the need to perform conventional actions in a precise, socially accepted manner – thus making individuals more attentive to the way their actions are executed, and more sensitive to possible mistakes and the consequences of failure to replicate them (being ridiculed, judged, ostracised, etc.)

Monitoring of complex actions and controlling one's behaviour place more demands on executive function, leading to its improvement, as discussed above. The improvement of executive function in turn mediates the enhancement of the ability to delay gratification. Indeed, the analyses showed that the ability to delay gratification improved after intervention ($F_{(2,\ 72.5)}$ = 31.1, $p < .001$, η^2= .53), with the effect of intervention on delayed gratification being significantly mediated by executive function improvement ($\chi^2_{(1)}$ = 1.83, p = .18, CFI = .99). Moreover, the largest improvement was recorded among children from the *ritual* group, whose ability to delay gratification improved to greater extent than that of their peers assigned both to the *instrumental* ($p < .002$, η^2 = .16) and *control* group ($p < .001$, η^2 = .49). The mediation analyses revealed that, much like the effect of intervention, the effect of ritual on the ability to delay gratification was significantly mediated by the improvement in the executive function ($\chi^2_{(1)}$ = 1.83, p = .18, CFI = .99). In other words, improvement in executive function mediated behavioural change, as a result of which participants were able to face and tolerate the aversive situation of waiting for a desired reward. All the results were confirmed by SEM analyses, which supported the prediction that a *ritual* stance, by enhancing executive function, significantly improves children's ability to delay gratification.

6.2 Cross-cultural similarities

As discussed in the empirical chapters, there were no statistically significant differences revealed between the participants in Slovakia and Vanuatu. This was surprising given that many theoretical frameworks that address ritual and normative tightness would propose that there would be differences in executive function and the ability to delay gratification between Slovak and ni-Vanuatu participants. As discussed in the previous chapters, the theory of Divergent Modes of Religiosity (Whitehouse, 2004) proposes that there are two ritual modalities, one based on rare but emotionally arousing rituals and another based on frequent low-arousal rituals. As discussed above, Vanuatu generally appears to adhere to the category of ritual modality (the imagistic mode) based on rare but emotionally arousing rituals such as female back scarification and male nangol. On the other hand, Slovakia does not have such rare and emotionally arousing experiences. Slovak culture largely operates in the ritual modality (the doctrinal mode) with central rituals that are frequently performed and have little arousal, such as those performed by the large Catholic population in Slovakia. These ritual performance styles would presumably result in different effects because the different rituals employ different cognitive facilities; e.g. the doctrinal is reliant upon semantic memory and logically based exegetical narratives, whereas the imagistic mode is more reliant upon episodic memory and analogical exegesis of ritual meanings. In this way, it may be offered that the frequent participation and reliance upon logical exegesis may increase executive function and delayed gratification in Slovak culture. However, the imagistic mode’s reliance upon analogical thinking may also be exercising executive function in such a way that it also increases executive function and delayed gratification. In this way, the theory of divergent modes of religiosity may require greater theoretical specificity regarding how ritual and executive functions interact because it is not that one evokes executive function and delayed gratification more than another; rather, both modalities are reliant upon these cognitive facilities in some way, although the ways in which they are reliant may differ. More specifically, although it is the case that the imagistic mode (that which best describes the context of Vanuatu) is reliant upon rare and emotionally arousing experiences, the practices of *kastom* and *rispek* are examples of a subtle ritual which is performed constantly, not just on set occasions. In this way, there is a strict ritualized aspect of ni-Vanuatu culture which is neither fully imagistic nor doctrinal. Rather, the normative tightness of the culture itself imposes a ritualised aspect into daily life. In this way, future research may benefit from a more specified definition of "ritual" in the theory of divergent modes of religiosity which might help to clarify what counts as a ritual and therefore what sort of actions we should expect to have specific effects.

Similarly, theories addressing normative tightness also would have suggested that significant differences may be seen between the two cultures. For example, one could posit that the resource scarcity and lack of access to modern healthcare services would result in a more "tight" culture in Vanuatu than in Slovakia (Gelfand, et al. 2011). In this sense of normative tightness, Gelfand, et al. (2011) refer more to the implicit scripts of a culture. *Kastom* and *rispek* would be great examples of this type of cultural tightness. The cultural differences between Vanuatu and Slovakia would have led one to hypothesize that there would be performance differences between the two samples. Furthermore, Evolutionary Life History Theory would have posited that individuals with less access to resources, such as those in Vanuatu, would exhibit significantly lower ability to delay gratification than participants from Slovakia, which does not have a comparable dearth of resources (Frankenhuis, et al., 2016). However, as noted above, no significant differences were observed. It is possible that this is because the patterns noted in relation to delaying gratification may be the result of other cultural factors. For example, a well-documented pattern exists between the ability to delay gratification, resource scarcity, the date of first pregnancy and sexual debut. It is possible that these correlates are the result of cultural pressures and a lack of access to contraceptives in some cultural contexts rather than being caused by the individual's ability to delay gratification. The results of this thesis seem to suggest that more research is needed to elucidate the mechanisms underlying the cultural patterns that correlate with delayed gratification. Although the ability to delay gratification may be an important cognitive component in these cultural patterns, it is possible that context plays a large role in ways that were external to the focus of the current thesis. This is clearly a potential question for future research on the topic.

In conclusion, the theories regarding ritual and normative tightness discussed above are underspecified in regards to the roles of delayed gratification and executive function. This should be a focus for future research. Specifically, future research should address the different components in executive function and address how each one of them may have differing behavioural results or is elicited differently in different cultures. That is to say, while there were no differences between the cultures in executive function as measured by a single measure, it is possible that one of the three components of executive function is driving the results in one culture whereas a separate component is driving the results in another. In this way, the specific components of executive function become significant independent variables for future cross-cultural developmental research and such research should attempt to create unique measures that capture only a single component of executive function at a time so that more complex structural equation models – extending the model presented in Chapter 5 – can be used to better understand what aspects drive executive function in different cultures. The results of such a study may help to guide future theoretical revisions in how we approach ritual systems and normative tightness.

It is also possible that the socio-economic factors that are unique to each country affected the participants' performance. Given that no significant differences were revealed between the two groups, it may be that aspects of Vanuatu society such as ritual, combined with customary lifestyle and a lack of impulsivity cues have an equal effect as the socio-economic variables that affect the Slovak participants (e.g. greater levels of education, literacy, life expectancy, income, and physical resources). Because it appears that children in both countries performed similarly, and were affected similarly by the intervention, it might be that aspects of the cultural contexts may have had effects that ultimately balanced out the participants' performance. Future research may wish to investigate these issues further.

Nevertheless, it still remains the case that the present thesis has shown that ritual participation helps individuals to practise and enhance executive function abilities, contributing to their ability to pursue distant goals more reliably and effectively. The results presented here indicate that the common view of ritual as based on mindless copying is incomplete and neglects the human need to gain social acceptance and avoid ostracism, and the complex psychology machinery this requires. All else being equal, adopting a ritual stance makes more cognitive demands on at least some aspects of executive function than does adopting an instrumental stance; in particular, ritual practice engages those aspects of the executive function that are related to one's ability to delay gratification. Far from being a simple matter of mindless copying, ritual participation requires the kind of rigorous computation of arbitrary detail and avoidance of normatively proscribed deviation from the script that engages and exercises our executive functioning abilities.

Further, the presented results show that no significant differences were found either at the time of pre-test (suggesting similar executive function skills and similar ability to delay gratification) or post-test (suggesting that the intervention had similar effects on children's executive function and their ability to delay gratification) between Slovak and Vanuatu sample. This lack of significant differences between Slovak and ni-Vanuatu participants also provides some guidance in how it can affect education. In the way in which education is approached in Vanuatu, it is often assumed that local students cannot be taught in the same way that Western students can. Moreover, it is assumed that local teachers do not have sufficient skills to appropriately teach or handle the pressure of the occupation. This often results in volunteer teachers arriving to Vanuatu from WEIRD countries in order to teach. The issue is that these volunteers very often have no background in teaching, are very young with no experience or knowledge of how to approach children, and often teach subjects that are not related to their core area (ex. an 18-year-old Australian Peace Corps volunteer who is an undergraduate student of arts teaching third grade mathematics). As a result, these volunteers are not respected by the children. This can lead to disciplinary issues in the classroom, which are blamed on the children rather than insufficiently trained tutors; this usually results in more harm than good as students do not receive the quality education they deserve. The opposite however, does not occur; even qualified graduates from universities in Vanuatu are unable to teach in Western countries and no program exists to pay for travel and lodging in order to provide their sustenance should they wish to teach Western students. This would appear to be misguided.

Given the results above, it appears that children in both cultures operate with the same cognitive facilities and react similarity to the interventions of the study. The effects on executive function and delayed gratification were not significantly different in either culture. This fact can facilitate some general conclusions, which may help to reframe debates about education in traditional societies. Namely, assuming that children in one culture can be held to a higher standard of education than those in another becomes suspect at best. Rather, it would appear that education that aims to use interventions to increase executive function, or if it were to aim to increase the ability to delay gratification in order to provide better socio-economic outcomes, can be reliant on similar policies in both cultures.

7. Conclusions, limitations and future directions

The English word ‘ritual’ is used to refer to a wide range of psychological and behavioural patterns – the focus of interest ranging between features as disparate as goal demotion (e.g. Schjoedt et al., 2013) to the postulation of supernatural causation (e.g. Malinowski, 1966). It is therefore important to specify precisely which aspects of ritual are of interest for a particular theory or programme of research (Whitehouse & Lanman, 2014; McKay & Whitehouse, 2014). Here the primary interest is in action sequences that are interpreted in conventional rather than instrumental terms. Thus, in the presented studies – across two sites, among two culturally and linguistically distinct groups – children’s ritual participation was manipulated by framing the task in either conventional or instrumental terms. This manipulation enabled to look at the downstream developmental effects of ritual participation *per se* in a well-controlled manner, as the ritualised action sequences are identical to the instrumentalist action sequences.

Although psychologists have invested considerable effort in the study of how instrumental skills such as tool use are socially learned (e.g., Carpenter, Call, & Tomasello, 2005; Gleissner, Meltzoff, & Bekkering, 2000; Williamson & Markman, 2006; Woodward, 2009), much less is known about how cultural conventions are acquired and transmitted (Harris, 2012; Whitehouse, 2011; 2012). Recent research suggests that even preschool children are alert to a distinction between instrumental and ritual action and are liable to copy the latter more precisely with less propensity to innovate or embellish modelled behaviour (Legare et al., 2015). These tendencies increase when conformism cues (Herrmann et al., 2013) or ostracism threats (Watson-Jones et al., 2014) are made salient. These findings imply two distinct interpretive framings of modelled behaviour (Hermann et al., 2013). The first of these – an *instrumental stance* – involves the assumption that the modelled actions are performed in the service of a specific concrete goal in accordance with normal expectations about physical causation. The second – a *ritual stance* – involves the assumption that the actions are conventional, being arranged that way for no other reason than that it is the 'done' or 'proper' way of behaving. Whereas activation of an *instrumental stance* may engender innovations, modifications, or embellishments insofar as the actor can detect and manipulate the causal mechanisms by which the actions accomplish the goal, activation of a ritual stance promotes imitation with high precision and rigidity.

The present studies investigated the cognitive effects of activating a ritual stance. In particular, they examined the effects of *ritual stance* activation on executive functioning, and one of its socially and psychologically important outcomes: the ability to delay gratification (Inzlicht & Schmeichel, 2012; Shamosh et al., 2008; Weatherly & Ferraro, 2011). It hypothesised that a ritual stance activation affects executive functioning precisely because it promotes imitative fidelity, which in turn requires maintenance of attention on the model, memory for detailed action sequences, and inhibition of instrumental goals. That is, imitative fidelity makes significant demands on the major constituents of executive functioning: attention, memory, and inhibitory control (e.g., Friedman et al., 2007; Hull et al., 2008; Miyake et al., 2000). As activities that challenge executive functioning also improve it (Diamond & Lee, 2011), recurrent activation of a ritual stance was expected to cultivate executive functioning, and consequently the ability to delay gratification. Indeed, there is some correlational evidence for a link between ritualised behaviour and the relevant aspects of executive functioning in the previous research. For example, Pietrefesa and Evans (2007) found that among children over the age of six years, those who engaged in more ritualised or 'just right' behaviours also demonstrated greater inhibitory control. In the present study, the hypothesis was subjected to experimental testing by manipulating the activation of the ritual and instrumental stances, and measuring children's executive functioning and ability to delay gratification.

The manipulation of the ritual and instrumental stances involved a series of "circle time games", previously used in developmental research on executive functioning (Tominey & McClelland, 2011; 2013). These games were suitably modified to activate the ritual and instrumental stances respectively. It was expected to replicate and extend Tominey and McClelland's (2011; 2013) finding that these games improve children's executive functioning, as measured via the HTKS (Head-Toes-Knees-Shoulders) task, a direct measure of the relevant aspects of behavioural regulation (viz., inhibitory control, attention, and working memory; Cameron Ponitz et al., 2009). Positive effects of the circle time games on children's ability to delay gratification, as measured via an adaptation of the marshmallow test (Mischel et al., 1972) were also expected. The main hypothesis was that the ritualised version of the circle time games would have greater positive effects than the instrumentalist version. Furthermore, a mediation model, such that the effect of ritualised intervention games on children's ability to delay gratification is mediated by improvements in executive function, was proposed. Finally, to account for possible variation in sensitivity to ritual cues caused by different cultural environments, the data were collected in two cultural contexts: (a) Slovakia, a post-industrial Western culture where child-rearing practices emphasise instrumental learning, and (b) Vanuatu, a traditionalist Melanesian culture where adherence to ritual scripts and normative conventions are more highly prized in child development (Miles, 1998).

Replicating the results of Tominey and McClelland (2011; 2013), it was found that participation in circle time games facilitated children's executive functioning; and furthermore, they improved children's performance in a delay of gratification task. As hypothesised, it was also found that compared to instructions emphasising the instrumental function of the activities, framing the same behaviours as prescribed conventions led to greater improvement in children's executive function and their ability to delay gratification. Indeed, the analyses also confirmed the hypothesised causal model: the effect of the activation of a ritual stance on children's capacity to delay gratification was mediated by its effect on executive functioning. These effects were equally strong in both Western and Melanesian populations, suggesting that the effects of ritual participation may be equally effective in widely differing cultural environments. Thus, whatever else its social and cultural functions may be, ritual participation might well serve to cultivate executive function, and consequently one of its socially and psychologically important outcomes: the capacity to delay gratification (Inzlicht & Schmeichel, 2012; Shamosh et al., 2008; Weatherly & Ferraro, 2011).

One might argue that because the presented design used games to elicit ritual stance, in contrast to 'serious' conventional and normative practices, the effect of intervention is overstated because games do not depend on the rest of the social reality in the same way as, for example, economic notions. However, because the intervention improved participants' ability to delay gratification, which depends on maximizing one's gain, it can be concluded that despite the special status of games, the effect of game-like intervention can be considered to be a useful proxy for social reality. It is possible that games present a base for a more institutional conventions and norms as they allow children to actively participate, and have local transient context.

Future studies should address some of the limitations of the current studies. For example, executive function has been shown to consist of three components (Chapter 3), and the measure deployed in this research can efficiently capture aspects of all three components.

However, it is possible that all three components of executive function are not affected equally by ritual participation. It is also possible that all three components of executive function do not contribute equally to the ability to delay gratification. Future studies could attempt to utilize measures for all three components individually. Doing this could allow for more complex SEMs (similar to those used in the previous chapters) to better understand the extent to which ritual manipulates different factors of executive function in regards to our ability to delay gratification. Doing so, could result in an even clearer picture of rituals effects than that provided in this thesis. Furthermore, this could better illuminate which components of executive function effect delayed gratification in different ways.

Due to the difficulties in implementing tasks in rural Vanuatu, given the lack of materials and resources (e.g., electricity) there, only one task was used to assess children's executive functioning (see Diamond, 2014; Diamond & Lee, 2011, for other tasks). The HTKS task was chosen because it is a valid and reliable measure of children's executive function (Cameron Ponitz et al., 2008; Cameron Ponitz et al., 2009); tests executive function components without being tied to interpersonal skills (Cameron Ponitz et al., 2009); and has been used previously in cross-cultural research (Wanless et al., 2011). Future cross-cultural research should endeavour to use a wider variety of tasks, and also test for possible effects of different kinds of intervention on different age groups, in various cultures.

Taking into account the results of previous research showing high correlations between the ability to delay gratification and schooling, future research should include children who do not attend the formal education to reveal wider effects and applicability of intervention sessions. Research on executive function is generally conducted in societies with formal schooling. Although the samples often include children from disadvantaged families and children from minority groups, we lack executive function research in societies where formal schooling is not a standard. This could be one of the future directions of executive function research, enabling to truly understand how diverse backgrounds influence its development and improvement. Although it was found that children with poor executive function benefit the most from receiving an intervention, an additional research would help to understand whether the benefit of interventions is greater in some culturally-specific contexts than others.

Another possible avenue for future research is to examine long-term impacts of intervention, that is if and how long the benefits of intervention last, and in which domains and areas are they most effective. We also know little about optimal dose and duration of intervention sessions. Perhaps a longitudinal study that would allow examining consistency and development of the executive function and delay of gratification abilities would be helpful in developing programs that prevent impulsive behavioural tendencies which can develop into unhealthy or chronic lifestyle (overriding obesity, school drop outs, addictions, peer rejections, etc.)

Additionally, many studies of delayed gratification have addressed how the ability to delay gratification results in notable benefits later in life (Mischel et al., 1989; Caset et al., 2011). Earlier studies did not demonstrate the relationship between ritual and delayed gratification that was shown by this thesis. Given the prevalence of ritual behaviours in cultures throughout the world, future studies should attempt to capture longitudinal data. This can serve two purposes. First, it could demonstrate that ritual performance early in life may have effects at later points in life that are similar to those noted by previous research on delayed gratification. For example, individuals who are able to delay gratification early in life have higher SES status than those who cannot; perhaps this effect is caused by early childhood ritual attendance. By collecting the appropriate longitudinal data, it could show that the relationships addressed in this thesis are robust into adulthood.

Second, by measuring delayed gratification and ritual performance at multiple periods of one's life, it could serve to demonstrate the extent to which ritual interventions have long lasting effects on delayed gratification for individuals who do not continue to participate in rituals in their adolescent years. If there is variance throughout a participant's life in regards to their socio-economic context, it may also be able to demonstrate what effects cultural context and resource scarcity have on delayed gratification and directly address the hypotheses of Evolutionary Life History Theory. It has been proposed that individuals in more stressful environments do not delay gratification as well as those in less stressful environments (Frankenhuis, et al., 2016). The results reported above reveal that participants from Slovakia, an OECD Eurozone member with a high standard of life, and Vanuatu, a nation with little social welfare and low relative resources and standard of living, did not exhibit significant differences in their ability to delay gratification at pre-test or post-test, as noted above in section 5.3.3. This may be due to the ability to delay gratification also being part of a cross-culturally recurrent cognitive system that can be trained, but is not developed through entrainment. That is to say, the cognitive facilities required to delay gratification are naturally developed; although cultural contexts may provide unique pressures that would manipulate one's actual decision to delay or not to delay gratification. This suggestion does not deny the noted patterns associated with the inability to delay gratification such as early sexual debut and younger age at first pregnancy. These may not be related to more stressful environments affecting one's ability to delay gratification, but examples such as early sexual debut and younger age at first pregnancy may instead be the result of other cultural pressures such as societal norms or access to contraceptives.

As presented in Chapter 1, Shoda et al. (1990) found that four-year-old children who were able to delay gratification developed into "more cognitively and socially competent adolescents, achieving higher scholastic performance and coping better with frustration and stress" (Mischel et al., 1989: 933, also Shoda et al., 1990). These participants were recruited from Stanford University. While the results of this thesis show that no differences exist between Vanuatu and Slovakia at the time of the data collection, the extent to which the differences in cultural context may affect individuals in Vanuatu over time (because of a relatively lower SES than their Slovak counterparts), remains to be seen. Possibly, children from households in Slovakia and Stanford are affected differently over their lifespans than children in Vanuatu and the results of earlier studies do not hold for cultures with relatively lower socio-economic measures. These questions, which are beyond the scope of the current thesis, would be a fruitful area for future research.

A potential limitation of the present study is the compromise made between experimental control and experimental blindness: all the sessions were supervised by the same researcher, who was not blind to conditions, with assisting teachers who provided the instructions and who were condition- and hypotheses-blind. This might have led to an implicit experimenter bias. Therefore, future studies should aim to have the data gathered by hypotheses- and condition-blind experimenters.

Furthermore, although the Solomon's Four-Group design did not result in participants being assigned to one specific group, since the nature of the design embeds any intervention or control group simultaneously within a group of those who were – or were not – pre-tested, this does not rule out the possibility for a group effect, it only lessens such an effect. Although no effect could be discerned in this research, it is possible that in social tasks such as this one which involve larger groups a potential effect may be observable; however, the groups in this study were too small.

Future research should aim to look more closely on the relationship between basic motivations (emotions, mood, etc.), executive function and ritual. It is likely that emotional development is closely connected to executive function development. Moreover, emotions and basic motivations are important in normative (ritualised) context, which require one to internalise various rules, prescriptions and proscriptions. Such research program could thus help with intervention implementation and results interpretation.

Future research could also expand the presented design by closer examining utterance (normative, imperative, and descriptive) that children would use to describe and further transmit the activities in ritual vs. instrumental intervention group. This would help to clarify whether children understood the games in the ritual condition as normative, i.e. whether the ritual priming in fact activated norm learning in children. Given that various types of normative language have not yet been systematically investigated, this would be a particularly interesting research area.

Although there did not appear to be any between group differences in regards to the performance of participants from Vanuatu and Slovakia, this may be because of other social factors that should be addressed in future research. For example, some cultures differ on their relational mobility (Schug, Yuki, & Maddux, 2010), which refers to the ability for an individual in the group to form new ties. When relational mobility is high, individuals can easily drop and add new social ties in their group but when relational mobility is low, individuals may find it difficult to drop or add new social ties. As such, it stands to reason that groups with low relational mobility will be more attentive to ritual cues because if an individual violates a normative convention, the potential loss of social support would be harder to address than if the individual existed in a society with high relational mobility, where potential social punishment can be more easily overcome. Although there have been recent studies on relational mobility addressing cross-cultural differences (Li, Adams, Kurtis, & Hamamura, 2015; Takemura & Suziki, 2015) and their potential effects on the perception of normative cultural features such as social commitment and trust (Schug, Yuki, & Maddux, 2010; Thomson, Yuki, & Ito, 2015), to our knowledge no study of relational mobility has ever been conducted with children (nor has any study of relational mobility ever used samples of Slovak or ni-Vanuatu adults). Therefore, this may be an interesting avenue for future research. Given that children have social networks that are largely made up of family and peers it may be the case that the effects of ritual on the ability to delay gratification would be similar for children from various cultures (as they were found be between Slovakia and Vanuatu). However, as the children age, with adults now being able to easily expand their perceived social networks by means of modern communication technologies and easier physical mobility in adulthood, participants from some cultures – in principle – have greater access to communication technologies and are more able to easily travel around their own country as well as to other countries in Europe, as is the case for Slovak participants. Members of island cultures like Vanuatu have less access to modern communication technologies, such as online social networking sites, and the island geography makes traveling within the country, as well as between countries, difficult. As such, one might expect that adult relational mobility in Vanuatu is lower than in Slovakia. This may result in adults being more sensitive to ritual cues as markers of in-group commitment because there is a greater cost for violating normative conventions in Vanuatu than Slovakia. In addition to the measures used in this thesis, future research should track the expansion of a participants' social network, their perceived relational mobility, and the importance that they put on ritual as they age. This may help to show between-groups differences as well as longitudinal differences over the life-span of the participant.

Furthermore, there have been documented differences between cultures regarding the extent to which they impose greater sanctions for norm violations (Gelfand et al., 2011). It has been shown that "tight" cultures (i.e. cultures with more norms and greater sanctions for violations of those norms) have often experienced natural disasters or other threats to their group (such as wars); this stands in contract so "loose" cultures, which have fewer norms and less harsh sanctions for their violation. Cultural tightness and looseness could also serve as an interesting variable to focus on in future research. If it is the case that in cultures that impose greater sanctions for normative conventions violations, individuals will be more attentive to ritual cues. However, the differences between Vanuatu and Slovakia noted in Chapter 2 complicate the ability to formulate a clear hypothesis (as discussed in previous chapters). While Vanuatu has experienced a great deal of natural disasters such as earthquakes, volcanic eruptions, and cyclones, the country has not been actively engaged in warfare in a generation. Slovakia, on the other hand, has been engaged in conflicts infrequently for the past 100 years (e.g. WWI, WWII, and a number of uprisings regarding the independence of Slovakia from Soviet control). As such there are reasons to hypothesise that either country would be of high normative tightness, although the reasons for this may vary. Therefore, future research that seeks to use the construct of normative tightness (ala Gelfand et al., 2011) should measure not just tightness, but also the proposed underlying causes of tightness. This would enable to understand the extent to which any causal factor – or subset of factors – is driving the differences in normative tightness that might be affecting the burden on executive function caused the attentiveness to ritual cues.

Furthermore, previous research has demonstrated that children who are asked to perform tasks in groups, where they must rely on their fellow students to complete their assigned part of a task successfully, typically perform better on the task (Aronson, 2011). This aspect of social bonding and trust has also been well documented in studies of ritual. For example, it has been demonstrated that there are aspects of ritual, such as costliness (Sosis & Bressler, 2003; Henrich 2009), dysphoric arousal (Atkinson & Whitehouse, 2011; Whitehouse, 2004; Xygalatas et al., 2013; Jong, Whitehouse, Kavanagh, & Lane, 2016), and synchrony (Reddish, Fischer, & Bulbulia, 2013; Wiltermuth & Heath, 2009), that appear to have the ability to increase social bonding between those who perform the ritual together. However, given the obvious ethical issues with implementing some intervention that would be costly or dysphoric to a group of children, this may not be the most fruitful line of research. On the other hand, synchrony is a common aspect of ritual actions which could ethically and easily accompany ritually framed behaviours in educational settings; however, it has also been shown that performing actions in synchrony is not enough by itself to increase cooperation. Still, synchronous actions that are performed with primes of one's in-group (such as culturally specific drums) have been demonstrated to increase cooperation (Cohen, Mundry, Kirchner, 2013). Performing ritually framed actions in synchrony that employ cultural group markers should – in principle – not only increase the executive function and ability to delay gratification in each child individually, but it should also increase the social bonding and trust throughout the group. Doing so could potentially allow for the results of this study, as well as those outlined by Aronson (2011) to be incorporated into successful classroom curricula.

Finally, although the contention is that activation of the ritual stance affects executive functioning because it leads to greater fidelity of imitation (it is suggested that the imitator pays close attention to all aspects of the modelled behaviour, copying each and every parseable feature rather than just the causally efficacious elements), no measures of imitative fidelity or personal innovation were collected in the present study. It would be beneficial for the future studies to incorporate such measures. Additionally, future research should include direct measures of other hypothesized causal mechanisms discussed in this thesis; specifically, the desire to belong, high fidelity copying, and goal demotion. Although these variables are not currently believed to be components of executive function in the same way as attention, working memory, and inhibitory control, they appear to be the result of executive function. Their inclusion in future studies may provide the basis for an even stronger model than that presented above, which included aspects of executive function such as attention, working memory, and inhibitory control as measured by the HTKS task.

The finding that ritual participation improves aspects of behavioural regulation (i.e., inhibitory control, attention, memory) and children's capacity to defer gratification might seem surprising given that ritual routines are commonly regarded as an expression of mindless conformism, rather than reflective and critical engagement. However, this common view of ritual behaviour may be incomplete. The research reported here suggests that, all else being equal, adopting a ritual stance makes more cognitive demands on at least some aspects of executive function than does adopting an instrumental stance; in particular, ritual practice engages the aspects of executive function related to one's ability to delay gratification. Far from being a simple matter of mindless copying, ritual participation requires the kind of rigorous computation of arbitrary detail and avoidance of normatively proscribed deviation from the script (Herrmann et al., 2013) that engages and exercises our executive functioning abilities. The failure of much previous research on social learning to appreciate this point may be symptomatic of a widespread devaluation of ritual and tradition in Western childrearing (Kanu, 2007; Matthews, Watego, Cooper, & Baturo, 2005; Provenzo, 2009) and educational practice. The irony may be that in devising strategies for parenting and schooling geared to a world of rapid technological change, while neglecting the importance of traditional cultural practices, we may be contributing to the deterioration of young people's attentive and inhibitive resources, thus promoting impulses toward instant gratification.

The results of this research can help shed light on ways in which new educational policies can be adopted in order to implicitly increase a child's executive function and the ability to delay gratification. For example, the study by Trulson (1986) concluded that children who were given training in martial arts without any of the philosophical and ritual framing of the actions exhibited greater levels of anti-social behaviours. However, those children who did receive the martial arts training in conjunction with the philosophical and ritual framing of the tradition exhibited less anti-social behaviours. This seems to support the general conclusions of the research presented here: that children who are presented with actions under a ritual frame can benefit indirectly by increases in executive function and the ability to delay gratification which in turn should decrease anti-social behaviours in the long term. This information could be incorporated with the current literature on how to help children through indirect benefits through educational policy. For example, this could be used in conjunction with the findings of cognitive dissonance theory, which has demonstrated that in lieu of large and tangible motivational stimuli (such as punishments or rewards), children will create internal motivations for their actions (Aronson, 2011). This can be combined with the use of learning activities presented in a ritual frame in order to increase executive function and the ability to delay gratification in children. Instructing that such actions be done without reasonable and tangible rewards should – according to Aronson (2011) – result in the child performing the action of their own internal motivation, which could potentially have positive social and economic effects in the child's future.

Given that a poorer ability to delay gratification has been shown to predict addictions, earlier sexual debut and unwanted pregnancy, problems with emotion regulation, and lower levels of academic performance (e.g. Casey et al. 2011; Gross, 1998; Hanoch et al., 2013; Kirby et al., 1999; Shoda et al., 1990), our results might have important implications for the design and implementation of future educational strategies in both “traditional” and “modern” cultures. Quality intervention, which is well tested and uses carefully designed procedures of which effects (cognitive and behavioural) are well understood, would increase the likelihood of improving children’s behavioural problems and help them to meet social and academic demands present in their environment. Such intervention would allow integrating its procedures into daily practice, and doing so it would enable practicing the needed skills to prevent maladaptive and antisocial behaviours.

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Appendix 1: Head-Toes-Knees-Shoulders (HTKS) task

The experiment had two phases: a practice phase and an experimental phase. Children were escorted individually into an experimental room and began with practice phase.

<u>Phase 1: Practice phase</u>

We are going to play a game together. Now, touch your head.

The child touched her head.

Good. Now, touch your toes.

The child touched her toes.

(If the child was shy or afraid, she was be encouraged to play and the commands were repeated until the child was comfortable and performed the tasks.)

Tell me what will you do when I ask you to touch your head.

The child then answered the question. If she answered correctly ("I will touch my head"), she was asked the next question. If she answered incorrectly, she was corrected and the question was repeated. The whole procedure (explanation and asking the question) was repeated a maximum of twice.

And now tell me what will you do when I ask you to touch your toes.

The child then answered the question. If she answered correctly ("I will touch my toes"), the practice phase continued. If she answered incorrectly, she was corrected and the question was repeated. The whole procedure (explanation and asking the question) was repeated a maximum of twice.

Very good. Now, let's make it fun. When I tell you to touch your head, you will touch you toes. And when I tell you to touch your toes, you will touch your head. Let's play.

Touch your head.

The child then responded to the command. If she responded correctly (touches her toes), she was given the next command. If she responded incorrectly, she was corrected and the command was repeated. The whole procedure (explanation and command) was repeated a maximum of twice.

Touch your toes.

The child then responded to the command. If she responded correctly (touches her head), she continued in the practice phase. If she responded wrongly, she was corrected and the command was repeated. The whole procedure (explanation and command) was repeated a maximum of twice.

Great! You do very well – you are a big boy/girl and this is too easy for you, isn't it? Let's make it a little bit interesting and even more fun. Touch your shoulders.

The child touched her shoulder.

Good. Now, touch your knees.

The child touched her knees.

Tell me, what will you do when I ask you to touch your knees.

The child then answered the question. If she answered correctly ("I will touch my knees"), she was asked the next question. If she answered incorrectly, she was corrected and the question was repeated. The whole procedure (explanation and asking the question) was repeated a maximum of twice.

And now tell me what you will do when I ask you to touch your shoulders.

The child then answered the question. If she answered correctly ("I will touch my shoulders"), the practice phase continued. If she answered incorrectly, she was corrected and the question was repeated. The whole procedure (explanation and asking the question) was repeated a maximum of twice.

Very good. Now, let's make it the other way round again. When I tell you to touch your knees, you will touch you shoulders. And when I tell you to touch your shoulders, you will touch your knees. Let's play.

Touch your knees.

The child then responded to the command. If she responded correctly (touches her shoulders), she was given the next command. If she responded incorrectly, she was corrected and the command was repeated. The whole procedure (explanation and command) was repeated a maximum of twice.

Touch your shoulders.

The child then responded to the command. If she responded correctly (touches her knees), the experimental phase began. If she responded incorrectly, she was corrected and the command was repeated. The whole procedure (explanation and command) was repeated a maximum of twice.

<u>Phase 2: Experimental phase</u>

In this phase, ten test commands were given verbally to the child, without feedback from the experimenter. The experimenter stated the commands without modelling, gesturing, pointing, gazing or otherwise suggesting any actions. Each child was asked to respond in an unnatural way to two types on the first 10 trials (half of the children will start with the "Touch your head!" and "Touch your toes!" pair; the other half will start with the "Touch your shoulders!" and "Touch your knees!" pair) and then four types on the second 10 trials ("Touch your head!" "Touch your toes!" "Touch your shoulders!" "Touch your knees!") of paired behavioural commands. In the end, the child was praised for completing the task successfully.

Appendix 2: The delay of gratification experiment

Children were be escorted individually into an experimental room. The room was deliberately cleared of any distractors which could draw the children's attention (toys, crayons, books, etc.)

I would like to play a game with you today.

The child was seated at the table on which there was a bell and the reward objects (one sweet on the one hand, and three sweets on the other). The child was then be presented with the choice paradigm.

I have some sweets here. I have to go away for a while, but don't worry – I'll be just there, in the other room. You can bring me back any time you want to by ringing this bell and I will give you this one [pointing to the sweet]. If you wait until I come back by myself, then I will give you these [pointing to the three sweets]. *But if you ring the bell you can only have this one [pointing to the sweet] but not these* [pointing to the three sweets].

So, which one will you get when you ring the bell?

The child then answered the question. If she answered correctly (points to one sweet), she was asked another question. If she answered incorrectly, she was corrected and the question was repeated. The whole procedure (explanation and asking the question) was repeated a maximum of twice.

And which one will you get if you wait for me?

The child then answered the question. If she answered correctly (points to three sweets), the experiment began. If she answered incorrectly, she was corrected and the question was repeated. The whole procedure (explanation and asking the question) was repeated a maximum of twice.

OK, now, let's play. I will go away for a while.

The experimenter then left the room and returned when the subject rang the bell or reached a predetermined criterion time (15 minutes).

Appendix 3: The intervention games and experimental manipulations

Intervention game 1: Red light, purple light

Experimental subgroup 1 – instrumental stance	***Experimental subgroup 2 – ritual stance***
We are going to play a game together now. Here are the rules [the rules of the game are explained to the children]. *It's very important that you follow these rules, because* ***if you do you will be fitter and stronger.***	*We are going to play a game together now. Here are the rules* [the rules of the game are explained to the children]. *It's very important that you follow these rules, because* ***the game has always been played this way.***

In this game, the examiner acts as a "stop light" by standing at the opposite end of the room from the children and holding up different coloured construction paper circles to represent stop and go. First, children respond to specific colour cues: red means "stop" and purple is "go".

Children play three rounds of the game.

On the next level, children respond to the opposite cues – the red sign means "go" and the purple sign "stop".

After three rounds, children respond to different shapes representing stop and go: any colour circle is "go" and any colour square is "stop". (For example a red circle means "go," but a red square means "stop".) To make the game more interesting and enjoyable, the children also takes turns being the stop light.

Intervention game 2: Sleeping, sleeping, all the children are sleeping

Experimental condition 1 – instrumental stance	***Experimental condition 2 – ritual stance***
We are going to play another game now. Here are the rules [the rules of the game are explained to the children]. *It's very important that you play the game like this,* ***because if you do you will learn about how different animals behave.***	*We are going to play another game now. Here are the rules* [the rules of the game are explained to the children]. *It's very important that you play the game like this,* ***because those are the rules and they must be followed.***

This game starts with all the children sitting in the circle. They pretend to sleep with their eyes closed and head resting on their hands. Meanwhile, the circle leader sings, "Sleeping, sleeping, all the children are sleeping." Once the children are pretending to sleep, the circle leader says, "And when they woke up… they were [monkeys]!" The children "wake up" and pretend to act like monkeys. The circle leader then repeats the song and suggests other animals (a butterfly, a snake). Children who are pretending to sleep are called on to give suggestions for other animals and also have in a turn in being the circle leader.

To make this more complicated, three different coloured circles (for example, green, yellow, blue) are shown. On the green circle will be a picture of a snake, on the yellow circle a picture of a butterfly and on the blue circle a picture of a duck. When it is time to wake up, the circle leader points to one of the circles and the children act out the animal on that circle (snake – children stretch their arms above their head and stand on their tiptoes to make themselves as long as possible, walk around and wave their stretched arms sideways; butterfly

– children raise their arms sideways and pretend to wave with them forward and backward like a flying butterfly, moving by means of long soft jumps; duck – children crouch down and walk around like ducks with their hands on their arms, pretending to wave with them upward and downward like the duck's wings).

After a few rounds, the pictures are removed and children have to remember what animal was on each circle.

Intervention game 3: Freeze

Experimental condition 1 – instrumental stance	***Experimental condition 2 – ritual stance***
We are going to play another game now. Here are the rules [the rules of the game are explained to the children]. It's very important that you play the game like this, ***because if you do you will learn how to dance.***	*We are going to play another game now. Here are the rules [the rules of the game are explained to the children]. It's very important that you play the game like this,* ***because this game must be played properly.***

Children and teacher (experimenter) dance to music. Slow and fast songs are used: children dance slowly to slow songs and quickly to fast songs. When teacher stops the music everyone freeze (stop moving and stands still). Once children master these skills, they try to move to the opposite cues: they try to dance quickly to the slow songs and slowly to fast songs.

Intervention game 4: Colour-matching freeze

Experimental condition 1 – instrumental stance	***Experimental condition 2 – ritual stance***
We are going to play another game now. Here are the rules [the rules of the game are explained to the children]. It's very important that you play the game like this, ***because if you do you will learn the different colours.***	*We are going to play another game now. Here are the rules [the rules of the game are explained to the children]. It's very important that you play the game like this,* ***because it is important to follow the rules of the game.***

In this game, which is related to The Freeze Game, children dance when music plays and freeze when the music stops. However, children are asked to perform an additional step before freezing. Teacher taps different-coloured pieces of paper to mats placed on the ground. When the music stops, the teacher holds up a specific colour and children are instructed to find and stand on a mat of that colour.

Intervention game 5: Drum beats

Experimental condition 1 – instrumental stance	***Experimental condition 2 – ritual stance***
We are going to play another game now. Here are the rules [the rules of the game are explained to the children]. It's very important that you play the game like this, ***because if you do you will learn how to move to the rhythm.***	*We are going to play another game now. Here are the rules [the rules of the game are explained to the children]. It's very important that you play the game like this,* ***because this is the proper way to play this game.***

In this game, children respond to different drum cues with body movements. Teacher choose actions for children to perform while sitting (e.g., clapping or stomping) and while moving around the room (e.g., walking or dancing). For example, children are instructed to walk quickly to fast drumming, walk slowly to slow drumming, and freeze when the drumming stopped. Teacher also asks children to respond to opposite cues (walking slowly to fast drum beats and quickly to slow drum beats) and associates different actions with specific drum cues (e.g., hopping to fast drum beats and crawling to slow drum beats).

Intervention game 6: Orchestra

Experimental condition 1 – instrumental stance	***Experimental condition 2 – ritual stance***
We are going to play another game now. Here are the rules [the rules of the game are explained to the children]. It's very important that you play the game like this, ***because if you do you will learn about how to play music.***	*We are going to play another game now. Here are the rules [the rules of the game are explained to the children]. It's very important that you play the game like this,* ***because this is the way the game is played.***

In this game, the teacher uses a dowel rod as a conducting baton to lead children in playing musical instruments (e.g., jingle bells, drums). When the conductor (i.e. teacher) waves the baton, children play their instruments; when the conductor put the baton down, children stop playing. Childrenare then instructed to play their instruments quickly when the baton moves quickly and slowly when the baton moves slowly. Children are also asked to respond to opposite cues: When the conductor waves the baton, children stop playing their instruments, and when the conductor set the baton down, children play their instruments.

Appendix 4: Statistical tables and additional results

Table 1a: Unitary model of executive function: Baseline comparisons, RMSEA

Baseline Comparisons					
Model	Null Fit Index	Relative Fit Index	Bollen's Incremental Fit Index	Tucker-Lewis Index	Comparative Fit Index
Default model	0.744	0.705	0.793	0.76	0.791
Saturated model	1		1		1
Independence model	0	0	0	0	0

Table 1b: RMSEA

RMSEA		Confidence Intervals		
Model	RMSEA	LO 90	HI 90	p-value
Default model	0.122	0.113	0.132	0
Independence model	0.249	0.241	0.258	0

Table 2a: Two-factor model of executive function: Baseline comparisons

Baseline Comparisons					
Model	Null Fit Index	Relative Fit Index	Bollen's Incremental Fit Index	Tucker-Lewis Index	Comparative Fit Index
Default model	0.829	0.804	0.884	0.866	0.883
Saturated model	1		1		1
Independence model	0	0	0	0	0

Table 2b: RMSEA

RMSEA		Confidence Intervals		
Model	RMSEA	LO 90	HI 90	p-value
Default model	0.091	0.081	0.101	0
Independence model	0.249	0.241	0.258	0

Table 3a: Three-factor model of executive function: Baseline comparisons,

Baseline Comparisons					
Model	Null Fit Index	Relative Fit Index	Bollen's Incremental Fit Index	Tucker-Lewis Index	Comparative Fit Index
Default model	0.86	0.838	0.917	0.903	0.916
Saturated model	1		1		1
Independence model	0	0	0	0	0

Table 3b: RMSEA

RMSEA		Confidence Intervals		
Model	RMSEA	LO 90	HI 90	p-value
Default model	0.078	0.067	0.088	0
Independence model	0.249	0.241	0.258	0

Table 4a: Four-factor model of executive function: Baseline comparisons.

Baseline Comparisons					
Model	Null Fit Index	Relative Fit Index	Bollen's Incremental Fit Index	Tucker-Lewis Index	Comparative Fit Index
Default model	0.838	0.812	0.893	0.875	0.892
Saturated model	1		1		1
Independence model	0	0	0	0	0

Table 4b: RMSEA

RMSEA		Confidence Intervals		
Model	RMSEA	LO 90	HI 90	p-value
Default model	0.088	0.078	0.098	0
Independence model	0.249	0.241	0.258	0

Table 5a: Between-by-within ANOVA, pre-tested children, executive function scores

HTKS[41]
F pretest
[1] 0.8875389
p-value
[1,] 0.4184042
F post-test
[1] 13.41253
p-value
[1,] 0.0004915372
F Interaction
[1] 12.15598
p-value
[1,] 5.476673e-05

[41] Head toes knees and shoulders task, used to measure executive function.

Table 5b: One-way ANOVA, all groups, multiple contrast comparisons, executive function scores

HTKS
f
[1] 30.2188
df regression
[1] 1
df residual
[1] 54.05348
p-value
[1] 1.073713e-06
variance explained
[1] 0.3918586
effect size
[1] 0.6259861

Table 5c: one-way ANOVA, all groups, multiple contrast comparisons, executive function scores

HTKS							
$test	$n	[1] 75	67	68			
	Group	Group	test	crit	se	df	
[1,]	1	2	3.489364	2.431725	2.353726	76.25875	
[2,]	1	3	6.436349	2.462720	2.030136	51.76885	
[3,]	2	3	3.353712	2.457446	1.447250	54.89111	
	Group	Group	psihat	ci.lower	ci.upper	p.value	Effect Size
[1,]	1	2	-8.213008	-13.936624	-2.489392	8.077991e-04	0.4585173
[2,]	1	3	-13.066667	-18.066324	-8.067009	3.983931e-08	0.7491161
[3,]	2	3	-4.853659	-8.410196	-1.297121	1.450585e-03	0.4864247

Table 6: Regression, all children, delay of gratification scores

Percentile bootstrap regression with Theil-Sen estimator					
	LLCI	ULCI	Estimate	S.E.	p-value
Intercept	2.217333	6.3885417	3.949074	1.07455054	0
Slope	0.187500	0.3045455	0.258642	0.02994001	0

Percentile bootstreap correlation (pearson) = 0.5115118

Table 7: Nought multilevel model

Generalized least squares fit by REML			
Model: FDtime2 ~ 1			
Data: total			
AIC	BIC	Log Likelihood	Log Likelihood Ratio
1278.7	1285.385	-637.3499	1274.6998

Tables 8: 1st Multilevel model

8a: Model fitdata

Generalized least squares fit by REML			
Model: FDtime2 ~ ConInst + ConRit			
Data: total			
AIC	BIC	Log Likelihood	Log Likelihood Ratio
1240.928	1254.259	-616.4639	1232.9278

8b: Coefficients

Coefficients:				
	Value	Std.Error	t-value	p-value
(Intercept)	7.659111	0.5323932	14.386192	0,00E+00
Control Instrumental	2.715516	0.7750671	3.503588	6,00E-04
Control Ritual	5.045791	0.7720512	6.535565	0,00E+00

8c: Information criterion and significance values

	Model	df	AIC	BIC	Log Likelihood	Test	Log Likelihood Ratio	p-value
Null.Model	1	2	1278.424	1285.118	-637.2119			
Model.1	2	4	1242.848	1256.237	-617.4242	1 vs 2	39.57543	<.0001

Tables 9: 2nd Multilevel model

Table 9a: Model fit data

Linear mixed-effects model fit by REML			
Data: total			
AIC	BIC	Log liklihood	Log-liklihood Ratio
1242.759	1259.422	-616.3794	1232.7588

Table 9b: coefficients and information criterion comparison table

	df	AIC	BIC	Log Likelihood	Test	Log Likelihood Ratio	p-value
Model.1	4	1242.848	1256.237	-617.4242			
Model.2	5	1244.851	1261.586	-617.4254	1 vs 2	0.00235555	0.9613

Table 10: ICC

Country		
	Variance	StdDev
(Intercept)	0.1421375	0.3770113
Residual	21.1863382	4.6028620
[1] 0.006664213	ICC	

Table 11: 2 x 2 ANOVA, all children, delay of gratification scores

FDtime2		
Measure	Value	P value
(pretest)	[1] 25.15301	[1] 0.001
(intervention)	[1] 44.93785	[1] 0.001
*(pretest*intervention)*	[1] 12.39954	[1] 0.001

Table 12: One-way ANOVA, pre-tested pre-tested children, delay of gratification scores

DG2[42]
F
[1] 5.347993
df regression
[1] 1
df residual
[1] 33.72566
p-value
[1] 0.02698264
variance explained
[1] 0.1443875
effect size
[1] 0.3799835

Table 13: One-way ANOVA, non-pretested children,delay of gratification scores

DG2
F
[1] 49.63299
df regression
[1] 1
df residual
[1] 51.99288
p-value
[1] 4.196589e-09
variance explained
[1] 0.4651704
effect size
[1] 0.682034

[42] DG is the delay of gratification task, DG2 is the post-test measurement (i.e. time 2).

Table 14: Between-by-within ANOVA, pre-tested children, delay of gratification scores

DG2
F factor
[1] 0.08490965
p-value
[1,] 0.9187372
F condition
[1] 19.1485
p-value
[1,] 4.148768e-05
F interaction
[1] 8.783681
p-value
[1,] 0.0005676191

Table 15a: One-way ANOVA, all groups, multiple contrast comparisons, delay of gratification scores

DG2
F
[1] 40.65997
df regression
[1] 1
df residual
[1] 62.3718
p-value
[1] 2.493461e-08
variance explained
[1] 0.3319619
effect size
[1] 0.5761614

Table 15b: One-way ANOVA, all groups, multiple contrast comparisons, delay of gratification scores

DG2							
$test	$n	[1] 75	67	68			
	Group	Group	test	crit	se	df	
[1,]	1	2	4.175277	2.428158	1.0025807	80.51727	
[2,]	1	3	7.626536	2.453966	0.8533938	57.16608	
[3,]	2	3	3.381793	2.450558	0.6867323	59.58446	
	Group	Group	psihat	LLCI	ULCI	p-value	Effect Size
[1,]	1	2	-4.186052	-6.620477	-1.7516277	7.484287e-05	0.4152939
[2,]	1	3	-6.508439	-8.602638	-4.4142398	2.824445e-10	0.6969972
[3,]	2	3	-2.322387	-4.005264	-0.6395095	1.276819e-03	0.3957778

Table 16a: Mediation analyses, control vs. experimental groups

Confidence interval for indirect effect	
1.431675	3.276305
p-value	
<.01	
direct effect (a) estimation	
10.08442	
direct effect (b) estimation	
0.2258047	
indirect effect estimation	
2.277109	

Table 16b: default, saturated, and independence model significance information

Model	NPAR	CMIN	DF	p-value	CMIN/DF	CFI
Default model	8	1.826	1	0.177	1.826	1.000
Saturated model	9	0	0			1.000
Independence model	6	114.854	3	0	38.285	0

Table 16c: model regression wights

Regression Weights: (ALL - Default model)							
			Estimate	S.E.	C.R.	p-value	Label
HTKS2	<---	Intervention	9.956	1.429	6.965	***	par_1
DG2	<---	HTKS2	0.215	0.027	8.025	***	par_2
DG2	<---	Intervention	1.000				

Table 17a: Mediation analysis, control vs. ritual group

Confidence interval for indirect effect	
1.074744	2.267594
p-value	
<.01	
direct effect (a) estimation	
6.366532	
direct effect (b) estimation	
0.2549914	
indirect effect estimation	
1.623411	

Table 17b: default, saturated, and independent model significance information

Model	NPAR	CMIN	DF	p-value	CMIN/DF	CFI
Default model	8	0.169	1	0.681	0.169	1.000
Saturated model	9	0	0			1.000
Independence model	6	126.816	3	0	42.272	0

Table 17c: model regression wieghts

Regression Weights: (ALL - Default model)							
			Estimate	S.E.	C.R.	p-value	Label
HTKS2	<---	Intervention	6.186	0.847	7.306	<.001	par_1
DG2	<---	HTKS2	0.228	0.027	8.4	<.001	par_2
DG2	<---	Intervention	1.000				

Tables 18: SEM Model 1: Effects of intervention and

Table 18a: CMIN

Model	NPAR	CMIN	DF	p-value	CMIN/DF
Default model	22	11.596	6	.072	1.933
Saturated model	28	.000	0		
Independence model	16	180.735	12	.000	15.061

Table 18b: baseline comparisons

Model	Null Fit Index	Relative Fit Index	Bollen’s Incremental Fit Index	Tucker-Lewis Index	Comparative Fit Index
Default model	.936	.872	.968	.934	.967
Saturated model	1.000		1.000		1.000
Independence model	.000	.000	.000	.000	.000

Table 18c: intercepts (default model)

	Estimate	S.E.	C.R.	p-value	Label
post_EF	3.950	.725	5,.445	<.001	effect
sumHTKS_1	27.026	1.655	16.326	<.001	a_HTKS1
DG_1	10.494	.872	12.040	<.001	a_DG1
sumHTKS_2	25.283	1.437	17.594	<.001	a_HTKS2
DG_2	9.992	.710	14.072	<.001	a_DG2

Table 18d: RMSEA

Model	RMSEA	LLCI 90	ULCI 90	p-value
Default model	.000	.000	.161	.561
Independence model	.490	.433	.549	.000

Tables 19: SEM Model 2: Effects of ritual and instrumental intervention

Table 19a: Intercepts: (instrumental - Default model)

	Estimate	S.E.	C.R.	p-value	Label
post_EF	3.345	.738	4.535	<.001	effect
sumHTKS_1	26.956	1.681	16.039	<.001	a_HTKS1
DG_1	10.445	.863	12.102	<.001	a_DG1
sumHTKS_2	25.199	1.472	17.119	<.001	a_HTKS2
DG_2	9.992	.713	14.023	<.001	a_DG2

Table 19b: Intercepts (ritual - Default model)

	Estimate	S.E.	C.R.	p-value	Label
post_EF	4.589	.829	5.538	<.001	effect_r
sumHTKS_1	26.956	1.681	16.039	<.001	a_HTKS1
DG_1	10.445	.863	12.102	<.001	a_DG1
sumHTKS_2	25.199	1.472	17.119	<.001	a_HTKS2
DG_2	9.992	.713	14.023	<.001	a_DG2

Table 19c: CMIN data for default, saturated, and indepentence models

Model	NPAR	CMIN	DF	p-value	CMIN/DF
Default model	31	14.762	11	.194	1.342
Saturated model	42	.000	0		
Independence model	24	184.639	18	.000	10.258

Table 19d: Baseline Comparisons

Model	Null Fit Index	Relative Fit Index	Bollen’s Incremental Fit Index	Tucker-Lewis Index	Comparative Fit Index
Default model	.920	.869	.978	.963	.977
Saturated model	1.000		1.000		1.000
Independence model	.000	.000	.000	.000	.000

Table 19e: RMSEA

Model	RMSEA	LLCI 90	ULCI 90	p-value
Default model	.028	.000	.141	.526
Independence model	.395	.348	.444	.000