
ADOLESCENT SOCIAL COGNITION ACROSS CULTURES: EAST VS. WEST



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Abstract

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Background: Adolescence is a period during which humans undergo significant changes in the social cognitive domain – changes that are likely to be adaptive, by allowing adolescents to respond adequately to new challenges as they gain independence from the family, and establish themselves in society. Recent neuroscience data suggest protracted maturation of key brain circuits during adolescence, which are involved in the underlying cognitive processes of social understanding. While these age-associated changes are commonly recognised to arise from a biological program unravelling across time, it is also possible that development is driven by experience. To date, few studies have empirically studied the development of social cognition in adolescence, especially as compared to infancy and childhood. Outstanding questions also remain on whether variability in the experience of adolescence, such as is present across different cultures, can modulate the expression of adolescent-associated maturational changes in social cognition.

Aims: The purpose of this thesis was i) to investigate developmental changes in social cognition during adolescence, and ii) to examine sociocultural factors that may influence this ability and its developmental trajectory.

Methods: In total, 668 young people (aged 9 to 21 years) from the United Kingdom, China, and Malaysia took part in the studies outlined in this thesis. In

Chapter 2 (UK: N = 226; China: N = 175; Malaysia: N = 225), the self-construal scale (Singelis, 1994) was administered to explore the adolescent 'self' as an independent entity as well as an interdependent social agent across all cultures. Chapters 3 and 4 consisted of a battery of cognitive and affective theory of mind as well as domain general cognitive tasks, which were completed by adolescents from the UK (N = 188) and China (N = 116). In Chapter 5, a novel social networks paradigm was used with a Game Theory task to investigate the impact of social reciprocity on cooperative investment in authentic adolescent school-based networks from the UK (5 classes; N = 70) and Malaysia (7 classes; N = 147).

Results: First, young people from different cultures were characterised by culture-dependent construals of the self. In particular, youths from China defined themselves as more interdependent, i.e. in relation to others and in terms of social roles, than those from the UK and Malaysia. Second, although Chinese adolescents reported overall lower performance, they showed similar age associated changes in cognitive and affective theory of mind as UK adolescents. Finally, social reciprocity predicted cooperative investment behaviour within authentic adolescent networks in both the UK and Malaysia. Interestingly, there were no age effects or differences between cultures in the impact of social reciprocity on cooperative behaviour.

Conclusions: Results from this combination of studies paint a multifaceted picture of adolescent social cognition across cultures. They suggest a complex interplay of factors both at the individual and sociocultural level that give rise to the sophisticated ability of social cognition as it matures across adolescence. They also highlight methodological issues in multicultural research.

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1. Introduction

Adolescence marks the end of one's childhood and is a preparatory stage that leads us into man- or woman-hood. Research and anecdotal accounts have illustrated a plethora of changes in social behaviour and cognition that take place during the adolescent years (Spear, 2000; Steinberg, 2008). Presumably, these reflect the increasingly complex interpersonal relationships that emerge during these years and equip the adolescent with appropriate skills to face new demands from the social world. Despite these changes, only a handful of empirical studies has investigated the continued maturation of social cognitive abilities outside of infancy and early childhood (Valle, Massaro, Castelli, & Marchetti, 2015; Dumontheil, Apperly & Blakemore, 2010a; Burnett Heyes, Jih, Block, Hiu, Holmes & Lau, 2015; Devine & Hughes, 2013; Vetter, Altgassen, Phillips, Mahy, & Kliegel, 2013a; Vetter, Leipold, Kliegel, Phillips, & Altgassen, 2013b). More research is thus needed to build on the existing literature to map out the development of social cognition during adolescence. Furthermore, while some aspects of development, such as affective development, may be the product of a genetically determined program unravelling across time (Lau & Eley, 2006), environmental factors may also influence social cognitive maturation and its corresponding behavioural outcomes (Crone & Dahl, 2012; Ellis et al., 2012; Choudhury, 2010). Indeed, while the start of adolescence can be defined biologically, its features and endpoint are largely characterised by sociocultural factors (Schlegel & Barry, 1991).

In this Chapter, I combine views from the fields of cultural anthropology and developmental cognitive psychology to propose the hypothesis that

differences in the experience of adolescence across cultures can modulate age-typical changes in social cognition across the adolescent years (Nielsen & Haun, 2015; Choudhury, 2013; Schlegel & Barry, 1991; Schlegel & Hewlett, 2011; Fiske & Taylor, 2013). After briefly defining social cognition, I review recently published evidence for the protracted development of social cognitive abilities during adolescence, borrowing from current neuroscientific understanding of the developing adolescent brain to shine light on behavioural findings. Furthermore, I discuss a number of individual difference factors that may also affect the development of social cognitive abilities. I suggest that continued maturation of social cognitive skills during adolescence occurs through a combination of biologically driven maturational processes, individual difference factors, and experience-dependent pruning (Blakemore & Mills, 2014; Crone & Dahl, 2012). Next, using Eastern and Western cultures as a framework for discussion, I highlight differences in the values and experiences of adolescence across cultures, and how a Western emphasis on self-independence (Blos, 1979) and an Eastern focus on interdependence (Markus & Kitayama, 1991) during adolescence may influence social cognitive abilities and their developmental trajectories. Specifically, I suggest that across cultures where there are discrepant expectations of adolescence, these differences might subtly affect the degree of maturational changes in relevant neural circuits, in turn bringing out culture-bound differences in the developmental trajectory of social cognitive abilities. Finally, I summarise research in this thesis that builds upon the small body of studies reviewed in this Chapter. These aim to behaviourally map out social cognitive development across adolescence and to investigate potential

differences in these abilities and their maturational trajectories between adolescents from different cultures.

1.1 Social cognition

Human beings are exquisitely social creatures, a feature we share with our closest primate relatives (Tomasello, 2014; Tomasello & Vaish, 2013; Dunbar, 2009). Our natural tendency to form social alliances and to engage in cooperative behaviour has allowed us to evolve as collective societies in order to build civilisations and shape cultures. The underlying collection of psychological processes that enables individuals to make sense of others' behaviour to successfully navigate social groups, and to achieve such collaboration is commonly known as social cognition (Frith, 2008).

An important aspect of social cognition is the ability to make inferences about what is going on inside other people's minds – their intentions, feelings, desires, and thoughts, which is commonly referred to as Theory of Mind (ToM), or mentalising. This capacity equips an individual with the ability to understand the complexity of another's mind and to predict behaviour accordingly, allowing them to successfully navigate complex interpersonal situations (Crone & Dahl, 2012). In a broad sense, social cognitive processes also include a plethora of basic/automatic perceptual processes, such as face processing (Farroni et al., 2005), biological motion detection (Pelphrey & Carter, 2008), and joint attention/social referencing (Carpenter, Nagell, Tomasello, Butterworth, & Moore, 1998).

1.1.1 Early development of social cognition

The basic perceptual building blocks of social cognition have been shown to be present from infancy. Early research on social awareness has shown that infants as young as 3 months are able to follow eye gaze (Hood, Willen, & Driver, 1998). Specifically, the direction of gaze of a face on-screen prompted infants to look at a target faster, provided that the target was on the same side as the gaze. This innate tendency possibly provides a basis for shared attention and shared meaning in communication (Farroni, Csibra, Simion, & Johnson, 2002). As children get older, they master yet more advanced aspects of social cognition.

By age four, most children are able to pass basic false belief tasks (although see Mayer & Trauble, 2013; Oberle, 2009; and Chapter 4 for a multicultural perspective), whereby the child is required to understand that another individual holds knowledge different to their own (Wellman, Cross, & Watson, 2001). Passing this task has long been considered a milestone for basic ToM development. Undoubtedly, the literature on social cognition in the early developmental years is rich and informative. However, until recently, very little research has attempted to understand the development of social cognitive abilities past early childhood, even though qualitative accounts suggest profound changes in the social behaviour of adolescents.

1.1.2 Social cognition in adolescence

During their teenage years, the budding adolescent orients away from the family to increasingly focus on peer relationships and to establish their own social groups in society (De Lorme, Bell, & Sisk, 2013; Steinberg & Morris, 2001).

It is also a period where peer relationships become more complex, for example, the emergence of cliques and romantic relationships (Bagwell & Schmidt, 2011), which could require higher levels of social awareness and understanding (Lerner & Steinberg, 2009). As such, adolescent-typical behaviours of sociability may have evolved to serve an adaptive function (Ellis et al., 2012). As the stage in life when humans change from pre-productive to reproductive, goals and resources shift to focus on sex and reproduction during adolescence. Thus, an increase in social-oriented behaviour may emerge to elevate social standing and desirability amongst peers. Similarly, a heightened consideration of others' opinions and perspectives may be necessary for forming alliances.

Despite this, currently the literature on social cognitive development in adolescence is scarce and scattered, particularly if compared to other stages of development, such as infancy and childhood, or other domains of cognition. Whilst it is slowly gaining traction, only a handful of empirical studies are available today that map out development of important social cognitive skills across adolescence (Valle et al., 2015; Dumontheil et al., 2010a; Burnett Heyes, et al., 2015; Devine & Hughes, 2013; Vetter et al., 2013; Vetter et al., 2013). These few studies suggest continued maturation of these abilities.

Adolescence is typified by an increased ability and propensity to take other people's perspectives into account (Dumontheil et al., 2010a). Studies using social decision-making games find that self-oriented thoughts decrease while other-oriented thoughts increase across age, with the amount of other-

oriented thoughts overtaking self-oriented thoughtsⁱ during mid-adolescence (12-16 years; Crone & Dahl, 2012; Guroglu, van de Bos & Crone, 2009a). In another example, Choudhury, Blakemore, and Charman (2006) showed that the differences in reaction time taken to imagine what emotion a character was feeling from a first and third person perspective decreased with age from childhood to adulthood as well. Apart from reaction time data, studies investigating social cognitive abilities in later development have mostly used story-based vignettes (such as videos, written excerpts), which require participants to predict and explain characters' actions using appropriate mental states (desires, intentions, emotions, beliefs). Given appropriate task difficulty, these studies have suggested continued improvement in ToM performance across later childhood and adolescence as well (Vetter et al., 2013a; 2013b; Devine & Hughes, 2013).

Recent studies have sought to distinguish between different aspects of theory of mind, for example the distinction between cognitive and affective ToM (Sebastian et al., 2011; Vetter et al., 2013a; Kalbe et al., 2010; Shamay-Tsoory, Tibi-Elhanany, & Aharon-Peretz, 2006; Shamay-Tsoory et al., 2007; Shamay-Tsoory & Aharon-Peretz, 2007). Whereas cognitive ToM requires an understanding of others' knowledge and beliefs, affective ToM requires the added ability to make inferences about another person's emotions (Shamay-Tsoory, Harari, Aharon-Peretz & Levkovitz, 2010). This distinction has been shown to exist even on the neural level (Sebastian et al., 2011; Kalbe et al., 2007). Studies investigating affective ToM only have reported that it also shows

ⁱ In social decision-making games, self-oriented thoughts are concerned with outcomes that benefit one's own gains while other-oriented thoughts refer to choices that benefit others, such as fairness and prosocial behaviour.

protracted maturation across adolescence (Vetter et al., 2013a; Sebastian et al., 2011).

The maturation of such social cognitive skills serves an important and practical social function, as adolescents navigate increasingly complex interpersonal networks during this period. For example, Fett et al. (2014) found that a greater propensity to take another's perspectives into account was associated with higher prosocial behaviour in adolescents and stronger trust toward others during cooperative interactions. Conversely, better perspective taking skills were associated with a more drastic decrease in trust and less benevolent reciprocity when they were paired with an unfair partner. Evidence from other social decision-making, or Game Theory, paradigms also suggests an increase in the use of cooperation strategies that take into account the perspectives, motives, and intentions of others when making relative contributions to the self and other across childhood and adolescence (Almås, Cappelen, Sørensen, & Tungodden, 2010; Güroğlu et al., 2009a; van den Bos, Westenberg, van Dijk, & Crone, 2010). Presumably, not only are social cognitive skills maturing during this period, adolescents are also increasingly able to use them in a practical manner to inform decision-making in social situations.

Along with an increased sensitivity to others (through a better understanding of other people's perspectives), adolescence is also a time when an individual becomes ever more reflective and conscious of their "self", continuously evaluating themselves through the eyes of others (Brinthaup & Lipka, 2012; Brizio, Gabbatore, Tirassa, & Bosco, 2015; Steinberg & Morris, 2001). Indeed, a construct that runs in parallel to social cognition is

metacognition, defined as the ability to think about thinking (Flavell, 1979). Metacognition is essential to social cognition in that it is the ability to recognise one's own thoughts and emotions, to relate them to relevant interpersonal events, to understand the mental states of others, and to keep them distinct from (and possibly different to) those of one's own (Semerari, Carcione, Dimaggio, Nicolo, & Procacci, 2007; Dimaggio, Lysaker, Carcione, Nicolò, & Semerari, 2008). This ability to evaluate one's self has also been shown to improve from adolescence to adulthood (Demetriou & Bakracevic, 2009; Weil et al., 2013). Arguably, perspective taking in social cognition would not be possible without this concurrent awareness of one's self, both as an independent agent, as well as in relation to others.

These changes in social cognition in adolescence reflect clearly the increasingly complex social relationships and demands that form during this period. However, it is important to note that there may be individual differences in these abilities. There may be differences between boys and girls; between those of high and low cognitive ability; and they may be influenced by trait factors such as empathy. These factors potentially underlie and may shape the adolescent's development of social cognitive abilities.

1.1.3 Individual differences in social cognition

Research on gender differences in social cognition during middle childhood (between four to nine years) has been mixed. Although there is evidence for early female advantage on passing false belief tasks, this is thought to disappear by the time children are four or five (Charman, Ruffman, & Clements, 2002). Nevertheless, some research in middle childhood report

increased ToM skills for girls (Calero, Salles, Semelman & Sigman, 2013), whilst others show no difference between genders (Jahromi & Stifter, 2008; Ronald et al., 2006). Studies on preadolescents suggest that a female advantage may yet again emerge. Even when matched for verbal ability and age, girls significantly outperformed boys in a group of eight to 12 year olds on ToM tasks (Devine & Hughes, 2013). Similarly, 10 to 13 year old females were better than males at interpreting ambiguous social situations and interacting effectively with peers (Bosacki & Wilde Astington, 1999). Adult literature suggests that female advantage in social cognitive capacity continues into adulthood (Baron-Cohen, 2004; Hall, 1978; Kirkland, Peterson, Baker, Miller & Pulos, 2013) although again this is not always consistent (see Russell, Tchanturia, Rahman & Schmidt, 2007 for evidence of male advantage). Taken together, these studies might suggest that gender differences in social cognition, while not consistent during early-mid childhood, may emerge and stabilise during the transition between childhood and adolescence, when social interactions and relationships often change between girls and boys. For example, girls frequently have fewer but more intimate relationships whereas boys prefer to socialise in bigger groups (Maccoby, 1990). Further research is necessary to better distinguish potential gender differences in social cognition across adolescence.

Interestingly, Ibanez et al. (2013) found that empathy (for which girls usually report higher levels of than boys; Baron-Cohen & Wheelwright, 2004) mediated the effect of gender on social cognition. The capacity to empathise is closely related to but distinct from ToM. Recent evidence points to two systems, dissociable on a neural level, for empathy. These are a basic emotional contagion

system ('I feel what you feel' or contagious crying), coined emotional empathy, and a more advanced cognitive perspective-taking system, or cognitive empathy, which requires an added *understanding* of emotional perspectives (Shamay-Tsoory, 2011; Shamay-Tsoory, Aharon-Peretz & Perry, 2009). According to Shamay-Tsoory (2011), while cognitive empathy is a response capacity related to both cognitive and affective ToM processes, emotional empathy may underscore more automatic behaviours, such as emotion recognition and shared pain. Supporting this theory, Rogers, Dziobek, Hassenstab, Wolf, and Convit (2007) found that performance on the Strange Stories task correlated with cognitive empathy, but not with emotional empathy scales.

Next, to what extent do individual differences in domain general cognitive abilities underscore skills in the social domain? Previous research has revealed robust associations between verbal ability and social cognitive tasks, particularly in early childhood (Astington & Jenkins, 1999; Happé, 1994; Ronald, Viding, Happé, & Plomin, 2006). Crucial support comes from longitudinal studies that show that language abilities in toddlers predict false belief and ToM ability several years later (Watson, Painter, & Bornstein, 2001; Ruffman, Slade, Rowlandson, Rumsey & Garnham, 2003). This association between individual differences in language and ToM abilities has also been shown in mid childhood (Devine & Hughes, 2013). Furthermore, fluid intelligence, defined as the ability to think logically and solve problems in novel situations, independent of acquired knowledge (Prabhakaran, Smith, Desmond, Glover, & Gabrieli, 1997), may also be important for social cognition. For example, psychosocial adaptation is associated with FI (Huepe et al., 2011), suggesting the latter as part of a

general capacity for adaptation to social contexts. Moreover, in a group of 12 to 13 year old secondary students, a direct positive association between fluid intelligence and ToM was found (Ibanez et al., 2013).

While studies on young children have illustrated the importance of working memory, the ability to hold and manipulate multiple pieces of information in the mind, on ToM (Hughes, 1998; Davis & Pratt, 1995; Keenan, Olson, & Marini, 1998), its relevance in the later developmental years has been questioned (Slade & Ruffman, 2005; Vetter, Leipold, Kliegel, Phillips and Altgassen; 2013). Little is currently known about the relationship between working memory and ToM in later childhood and adolescence. Adult studies suggest there exists a “social working memory” (SWM) system (Meyer & Lieberman, 2012) as distinct from cognitive working memory (CWM), which may be particularly important for social cognitive processing. SWM refers to the ability to maintain and manipulate social information, e.g. other people’s beliefs, traits and mental states. Behavioural evidence for SWM comes from studies that report an inverse relationship between social cognitive load and mentalising performance (Spunt & Lieberman, 2013; Schneider, Lam, Bayliss, & Dux, 2012; Rutherford, 2004; Apperly, Back, Samson, & France, 2008). As social load increases, extant research has also shown that there are parametric increases in both CWM and SWM neurocognitive networks (Meyer & Lieberman, 2012; Meyer, Spunt, Berkman, Taylor, & Lieberman, 2011). However, only load-dependent increases in the SWM neurocognitive network were associated with individual differences in a trait measure of social cognitive ability (Meyer et al., 2011).

Another aspect of executive function that has been shown to predict ToM performance is the ability to inhibit pre-potent responses, i.e. inhibitory control. While WM may be important for an individual to hold in mind multiple perspectives, good inhibitory control allows for the successful suppression of perspectives that are irrelevant, such one's own thoughts when thinking about another's mental state. On false belief tasks in early childhood, inhibitory control has been shown to predict performance after controlling for age as well as verbal and nonverbal intellectual ability (Carlson, Moses, & Claxton, 2004; Carlson & Moses, 2001; Carlson, Moses, & Breton, 2002). Furthermore, an adult study reported a common neural mechanism between basic motor inhibition and self-perspective inhibition in social cognitive processing, but not belief reasoning (van der Meer, Groenewold, Nolen, Pijnenborg, & Aleman, 2011).

Can domain general cognitive capacities and executive functions fully account for differences in social cognitive ability? It is clear that these are at least partially intertwined. Moreover, what might the relative contribution of development in cognitive abilities to age-related social cognitive changes be? While cognitive abilities may underlie some aspects of social understanding, recent neuroscientific research has found key brain areas dedicated to processing social stimuli (Blakemore, 2012), suggesting that there is indeed something distinctly 'social' about social cognition.

1.1.4 The adolescent 'social brain'

The burgeoning field of neuroscience has increasingly highlighted the role of brain maturation in accounting for some of the adolescent-typical changes in social behaviour (Blakemore, 2008; 2012; Crone & Dahl, 2012). In particular, in

the transition to and across adolescence, structural and functional changes occur in key circuits in the brain that are involved with social processing, such as the medial prefrontal cortex (mPFC), amygdala, superior temporal sulcus (STS), the fusiform face area (FFA), the anterior temporal cortex (ATC), the anterior cingulate cortex (ACC), and the temporoparietal junction (TPJ), collectively known as the 'social brain' (Blakemore, 2012). These changes are thought to equip adolescents with the ability to handle new and changing social pressures faced during this period. For example, the increasing sophistication with which adolescents understand and manipulate social interactions as they navigate their teenage years (Vetter et al., 2013a; 2013b; Burnett-Heyes et al., 2015; Dumontheil et al., 2010a) has been attributed to maturing 'social brain' structures (Figure 1.1).

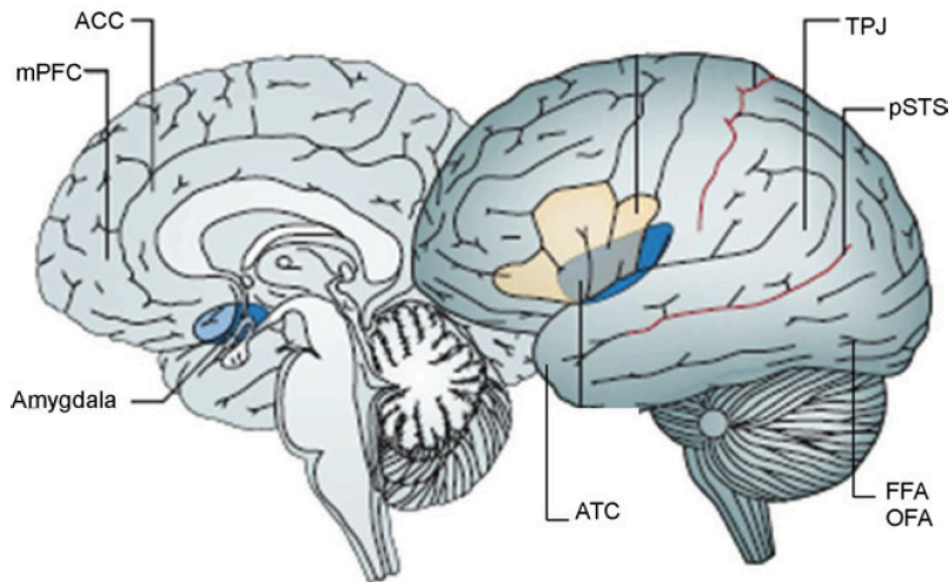


Figure 1.1 The social brain (reproduced from Burnett, Sebastian, Kadosh, & Blakemore, 2011). Regions shown (clockwise from top left) are medial prefrontal cortex (mPFC), anterior cingulate cortex (ACC), temporo-parietal junction (TPJ), posterior superior temporal sulcus (pSTS), fusiform face area (FFA), occipital face area (OFA), anterior temporal cortex (ATC) and amygdala.

While the FFA subserves basic face processing abilities (Haxby, Hoffman, & Gobbini, 2000), the ATC is thought to represent semantic social information (Olson et al., 2007), and the posterior STS (pSTS) is important for decoding social gestures and signals to form predictions of action or intent (Haxby, Hoffman, & Gobbini, 2002; Saxe, Xiao, Kovacs, Perrett, & Kanwisher, 2004). Considerable evidence implicates both the TPJ and mPFC in representing or attending to mental states (Amodio and Frith, 2006; Abraham, Schubotz, & von Cramon, 2008; Baron-Cohen, Lombardo, Tager-Flusberg, & Cohen, 2013; Sommer et al., 2007), with the mPFC involved in more self-oriented thoughts (Mitchell, Banaji, & Macrae, 2005) and the TPJ in perspective taking abilities or self-other agency (Schurz, Radua, Aichhorn, Richlan, & Perner, 2014), although this distinction is not yet clearly defined. Specifically, the ventromedial prefrontal cortex (vmPFC) has been found to underscore the ability to read another's social emotional cues (Winston, O'Doherty, & Dolan, 2003), i.e. affective ToM (Shamay-Tsoory, 2006; 2011; Vetter et al., 2013a). Moreover, the dlPFC has been shown to be selectively important for cognitive aspects of ToM (Kalbe et al., 2010) as well as social behaviour that require impulse control (Steinbeis, Berndhart, & Singer, 2012).

Changes in the brain during adolescence are driven by and also interact with a cascade of hormonal changes that occur during puberty, to affect social development (Blakemore, Burnett, & Dahl, 2010; Giedd et al., 2006; Lenroot et al., 2007; Crone & Dahl, 2012). Importantly, the onset of puberty represents a period of synaptic reorganisation in the brain, with some of the most protracted development found for areas implicated in social functioning, such as those discussed above (Giedd, 2004). For example, in the PFC, synaptic pruning takes

place across adolescence into adulthood (Blakemore & Choudhury, 2006). Mills, Lalonde, Clasen, Giedd, & Blakemore (2014) found that grey matter volume and cortical thickness in the mPFC, the TPJ and the pSTS decreased from childhood into the early twenties. The surface area for each region was found to peak in pre-adolescence or early adolescence before decreasing into the early twenties. Researchers believe that reductions in grey matter volume may reflect synaptic reorganisation and pruning that allow the adolescent to adopt more increasingly effective and efficient cognitive strategies when dealing with complex decision-making (Mills et al., 2014; Crone & Dahl, 2012).

In line with structural findings, functional neuroimaging studies consistently show a decrease in mPFC activation and increase in temporal cortex (e.g. ATC and TPJ) activation from adolescents to adults using a variety of mentalising tasks (Blakemore, 2012; Burnett, Bird, Moll, Frith, & Blakemore, 2009; van den Bos, van Dijk, Westenberg, Rombouts & Crone, 2011; Vetter, Weigelt, Dohnel, Smolka, & Kliegel, 2014; Goddings, Burnett Heyes, Bird, Viner, & Blakemore, 2012). In particular, Goddings et al. (2012) found that age (independent of hormone levels) predicted lower dmPFC activity, while pubertal stage (independent of age) predicted higher left ATC activity during processing of social emotions. Furthermore, there is also evidence for differential functional connectivity between the mPFC and other parts of the social brain network across age (Burnett & Blakemore, 2009; Kelly et al., 2009), which could be underpinned by changing cognitive strategies from adolescents to adults during mentalising activities or by basic neuroanatomical changes. For example, Klapwijk et al. (2013) found that pubertal indicators were correlated with the

functional connectivity in the social brain of girls during processing of social relative to basic emotions.

Importantly, prosocial behaviour and judgements of fairness and reciprocation, arguably key skills for an adult to effectively integrate into society, may require the development of effective perspective-taking abilities, and has been shown to also recruit the same brain regions (e.g. anterior mPFC and ACC) as mentalising tasks (Crone, 2013; Steinbeis et al., 2012; van den Bos et al., 2009; Guroglu, van den Bos, & Crone, 2009b).

More recently, research has suggested that the development of neural circuits and the corresponding behavioural outcomes can also depend on and be driven by experience and sociocultural factors (Crone & Dahl, 2012; Ellis et al., 2012; Choudhury, 2013; Blakemore & Mills, 2014). An outstanding question concerns whether it is the social pressures of adolescence and/or universal biological maturation that drives social cognitive development. In this respect, how might the wider social environment, such as socio-cultural variability in the nature and experience of adolescence, affect the expression of typical adolescent-associated maturational changes in social cognition? While some version of adolescence exists in virtually all human societies, including hunter-gatherers and pastoralists (Schlegel & Barry, 1991), its features are not universal, and in fact differ greatly between cultures. Whether cultural differences in the adolescent experience influence the developmental trajectories of social understanding remains unknown. To date, virtually all studies on adolescent social cognition and its neural correlates have been done in the West, lacking a culturally inclusive picture. Even prior to examining cultural effects on

adolescent neural trajectories, it may be important to first examine the potential cultural moderation of age changes in social cognition (Nielsen & Haun, 2016).

1.2 Culture

Culture arises from the explicit and implicit patterns of philosophies that are historically derived and refined over time, and embodies all levels of society – from abstract ideas and institutions to interactions and the individual (Markus & Kitayama, 2010). Touted as a uniquely human experience, it constantly evolves and shapes us in turn (Markus & Kitayama, 2010). Hence, culture is best thought of as a fluid entity that is ever changing, and in today's climate of rapid globalisation, cultural identity and norms exist in a constant state of flux. As such, before considering the differential effects of culture on the experience of adolescence, it must be noted that the isolation of “cultural values” will inevitably be, to a certain extent, an artificial imposition. Nevertheless, research has shown considerable differences in the social values as well as cognitive styles of people from different cultures (Markus & Kitayama, 1991; 2003; Nisbett, 2003). As a large part of multi-cultural research in adults thus far has focused on and found pronounced differences between the East and West, research outlined in this thesis will draw from these two broad cultural regions as a framework for analysis. Furthermore, I will contextualise the adolescent experience using each culture's distinct outlooks on life and societal values.

There are certain limitations to this approach. First, the cultures discussed are not exhaustive in the least; there exist many other cultural samples that require further examination and understanding. Second, within the framework of Eastern and Western cultures, there also exists great variability

between subcultures, as defined by nationality, geography, socio-economic status, and more. This distinction within and the overlap between cultures is an important caveat to keep in mind when examining cross-cultural literature.

1.2.1 Why culture matters to development

Despite limitations, steps taken to improve our understanding of the cultural effects on typical development would allow us to understand better how environmental variables can modulate so-called biologically based developmental 'milestones'. In addition, there are crucial implications for policies regarding diagnostic, intervention, and treatment approaches to adolescent mental health, which are currently largely based upon a Western conceptualisation of the self and lack the inclusion of a cohesive cultural perspective (Schwab-Stone, Ruchkin, Vermeiren & Leckman, 2001). Indeed, in recent years, researchers have highlighted the importance of taking into account the impact of culture on development (Nielsen & Haun, 2015), in how it might affect the neural substrates of human cognition (Han & Northoff, 2008), as well as in forming a developmental and psychobiological framework through which to understand adolescent psychiatry (Novins et al., 1997; Munir & Beardslee, 2001; Beauchaine, 2003).

1.2.2 East vs. West

Much evidence from cultural research has elucidated distinct differences in the social value systems between cultures from the East and the West. Whereas Westerners are individualistic in their values (Hofstede, 1980), emphasising values such as freedom of choice, autonomy and being different,

Easterners are collectivistic, with an emphasis on similarity, conformity and hierarchy (Kim & Drolet, 2009). In other words, Westerners have more independent self-construals, defining themselves as separate entities from others and in terms of their own aspirations and achievements, while East Asians have higher interdependent self-construals, defining themselves in terms of their relationships and social obligations (Markus & Kitayama, 1991; Figure 1.2), although both types of self coexist within an individual.

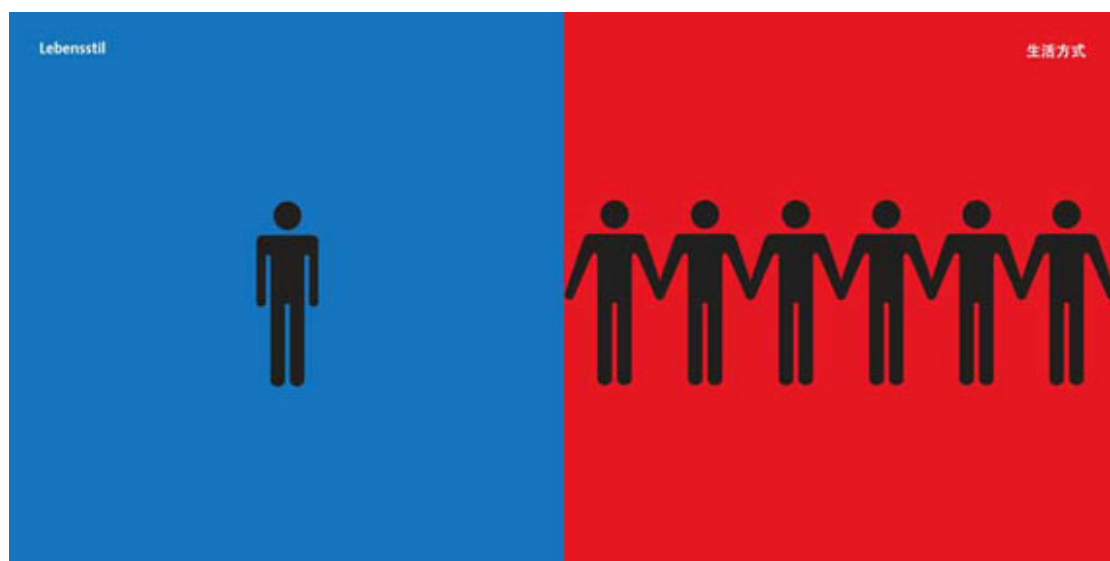


Figure 1.2 An infographic designed by the artist Yang Liu that illustrates the concept of self across individualistic Western (left) and collectivistic Eastern (right) cultures.

Behavioural differences in construing the self across cultures have been shown to be associated with functional differences in brain activation between Eastern and Western adults (Zhu, Zhang, Fan & Han, 2007). The mPFC, the region generally implicated in self-oriented thoughts, was activated in Chinese participants when thinking of their mothers as well as themselves, whereas activation for themselves but not their mothers was found in Westerners. As

expected, thinking about an unknown other did not activate the mPFC in either Chinese or Westerners, in line with the theory that self-representation is closely tied to “close others” in Asians, whereas it is autonomously represented in Westerners.

In the West, adolescent literature on the self has largely focused on self-independence (Blos, 1979; Steinberg, 2008; 2002). Whilst irrefutably an important hallmark of adolescence, as the self is a social entity and is potentially shaped by the distinct demands from society, this angle does not fully represent all cultures. In this respect, there is convincing anthropological evidence that the adolescent experience differs substantially from culture to culture.

1.2.3 Cultural differences in the adolescent experience

Adolescence, as a distinct developmental period, has been shown through numerous anthropological accounts to exist across virtually all pre- and post-industrial human societies (Schlegel & Barry, 1991). Moreover, observational studies suggest a period resembling adolescence in animals like rats and non-human primates too (Spear, 2000). In humans, there is little contention amongst researchers that the beginning of adolescence is demarcated by the onset of puberty. However, its features and endpoint, usually defined as when adult status is attained, vary considerably depending on historical and cultural contexts. The period of adolescence may last only for days or months in certain traditional cultures and involve formalised rituals or rites of passage, after which adult status is obtained, or span years as in Western contemporary society, the endpoint of which is defined legally (Schlegel & Barry, 1991; Schlegel & Hewlett, 2011).

The systematic differences in social value systems discussed above unsurprisingly trickle down to the adolescent experience found in Eastern and Western cultures. Confucianism, the dominant philosophy in China, emphasises social and family harmony (Hsu, 1985), and values such as filial piety and social reticence are highly regarded by Chinese society (Chen, DeSouza, Chen, & Wang, 2006). As such, children and adolescents in China, who might subscribe to more collectivistic values, might have closer relationships and spend more time with their parents, and correspondingly less time with their peers, as well as expect independence and autonomy later in development (Fuligni, 1998; Feldman & Rosenthal, 1991; Chen, Dong, & Zhou, 1997; Darling & Steinberg, 1993). Furthermore, research also suggests that non-parental adults may also play an important and involved role in the development of adolescents in China (Chen, Greenberger, Farruggia, Bush, & Dong, 2003), in contrast to the pervasive nuclear family (involving just the parents and their children) found in the West. As such, family and social structures within which adolescents grow up show considerable differences between cultures.

Interestingly, the differences in social values and pressures experienced by adolescents from the East and the West also manifest as distinct correlates of problem behaviour and mental health disorders. In general, mood and anxiety disorders in adolescence arise more from academic motivational goals and parental pressures in the East as compared to in the West (Essau, Leung, Conradt, Cheng & Wong, 2008). Furthermore, Chen, Greenberger, Lester, Dong, and Guo (1998) found that peer factors accounted for more variance in self-reported early adolescent misconduct (school misconduct, antisocial behaviours

and status-violations) in European and Chinese Americans compared to Chinese adolescents living in Taipei or Beijing, indicating culture-bound correlates of extreme behaviour. Greenberger, Chen, Tally, and Dong (2000) also found that the quality of family relationships and grades in schools were more strongly associated with depressive symptoms among Chinese than American youths.

Over and beyond situational sources of distress (e.g. academic, social, or parental pressures), even the trait correlates of social-emotional disorders have been found to differ across cultures. For example, behaviourally inhibited (shy) children are more likely to develop anxiety and depression in Western cultures (Boivin, Hymel & Bukowski, 1995; Rubin, Chen, McDougall, Bowker & McKinnon, 1995), where extraversion and confidence is valued, whereas in China, where reticence and behavioural restraint is essential for group functionality, children displaying the same traits of inhibition and social withdrawal as their Western counterparts have good outcomes and are socially competent (Kim, Rapee, Ja Oh, & Moon, 2008; Chen, Rubin & Li, 1995a; Chen, Rubin & Sun, 1992; Chen et al., 2006).

As another example, East Asians are typically more self-critical and endorse lower self-esteem (Heine & Lehman, 1999; Hetts, Sakuma, & Pelham, 1999; Kitayama, Markus, Matsumoto, & Norasakkunkit, 1997) than Westerners. However, while these are traits commonly related to negative emotional outcomes in the West (Kwan et al., 1997; Kopala-Sibley, Zuroff, Hankin, & Abela, 2015), they are less robust determinants of wellbeing in Asians (Kitayama, Mesquita & Karasawa, 2006; Uchida, Kitayama, Mesquita, Reyes, & Morling, 2008), and may even serve a functional purpose, i.e. identifying and adjusting

negative personal attributes to maintain group and social harmony (Kitayama et al., 1997). Indeed, as the valence (positive or negative) attached to many traits is embedded within each culture's unique niche of values and norms (Rubin, 1998), it is unsurprising that trait factors underlying emotional wellbeing, such as social disorders, anxiety, depression, and self-harm, also vary across cultures.

Given the many differences in sociocultural values, expectations, and pressures that face adolescents from the East and the West (as illustrated above), these may also have considerable impact on the social cognitive developmental trajectory in young people from different cultures.

1.2.4 Cultural differences in social cognition

Differences in basic cognitive styles have been found to correspond to the differences in social values between the East and the West. Experimental studies from the field of cognitive psychology have found that Westerners are better at making context-independent, analytical judgements, while people from collectivistic cultures show an emphasis on holistic relations (Nisbett & Masuda, 2003; Masuda & Nisbett, 2001; Nisbett & Miyamoto, 2005). For example, Westerners are better at making absolute judgments of the length or vertical alignment of a line (independent of the size or orientation of a surrounding box), whilst Easterners are better at making judgements of that line in relation to the surrounding box (Hedden, Ketay, Aron, Markus, & Gabrieli, 2008). In line with their social values, Eastern holistic cognition results in a preferred orientation toward the whole field, with special attention to the relationship between the object and the context. Holistic thought is also dialectical, involving multiple perspectives. On the other hand, Western analytical thought is characterised by

detaching the object from its context and by applying abstract rules rather than attending to specific contextual details. These differences in cognitive styles have been found in children as young as age four and increases steadily with age (Imada, Carlson, & Itakura, 2013).

In comparison to more basic perception and cognitive domains, culture affects the social world and the way we interact with it to the largest extent. However, although differences in social behaviour as well as basic cognitive styles are well documented, there is currently no study (that I know of) that explores differences in social *cognition* or its development between adolescents from Eastern and Western cultures. Notably, there are a number of studies on differences in early and middle childhood development (Callaghan et al., 2005; Liu, Wellman, Tardif & Sabbagh, 2008; Ahn & Miller, 2012; Hughes et al., 2014; Lecce & Hughes, 2010; Lewis et al., 2009; Sabbagh, Xu, Carlson, Moses & Lee, 2006; Wang, Devine, Wong, & Hughes, 2015).

Wu and Keysar (2007) proposed two competing theories on the impact of culture on social cognition, in particular visual perspective taking, namely the Representational Hypothesis and the Attentional Hypothesis. According to the first theory, collectivistic and interdependent Easterners would be more likely to confound their own knowledge and that of another person due to a weakened self-other distinction (Aron, Aron, Tudor, & Nelson, 1991), and thus make more egocentric errors than Westerners when reasoning about others' mental states. In contrast, the second theory suggests that collectivism and interdependence would lead to a greater emphasis on others, including a tendency to focus one's attentions on another's actions, knowledge, and needs. According to this hypothesis, Easterners should outperform Westerners on mentalising tasks.

Thus, the two theories represent competing hypotheses about the direction of group differences on social cognitive performance.

Curiously, the few cross-cultural studies on social cognition in adults and younger children report conflicting results. Behavioural findings show that Asian adults tend to take other people's perspectives into account more so than Westerners (Wu & Keysar, 2007). This may be in line with cultural and cognitive theories that Easterners more readily adopt different perspectives and think relationally, i.e. the Attentional Hypothesis. In contrast, studies using false belief tasks in childhood have suggested a lag between Asian children and their Western counterparts (Sabbagh et al., 2006; Wang et al., 2015). One reason for this might be the disparity in tasks used between child and adult literature, and conflicting results may have arisen due to task artifacts. For example, Asian adults could have performed better on the perspective taking task by employing more advanced executive function (Wu, Barr, Gann, & Keysar, 2013) instead of better perspective taking skills, and Asian children may perform just as well as Western children should the false belief tasks administered be more naturalistic and appropriate for their culture. Indeed, this lag in passing false belief tasks between Eastern and Western children is not always found (Liu et al., 2008).

Although there is some evidence that the ACC and mPFC might be consistently implicated in social cognition across cultures, interesting cultural differences in the neural circuitry underlying social cognitive abilities have also been shown (Frank & Temple, 2009). Kobayashi, Glover and Temple (2006) found that a mentalising task activated the right insula, TPJ, and right dmPFC, regions involved in the mediation and integration of sensory and limbic inputs with frontal regions, more in American adults, while Japanese participants

showed greater brain activity in their orbital frontal gyrus, or vmPFC, thought to be important for emotional processing. This might indicate a cultural difference in cognitive strategies when mentalising, with Japanese individuals possibly engaging a mental-attribution style that involves more “feeling” of other people’s emotions, rather than cognitively reasoning about. Another study compared brain activation between Japanese and American children (8 to 13 year olds; Kobayashi, Glover & Temple, 2007). While both cultural groups recruited the vmPFC on a cartoon-based mentalising task (which avoids language confounds), stronger activation in the right TPJ was observed in American than in Japanese children, in line with the adult study. It has been suggested that this area might be involved in the more general ability of distinguishing self-agency from others (Jackson, Meltzoff, & Decety, 2006; and see Decety and Grèzes, 2006 for a review). As such, diminished activity in the TPJ for both Japanese adults and children during ToM tasks may represent the weakened sense of self-other distinction found in Eastern cultures when mentalising.

Taken together, the behavioural and neural studies outlined above suggest that cultural differences in mentalising are present from a young age and persist into adulthood, indicating a role for acculturation in shaping social cognitive development during adolescence. However, currently, little is known about the differences or similarities in social cognitive abilities between Easterners and Westerners adolescents. As such, the directionality between the social pressures of adolescence and the universal biological maturation that drives social development remains a question to be answered.

1.3 Summary of thesis

To conclude, in our attempt to understand adolescent development in social cognition, it is crucial that researchers keep culture firmly in mind, and the knowledge of its potential effects on development at hand. The aim of the research outlined in this thesis was two-fold, namely i) to map out the developmental trajectory of important social cognitive skills (and its relationship to relevant individual differences factors) across adolescence, and ii) to address the aforementioned lack of cultural inclusion in our current understanding of social cognition in adolescence.

The cultures selected for examination were the United Kingdom, China and Malaysia. These were chosen for a combination of reasons, such as i) China and Malaysia are collectivistic societies that fall on the low end of Hofstede's (1980) Individualism-Collectivism (I-C) spectrum as compared to the UK, which is categorised as individualistic (Triandis, 1988; Lau, 1992; Bochner, 1994; Watkins et al., 1998), ii) there are well documented differences between Asian and Western cultures from other research domains, particularly in adult literature (such as anthropological accounts and cultural theories, as well as cognitive psychology; Wu & Keysar, 2007; Hofstede, 1980; Markus & Kitayama; Nisbett, 2003), upon which the empirical investigation on adolescent social cognitive development outlined in this thesis can build, and iii) there may exist variations within the large regional cultural definition of Asia, and to date very little is known about Malaysian adolescents specifically.

The structure of the thesis is as follows: Chapter 2 first aimed to establish whether or not adolescents from the UK, China, and Malaysia are characterised

by self-construals that are typical to Western and Eastern cultures, as found in adults. Next, Chapters 3 and 4 mapped out the development of cognitive and affective ToM in adolescents from the UK and China, before drawing comparisons between the two. Finally, Chapter 5 examined the propensity for adolescents to take into account social reciprocity (presumably driven by perspective taking skills) when making cooperative investment decisions in authentic adolescent peer networks from the UK and Malaysia, and whether or not this changes with age.

In total, 668 participants from the UK, China and Malaysia took part in the studies outlined in this thesis. 626 participants completed the self-construal scale (SCS; Singelis, 1994) as described in Chapter 2 (UK: N = 226; China: N = 175; Malaysia: N = 225), although some were excluded due to missing data. 188 adolescents from the UK (32 of whom did not complete the SCS in Chapter 2) took part in the ToM study outlined in Chapter 3. From this, an age-matched sample of 109 was selected as cultural comparison, to be analysed together with a sample of 116 Chinese adolescents who completed the same study in Chapter 4. Finally, 70 participants from the UK and 147 from Malaysia (10 of whom did not complete Chapter 2's SCS study) took part in Chapter 5's social network study. Further details on sample demographics are available in each individual chapter.

The broad questions and main hypotheses of this thesis are outlined below, with more specific background and detailed hypotheses described in subsequent chapters. Each study takes into account individual differences that are relevant to its investigation.

- i. Do sociocultural differences in the construal of 'self' as found in adults exist in adolescents from different cultures?
 - Young people from the UK, China, and Malaysia would be characterised by culture-bound self-construals (Chapter 2).
- ii. Do social cognitive abilities continue to mature across adolescence?
 - Both cognitive and affective Theory of Mind would continue to improve across adolescence (Chapters 3 & 4).
 - Social reciprocity would increasingly influence cooperative behaviour across adolescence (Chapter 5).
- iii. Is adolescent social cognitive development affected by sociocultural factors?
 - There may be differences in Theory of Mind ability and development between adolescents from the UK and China (Chapter 4).
 - The effect of social reciprocity on cooperative investment in adolescence may be different between adolescents from the UK and Malaysia (Chapter 5).

2. The independent and interdependent adolescent: cultural, socioeconomic, and gender influences

2.1 Abstract

Acquiring self-independence is an important developmental milestone in adolescence. Theories of self-construal (the interpretation of the self) suggest that the self can also be defined interdependently, through the lenses of one's social roles and relationships with others. Does a two-dimensional model of self-construal based on independence and interdependence similarly characterise adolescents from across the world? In the research reported in this chapter, data on these different aspects of self-construal were gathered from young people (age range: 9 to 21 years) in the United Kingdom (N = 220), China (N= 174) and Malaysia (N = 222) using the Self-Construal Scale (SCS; Singelis, 1994). SCS measures the degree to which participants identified with being an independent entity and an interdependent social agent. Exploratory Principal Components Analysis supported the two-component structure. Repeated measures analysis reported patterns of sociocultural variations in adolescent self-construal that were largely in line with adult studies, although there were interesting deviations. In line with expectations, adolescents from the UK, an individualistic culture reported higher independence than interdependence, while adolescents from collectivistic China showed the opposite pattern. However, Malaysian adolescents were found to be more independent than interdependent, even though it is traditionally identified as a collectivistic society. Across the whole sample, boys endorsed a more independent self-construal than girls, and a more independent than interdependent self-construal in general. Finally, familial

socioeconomic status positively predicted self-construal scores overall, in particular independence. Taken together, results from this study lend support to the two-dimensional model of self-construal in adolescents, and suggest that at least some cross- and within-cultural variations in self-construal found in adults are also present in adolescents. Future studies on adolescent self-development should address both types of self-construal in a culturally sensitive manner.

2.2 Introduction

Adolescence is a period of change. Despite being defined as the interim period between the end of childhood and the beginning of manhood or womanhood, adolescence is not a static stage of development. In fact, widespread changes take place in both the social environment and in biology, which co-occur with and may even drive various psychological changes (Crone & Dahl, 2012). One notable change is that as adolescents mature into adults, they become more independent and autonomous (Steinberg, 2008; 2002; Erikson, 1968). This is likely to be adaptive, facilitating the move away from the family unit to establishing independent social ties and networks (De Lorme et al., 2013). Indeed, gaining self-independence is regarded as a key developmental milestone of adolescence (Blos, 1979; Steinberg, 2008; 2002). Concurrently, from childhood to adolescence, individuals' self-identities and self-concepts change too, eventually stabilising during adolescence (Keltikangas-Jarvinen, 1990; Dusek, Flaherty, & Hill, 1981; Engel, 1959). There is an increasing individuation and differentiation of their self-concepts (Steinberg & Morris, 2001), as adolescents begin to hold themselves to more abstract yet personal beliefs and standards (Harter, 1998; 1999). These changes have been shown to have

important effects on self-esteem and other important social emotional outcomes in youth (Harter, 1999; Van Petegem, Beyers, Vansteenkiste & Soenens, 2012).

While intriguing, these studies of the change in self-concept and identity mainly consider the self as an individual unit. As the self is a social entity (Harter, 1999; Kagitcibasi, 2013), theories of self-construal suggest that how a person defines and makes meaning of the self (to construe is to “interpret”; Markus & Kitayama, 1991) can also be in the context of one’s relationships with others (see Figure 2.1a; Lam, 2006). Markus and Kitayama (1991) proposed two main kinds of self-construal: independent and interdependent. Independence refers to the tendency to view oneself primarily as a unique entity separate from others, and in terms of one’s own aspirations and achievements (I am happy, successful, well-read), while interdependence is the propensity to experience the self as intertwined with its social environment, through the lenses of relationships as well as social and group obligations (I am a sister, son, friend, employee). Though not without its critics (Levine et al., 2003; Kashima et al., 1995), data in adults generally provide support for this two-dimensional model of self-construal. Specifically, individuals can be characterised separately on *both* these dimensions of self-construal, which are orthogonal (Singelis, 1994; Yamada & Singelis, 1999; Imamoğlu, 2003; Imamoğlu & Karakitapoğlu-Aygün, 2004; Kam, Zhou, Zhang, & Ho, 2012), rather than high independence and high interdependence representing opposite poles of the same scale as is the traditional conceptualisation (Hofstede, 1980; Triandis, 1995; and see Schimmack, Oishi, & Diener, 2005, for a discussion). In fact, some studies have even found independence and interdependence to be slightly positively correlated (Kwan, Bond & Singelis, 1997).

Upon entering adolescence, not only do individuals become more independent, they also become increasingly aware of their self and identity in relation to the social world, and begin to establish themselves as social agents. As adolescence is a period where peer relationships and social feedback are salient (Brown & Larson, 2009) and where changes in the susceptibility to peer influence are evident (Gardner & Steinberg, 2005), these experiences provide crucial opportunities for adolescents to learn about social and group dynamics, as well as their positions within that (Dishion, McCord & Poulin, 1999; Gavin & Furman, 1989). Yet, there is surprisingly little research investigating the presence of the interdependent self as distinct from emerging independence in this age range. **The first goal of this study was therefore to investigate whether the two-dimensional model of self-construal characterises adolescents.**

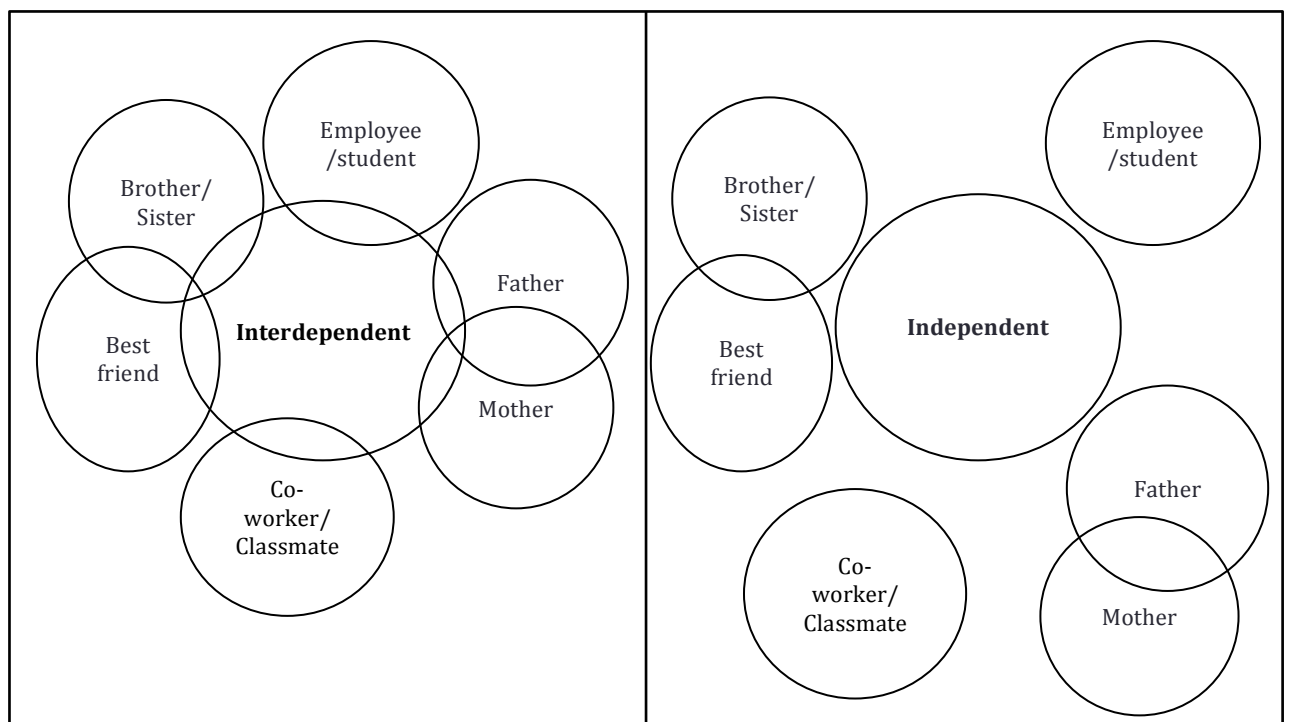


Figure 2.1a The independent and interdependent self. Based on Markus and Kitayama's (1991) construals of the self in relation to representation of others and one's social roles.

2.2.1 Cross-cultural influences on independent and interdependent self-construals

As adolescents begin to internalise global and societal values (Harter, 1999) and as the self becomes increasingly reflective of its interpersonal environment (Brinthaupt & Lipka, 2002), it is likely that the existence of both an independent and interdependent self may already be present in adolescence. However, adult studies suggest that the story is not so simple, and the degree to which individuals endorse the independent versus interdependent self is heavily affected by the wider social environment, particularly cultural norms and influences. Studies of adults generally suggest that individuals from Asia and Africa endorse interdependent self-construals more, and that the independent self-construal is more prominent in Western Europe and North America (Bochner, 1994; Eaton & Louw, 2000; Rhee, Uleman, Lee, & Roman, 1995), although this has not always been empirically supported (Matsumoto, Kudoh, & Takeuchi, 1996; Stephan, Stephan, Saito, & Barnett, 1998; and see Matsumoto, 1999 for a review). This notion of cultural specificity in the construal of the self is consistent with longstanding cultural theories that Western societies, such as the United Kingdom, embrace more individualistic values such as goal directedness and autonomy, while collectivistic Asian cultures, such as China and Malaysia, are characterised by allocentric values such as relatedness (Hofstede, 1980; Bochner, 1994; Markus & Kitayama, 1991; Markus, Mullaly & Kitayama, 1997; and see Oyserman, Coon, & Kemmelmeier, 2002 for a meta-analysis).

The influences of culture on self-representation have even been shown at a neural level (Zhu et al., 2007). For example, one study found that while the mPFC was activated in both Western and Chinese adults during self-judgements,

for Chinese participants it was also implicated during judgements about their mothers. These results were interpreted to suggest that judgements relating to the self and to close others shared an overlapping neural basis in the Chinese but not in the Western sample. As adolescence is a developmentally sensitive period primed for the absorption of culture (Kitayama & Uskul, 2011; Kitayama & Park, 2010), it is likely that sociocultural norms may impinge on and shape the individual across a range of domains (Crone & Dahl, 2012; Kagitcibasi, 2013) including self-identity or construal. However, few studies have measured self-concept during adolescence in a cultural context, and those that have do not use consistent measures across several cultures – therefore not allowing direct comparisons. **As such, using the same measures across different cultures, the second goal of the study was to investigate whether cultural differences in self-construal found in adults might also exist in adolescents.**

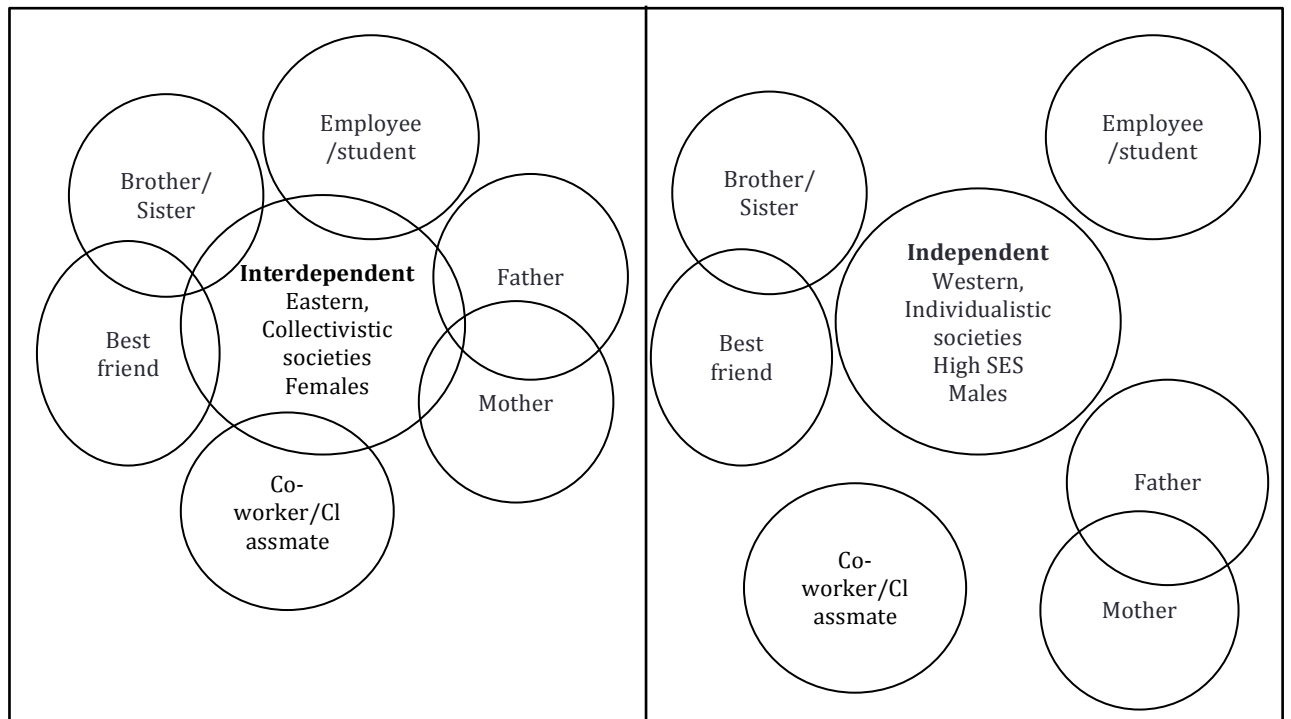


Figure 2.1b. Sociocultural-typical groups that elicit each self-construal type are listed within each circle. According to Markus and Kitayama (1991), every individual may concurrently hold both types of construals but socio-cultural circumstance elicit or shape activation of one more so than the other, i.e. they are distinct but not bipolar constructs.

2.2.2 Within-cultural influences on independent and interdependent self-construals

Within-culture variations in self-construal have also been reported and are stressed by researchers such as Markus and Kitayama (1994) who do not assume all individuals in a given cultural group are alike. Importantly, culture is not only defined by geographical and national boundaries, but also by social groups such as those based on gender or socioeconomic status (SES; Cross & Madson, 1997; Triandis, 1988; 1995; see Figure 2.1b). For example, with increasing education and urbanisation, there appear to be trends toward individuation and autonomy (Reddy & Gibbons, 1999; Kohn, Naoi, Schoenbach, Schooler, & Slomczynski, 1990; Grossmann & Varnum, 2010) without a

concomitant decrease in interdependent or relational values (Imamoğlu, 1987; 2003; Imamoğlu & Karakitapoğlu-Aygün, 2004). In line with this, Hamamura, Xu, and Du (2013) found that Chinese adolescents with well-educated parents embraced more independent attributes on a range of psychological indices than those with less educated parents.

Societal gender roles have also been shown to emphasise relative preferences for self-construal types in males and females, with males being more independent and autonomous and females more interdependent and relational (Cross, Hardin & Gercek-Swing, 2010; Cross & Madson, 1997; Kashima & Hardie, 2000; Gabriel & Gardner, 1999), although this finding has not always been consistent (Li, 2002) and is not without its critics (Martin & Ruble, 1997). These gender differences in self-construals have been shown to be especially salient in individualistic cultures and less in collectivistic cultures because both men and women tend to define themselves as relational in those cultures (Watkins et al, 1998)

In short, not only does the way in which we perceive our 'self' as a social entity develop and change over time (Harter, 1999; Kagitcibasi, 2013), this may be largely affected by cultural factors, as well as gender and socioeconomic status (Reddy & Gibbons, 1999; Kagitcibasi, 2013; Markus & Kitayama, 1991; Imamoğlu, 1987; 2003). **The third goal of this study was to thus to disentangle the relative effects of gender and SES on self-construal type in adolescence.**

2.2.3 Summary of goals and hypotheses of current study

This study set out to answer three overarching questions, which were:

i) Does adolescent self-construal vary on the two orthogonal dimensions of independence and interdependence? ii) Does adolescent self-construal conform to cultural-typical norms? iii) What are the relative effects of socioeconomic status and gender on self-construal? To address these questions, Singelis' (1994) 30-item self-construal scale (SCS), which was developed based on Markus and Kitayama's (1991) two-dimensional model of self-orientation (independence and interdependence), was administered to adolescents from the United Kingdom, China and Malaysia. According to Hofstede's (1980) Individualism-Collectivism (I-C) dimension data matrix, China and Malaysia rank low on the individualism dimension, reporting scores of 20 and 26 respectively (out of 100), identifying them as collectivistic cultures that should embrace interdependent self-construals. By contrast, the United Kingdom scores highly at 89, which classifies it as an individualistic culture with higher prevalence of independent selves. While there has been considerable empirical work on self-construal in China, other regions such as Southeast Asia's Malaysia remain sparsely studied and understood in the last two decades since this theory has become prominent in the field of cultural psychology (Matsumoto, 1999). To investigate whether independent and interdependent selves characterise this age group, I first assessed whether this measure yielded two components that fit the independent and interdependent subscales (Singelis, 1994; Markus & Kitayama, 1991). Next, retaining only items that were suitable across all cultures, I investigated whether or not the effects of culture on self-construal typically found in adults also exist

in adolescents. Finally, I also investigated the effects of gender and social class on adolescent self-construal.

The main hypotheses were:

- i. *Independent and interdependent selves.* Two factors would underlie the items of the SCS, corresponding to the independent and interdependent subscales as suggested by Singelis (1994).
- ii. *Cultural variations in the self.* While there would be an overlap between cultures, adolescents from the UK would report the highest levels of independent self-construal, followed by Malaysia and then China; the opposite pattern was expected for interdependent self-construal (Watkins et al., 1998; Hofstede, 1983; Markus & Kitayama, 1991).
- iii. *Within-culture variations in the self.* Females would report higher interdependent and lower independent self-construal levels than males (Cross & Madson, 1997; Kashima & Hardie, 2000; Gabriel & Gardner, 1999), and gender differences would be more pronounced in the UK than in Malaysia and China (Watkins et al., 1998). Adolescents from higher SES backgrounds would be more independent (Reddy & Gibbons, 1999), *without* being less interdependent (Imamoğlu, 1987; 2002; Imamoğlu & Karakitapoğlu-Aygün, 2004).

2.3 Methods

2.3.1 Participants

626 participants from the United Kingdom, Malaysia and China completed the SCS. Participants with more than 25% of missing item on each scale were excluded from analysis (United Kingdom: N = 6, Malaysia: N = 3, China: N = 1), resulting in a final sample of 616 (age range = 9.02 to 20.76 years; M = 15.06

years, SD = 2.09; 322 females; United Kingdom: N = 220, Malaysia: N = 222, China: N = 174; Table 2.1). Informed consent was obtained from all participants who were 18 years and above and from parents of participants under this age, who signed assent forms.

2.3.2 Materials

2.3.2.1 Translation work

For adolescents from the UK and Malaysia, where English was the primary language taught in the participants' schools, self-report measures were in English. For Chinese participants, measures were translated and back-translated from English to Chinese by myself and by two other bilingual English and Chinese speakers, for whom Chinese was their native language.

2.3.2.2 Self-construal scale

The 30-item SCS (Singelis, 1994) consisted of 15 Independent items (Ind; e.g. "I enjoy being unique and different from others in many respects") and 15 Interdependent items (Int; e.g. "My happiness depends on the happiness of those around me"). These were rated on a 7-point Likert-type scale (1 = "strongly disagree" to 7 = "strongly agree"). The language used in the original scale was simple and suitable for adolescents and so no adjustments were made. None of the items were reverse-scored.

The Independent and Interdependent subscales have reported alphas of .69 and .73 respectively (Singelis, 1994) and converge with other measures of individual level individualism-collectivism (Singelis et al., 1995; see Gudykunst & Lee, 2003 for a review of the validity of SCS). In this sample, the Independent and Interdependent subscales reported alphas of .77 and .84 respectively.

2.3.2.3 Family affluence scale II

The four-item Family Affluence Scale II (FAS II; Currie, Elton, Todd, & Platt, 1997; Currie et al., 2008; Boyce & Dallago, 2004) was administered as a measure of adolescents' familial socioeconomic status (SES). Respondents answered questions such as "Does your family own a car, van or truck?" (scored on a point system of "No" = 0, "Yes, one" = 1, "Yes, two or more" = 2) and "Do you have a bedroom for yourself?" ("No" = 0, "Yes" = 1). A composite FAS score was calculated from these items (Max = 9, Min = 0).

The FAS II was developed in the World Health Organisation (WHO) Health Behaviour in School-aged Children Study (HBSC) to measure associations between socio-economic status and health in youth. It has been shown to be a reliable indicator of adolescent familial wealth; a six-country study (Krolner, Andersen, Holstein, & Due, 2005; Andersen et al., 2008) on child-parent agreement for FAS II items reported high agreement levels on the whole scale across all countries. It has also shown strong associations with quality of life in adolescents both within countries and as a cross-national measure (Von Rueden, Gosch, Rajmil, Bisegger, & Ravens-Sieberer, 2006; see Currie et al., 2008 for a ten-year review). In a study across 35 countries, the FAS showed good correlations with absolute national wealth measures, reporting a Spearman rank correlation of .87 with Gross Domestic Product and a Kappa agreement coefficient of .57 (Boyce, Torsheim, Currie & Zambon, 2006).

2.3.3 Procedure

Participants completed the SCS and the FAS either as part of a larger battery of Theory of Mind tasks (presented in Chapters 3 and 4) or as part of the social networks study (presented in Chapter 5). Measures were administered either individually or as a class in exam-like conditions. After controlling for culture, there was no significant difference in self-construal scores between those who completed the measures individually and as a class (Independent: $p = .853$; Interdependent: $p = .310$).

Table 2.1. Sample demographics for all participants (N = 616).

	Total	Females	Males	Age (years)		Ethnicity ^a	FAS Mean (SD)
				Range	Mean (SD)		
All participants	616	322 (52.24%)	294 (47.76%)	9.02 to 20.76	15.06 (2.12)		6.78 (1.78)
United Kingdom	220	123 (55.90%)	97 (44.10%)	10.25 to 19.83	15.70 (2.26)	Caucasian (73.66%), South Asian (9.38%), Black or African (7.14%), East Asian (4.91%), Mixed (2.32%), Other (Turkish, Hispanic; 1.79%), Missing (0.89%)	7.00 (1.65)
Malaysia	222	101 (45.50%)	121 (54.50%)	10.81 to 17.68	15.04 (1.67)	Chinese (62.22%), Malay (21.33%), Indian (9.78%), Mixed Asian (4.44%), Other (Half Caucasian; Caucasian; 2.22%)	7.49 (1.22)
China	174	99 (56.90%)	75 (43.10%)	9.02 to 20.76	14.19 (2.18)	Han Chinese (90.97%), Other (Korean, Manchu, Hmong; 3.23%), Missing (5.81%)	5.44 (1.90)

Note. The distribution of females and males across cultures was significantly unequal, $X^2 = (2, N = 616) = 6.316$, $p = .043$. One-way analyses of variance also revealed significant differences in age, $F(2, 614) = 24.115$, $p < .001$, and FAS scores, $F(2, 614) = 93.935$, $p < .001$, across cultures. Bonferroni corrected pairwise comparisons revealed that this difference was significant between all cultures for age (UK and Malaysia: $p = .001$; UK and China: $p < .001$; Malaysia and China: $p = .001$) and for FAS (UK and Malaysia: $p = .004$; UK and China: $p < .001$; Malaysia and China: $p < .001$). ^a Ethnic categories are based on culturally appropriate norms and identification of race.

2.3.4 Data analysis overview

To address the first research question, exploratory principal component analysis (PCA) was conducted on SCS data from the whole sample to establish whether Markus and Kitayama's (1991) model of interdependent and independent self-construals was applicable to an adolescent sample. Next, PCA with Varimax rotation and with two factors specified was conducted for the whole sample and for each culture separately in order to investigate whether the two-factor structure was suitable for all cultures, as well as to identify items that may present culture-specific problems.

PCA was used, because the primary purpose was to identify the underlying components of the 30-item SCS. An orthogonal rotation (Varimax) was chosen as the correlation matrix between factors using an oblique rotation (Direct Oblimin) showed negligible correlations (all $r < .32$; Field, 2000). While it is important to acknowledge that PCA and factor analysis are methods based on different statistical concepts, previous evidence has suggested that they produce largely similar results, especially with a large number of variables with high communalities (Guadagnoli & Velicer, 1988).

The dataset was first examined for outliers (of which there were none). Then participants with missing data were excluded listwise from this analysis. This resulted in a sample size of 577 (UK: $N = 205$; Malaysia: $N = 209$; China: $N = 163$). For every analysis, the factorability of the 30 SCS items were also examined using several well-known criteria, such as the Kaiser-Meyer-Olkin measure of sampling adequacy (Kaiser, 1974), Bartlett's test of sphericity and the anti-image correlation matrix (see Appendix A for full details on each analysis).

Subscale scores were then developed by retaining only items that loaded strongly and consistently for the whole sample, and across all three cultures, on each subscale. Average scores for each subscale were calculated using only the retained items, which had to fulfil *all* of the following criteria:

- i. Items had to have factor loadings of at least .3 on the same component in every culture.
- ii. Items with complex factor loadings (loadings above .3 on both components) had to load in a consistent direction across cultures (i.e. Items that load more highly on the Interdependent scale than the Independent scale in one culture had to load more highly on the Interdependent scale in the other two cultures as well and vice versa).
- iii. Items retained on the final Independent and Interdependent scales had to be from the appropriate original subscales (i.e. only original Independent items would be used to assess independence and original Interdependent items to assess interdependence).

To address the second and third research questions concerning the relative effects of culture, gender and socioeconomic status on independent and interdependent self-construals, a 2x3x2 repeated measures analysis of covariance (rm-ANCOVA) was conducted on the whole sample (N = 616) with the two subscales scores (Ind and Int) as the within subject factor, and with culture (UK, Malaysia and China) and gender (male and female) as between subject factors. Age and FAS scores were included in the model as covariates. Data were checked for violations of assumptions of homogeneity using Levene's test for equality of variances.

Given the multi-racial nature of Malaysia's citizens, one-way analyses of variance (ANOVA) were also carried out on both subscales to check for potential differences in self-construal scores between the three main races: the Malays (N = 48), Chinese (N = 138) and Indians (N = 21). This revealed no significant differences for Independent scores ($p = .45$) or Interdependent scores ($p = .81$) between the three main ethnicities in Malaysia, confirming participants formed a homogenous culture.

2.4 Results

2.4.1 Exploratory PCA: whole sample

Initial eigenvalues showed that the first and second factor accounted for 23.24% and 9.41% of the variance respectively. A further five factors with eigenvalues above one were extracted, which accounted for a small amount of variance each (5.53%, 4.42%, 4.15%, 3.90% and 3.49% respectively). Based on these values and the point of inflexion on the scree plot (Figure 2.2), Singelis' (1994) original two-factor structure was retained, suggesting adolescents do indeed conform to Markus and Kitayama's (1991) two domains of self-construal

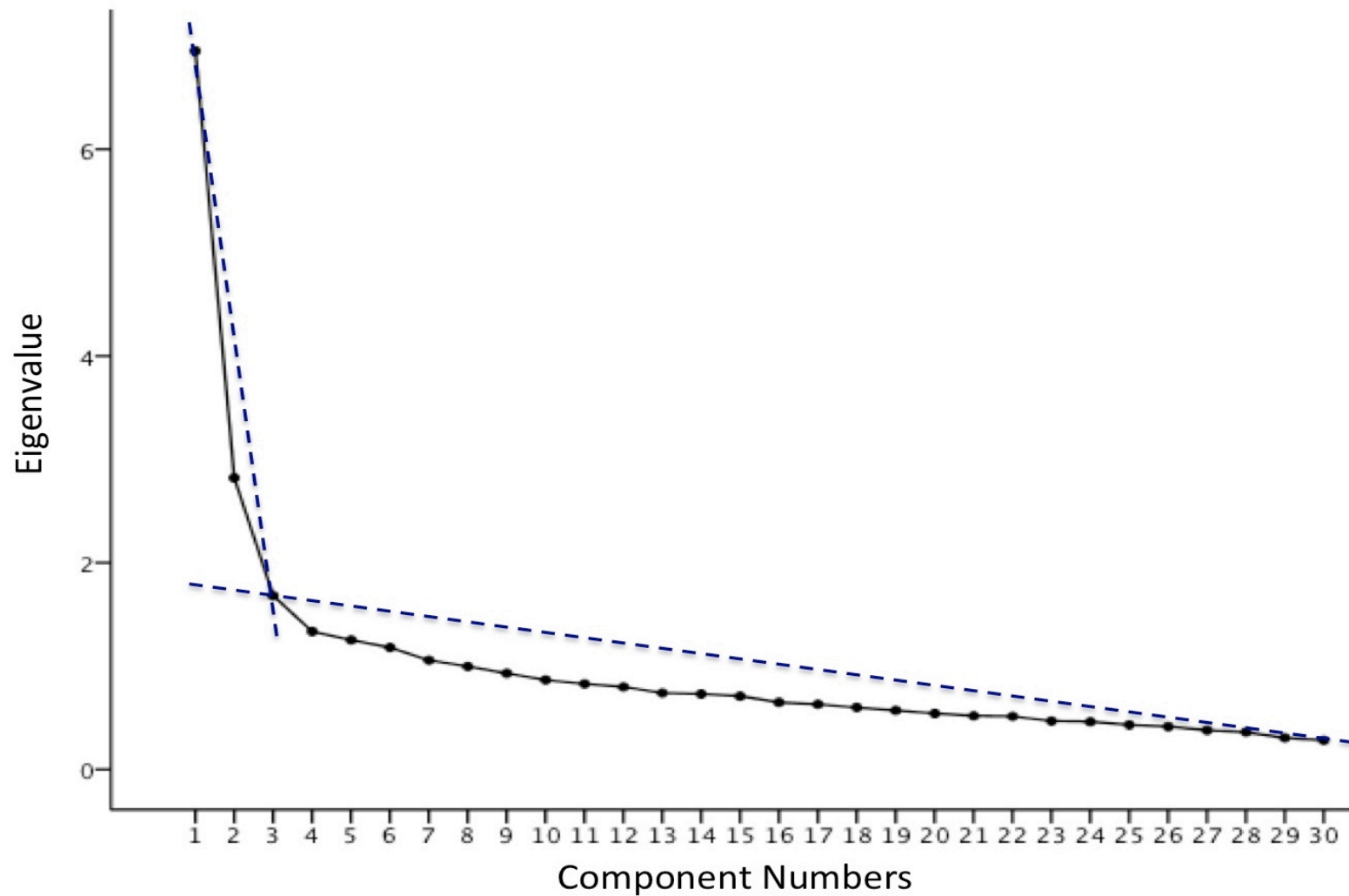


Figure 2.2 Scree plot from exploratory PCA on 30 items, with point of inflexion showing a “levelling off” after two factors (N = 559).

2.4.2 Two-factor PCA: whole sample

The two components accounted for a cumulative 32.69% of the variance (16.38% & 16.31% respectively). The items and factor loadings on each component after rotation are shown in Table 2.2.

Broadly speaking, items from the original Interdependent subscale loaded onto Component 1 while items from the original Independent subscale loaded onto Component 2. The two components were thus identified as the Interdependent and Independent subscales. Several items presented with low or complex factor loadings.

2.4.3 Two-factor PCA by culture

Two-factor PCA revealed components identified as the Independent and Interdependent subscales for all cultures. The two components accounted for a cumulative variance of 32.50% (Independent = 19.84%; Interdependent = 12.67%) for the UK, 36.16% (Interdependent = 19.65%; Independent = 16.51%) for Malaysia, and 32.96% (Interdependent = 22.39%; Independent = 10.57%) for China.

The items and factor loadings after rotation on each component across the whole sample and for each culture separately are shown in Table 2.2.

Table 2.2 Summary of results from the PCA conducted with participants from the UK (N =205), Malaysia (N = 209), China (N = 163) and the whole sample (N = 577). Factor loadings of below .3 are suppressed. Ind and Int indicate items from the original Independent and Interdependent subscales respectively. Items retained in the subscales and their appropriate factor loadings appear in italics. All items retained reported a factor loading of above .35 on their respective subscales in the whole sample analysis.

Items	Rotated factor loadings							
	Interdependent				Independent			
	UK	Malaysia	China	All	UK	Malaysia	China	All
<i>It is important for me to maintain harmony within my group (Int)</i>	<i>.631</i>	<i>.735</i>	<i>.799</i>	<i>.704</i>	<i>.461</i>	<i>.349</i>		<i>.376</i>
<i>I will stay in a group if they need me, even when I am not happy with the group (Int)</i>	<i>.595</i>	<i>.644</i>	<i>.776</i>	<i>.686</i>				
<i>It is important to me to respect decisions made by the group (Int)</i>	<i>.572</i>	<i>.679</i>	<i>.796</i>	<i>.672</i>	<i>.410</i>	<i>.319</i>		<i>.346</i>
<i>I will sacrifice my self-interest for the benefit of the group I am in (Int)</i>	<i>.508</i>	<i>.603</i>	<i>.663</i>	<i>.614</i>				

Rotated factor loadings

Items	Interdependent				Independent			
	UK	Malaysia	China	All	UK	Malaysia	China	All
<i>Even when I strongly disagree with group members, I avoid an argument (Int)</i>	.563	.693	.418	.552				
<i>[I] go along with what others want even when I would rather do something different (Int)</i>	.601	.531	.484	.536				
<i>My happiness depends on the happiness of those around me (Int)</i>	.541	.549	.484	.496	.309			
<i>If my brother or sister fails, I feel responsible (Int)</i>	.338	.301	.496	.466				
<i>I enjoy being unique and different from others in many respects (Ind)</i>					.679	.740	.646	.713
<i>I feel it is important for me to act as an independent person (Ind)</i>		.466	.386		.773	.648	.454	.689
<i>My personal identity, independent of others, is very important to me (Ind)</i>		.387			.712	.591	.615	.671
<i>I do my own thing, regardless of what others think (Ind)</i>	-.303				.470	.546	.567	.513

Rotated factor loadings

Items	Interdependent				Independent			
	UK	Malaysia	China	All	UK	Malaysia	China	All
<i>I am comfortable with being singled out for praise or rewards (Ind)</i>					.589	.467	.529	.500
<i>I prefer to be direct and forthright when dealing with people I've just met (Ind)</i>					.443	.498	.537	.466
<i>Speaking up during a class (or a meeting) is not a problem for me (Ind)</i>			.400		.507	.524	.412	.451
<i>I try to do what is best for me, regardless of how that might affect others (Ind)</i>	-.431			-.388	.300	.363	.559	.367
I should [consider] my parents' advice when making education/career plans. (Int)	.375	.511	.460	.375	.526	.460		.453
I feel good when I cooperate with others. (Int)	.406	.535	.542	.463	.569	.486		.480
I have respect for the authority figures with whom I interact (Int)	.416	.675	.629	.574	.545	.337		.387
I respect people who are modest about themselves (Int)		.496	.571	.429	.568	.445		.471
I would offer my seat in a bus to my teacher (Int)		.498	.658	.522	.309	.381		

Rotated factor loadings

Items	Interdependent				Independent			
	UK	Malaysia	China	All	UK	Malaysia	China	All
Being able to take care of myself is a primary concern for me (Ind)		.389	.501		.530	.519	.391	.551
Having a lively imagination is important to me. (Ind)		.417	.584	.342	.644	.554	.407	.583
I feel my fate is intertwined with the fate of those around me (Int)	.323	.531		.326			.333	
My relationships...are more important than my own accomplishments (Int)	.310		.552	.359				
I act the same way no matter who I am with. (Ind)						.400		
I'd rather say "no" directly than risk being misunderstood. (Ind)		.352						
I act the same way at home that I do at school. (Ind)								
I value being in good health above everything (Ind)		.499	.460	.427		.418		.326
I feel comfortable using someone's first name soon after I meet them (Ind)					.661	.434		.479

2.4.4 Descriptive results

Eight items each were retained for both the interdependent scale (Interdependent: $M = 4.58$; $\alpha = .78$; Table 2.3) as well as the independent scale (Independent: $M = 4.85$; $\alpha = .71$; see Table 2.4 for breakdown of averages by culture and gender). Cronbach's alphas for these subscales were higher than Singelis' (1994) original 15-item subscales.

Table 2.3 Final subscales with only retained items.

Independence	Interdependence
• I enjoy being unique and different from others in many respects • I feel it is important for me to act as an independent person • My personal identity, independent of others, is very important • I do my own thing, regardless of what others think. • I am comfortable with being singled out for praise or rewards • I prefer to be direct and forthright when dealing with people I've just met • Speaking up during a class (or a meeting) is not a problem for me • I try to do what is best for me, regardless of how that might affect others	• It is important for me to maintain harmony within my group • I will stay in a group if they need me, even when I am not happy with the group • It is important to me to respect decisions made by the group • I will sacrifice my self-interest for the benefit of the group I am in • Even when I strongly disagree with group members, I avoid an argument • [I] go along with what others want . . . even when I would rather do something different • My happiness depends on the happiness of those around me • If my brother or sister fails, I feel responsible

Table 2.4 Average Independent and Interdependent scores for females and males in each culture.

	Independence		Interdependence	
	Female	Male	Female	Male
UK	4.73 (0.95)	5.00 (0.91)	4.56 (0.92)	4.42 (0.89)
Malaysia	4.63 (0.90)	4.78 (1.02)	4.47 (1.13)	4.42 (1.10)
China	4.50 (0.93)	4.64 (0.96)	4.97 (0.96)	4.82 (1.17)

Across the whole sample, the two subscales showed a small but significant positive correlation with each other ($r = .18$, $p < .001$), suggesting they are distinct but overlapping constructs.

2.4.5 Repeated measures analysis results

Levene's test for equality of variances was significant for the Interdependent subscale, $F(2, 613) = 4.97$, $p = .0007$, which indicated data might violate assumptions of homogeneity. However, with a large sample size, small differences between group variances can produce a significant Levene's test (Field, 2000). As such, the variance ratio (ratio of variances between the group with biggest variance and group with smallest variance) was calculated and compared to critical values for Hartley's (1950) test (Kanji, 1993).

$$\text{Hartley's } F_{\text{Max}} = 1.24/0.83 = 1.494$$

As the sample size for each of the three groups (culture) was over 60, the variance ratio of 1.494 was below the critical value of 2.2, as specified by Hartley (1950) and data for Int was not transformed. The rest of the data did not violate assumptions of homogeneity.

There was no main effect of subscale, $F(1, 608) = 3.371$, $p = .067$, indicating no significant difference between Ind and Int scores overall. There was a significant main effect of culture, $F(2, 608) = 3.93$, $p = .0200$, but this was qualified by a

significant interaction between culture and subscale, $F(2, 608) = 9.34, p < .001$.

Furthermore, there was a significant interaction between gender and subscale, $F(1, 608) = 9.09, p = .0027$. There was no significant gender by culture by scale interaction ($p = .6228$).

There was a small between-subject effect of FAS, $F(1, 608) = 5.350, p = .0211$, indicating higher self-construal scores in general with increasing FAS scores. Lastly, there was a significant scale by age interaction, $F(1, 608) = 4.963, p = .0263$.

Interactions were decomposed as follows.

Tests of simple main effects show an effect of culture on the Interdependent subscale, $F(2, 608) = 9.37, p < .001$, but not on the Independent subscale, $F(2, 608) = 2.10, p = .1238$. Bonferroni corrected pairwise comparisons revealed that Chinese participants scored significantly higher on the Interdependent subscale than both UK and Malaysian participants (China: Mean = 4.92, SD = 1.05; UK: Mean = 4.50, SD = .91; $p = .0011$; Malaysia: Mean = 4.42, SD = 1.11; $p < .001$; Figure 2.3).

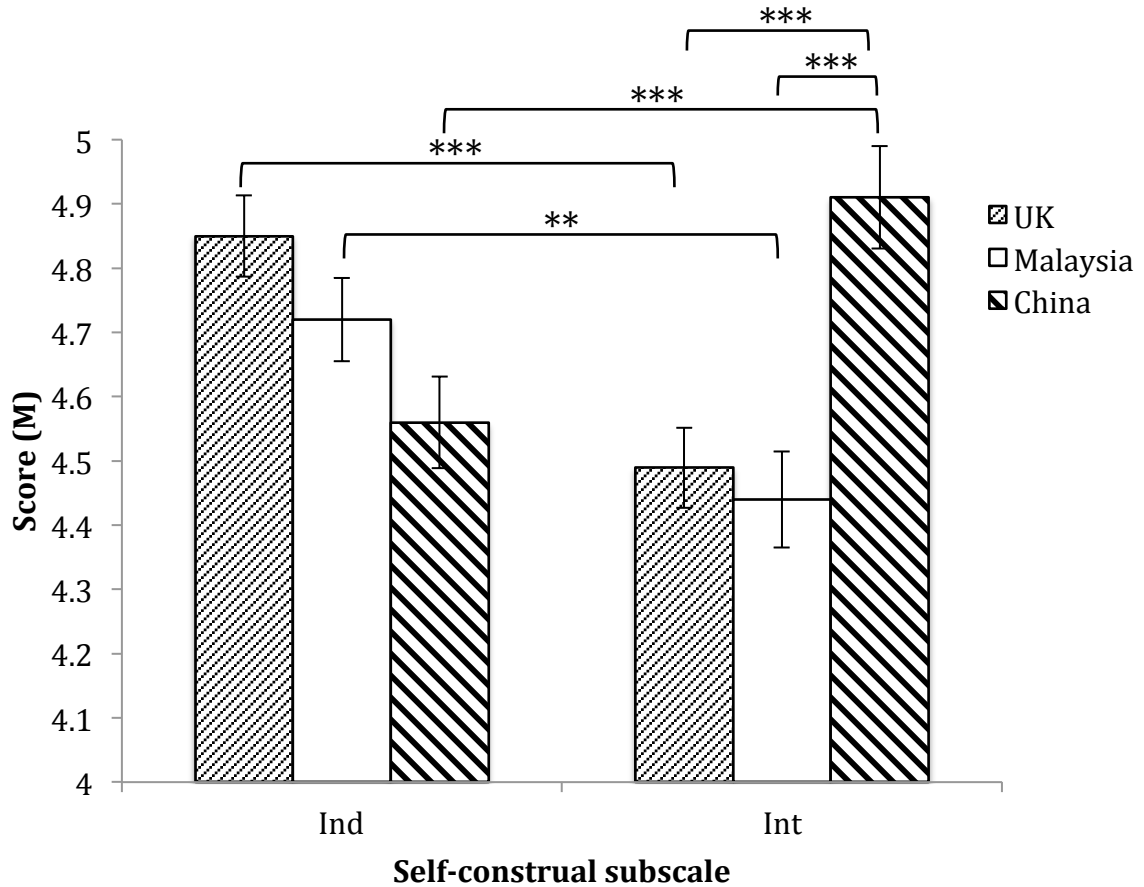


Figure 2.3 Mean (M) scores for the Independent and Interdependent subscales across cultures. Error bars indicate standard error (SE) scores.

* $p < .05$ ** $p < .01$ *** $p < .001$.

Tests of simple main effects revealed an effect of subscale on culture across all three cultures. Chinese adolescents were significantly more interdependent than independent, $F(1, 608) = 5.99, p = .0147$, while the opposite pattern was found for British adolescents, $F(1, 608) = 15.37, p < .001$. Surprisingly, Malaysian adolescents reported significantly higher independent scores than interdependent scores, $F(1, 608) = 8.61, p < .0035$, contrary to existing literature suggesting that they are a collectivistic society (Watkins et al., 1998; Bochner, 1994; Hofstede, 1980).

Next, the interaction between gender and self-construal type was investigated. Tests of simple main effects revealed a significant effect of gender on

the Independent scale (Females: $M = 4.63$, $SD = .93$; Males: $M = 4.81$, $SD = .97$; $F(1, 608) = 5.11$, $p = .0241$), but not significantly on the Interdependent scale (Females: $M = 4.67$, $SD = 1.02$; Males: $M = 4.55$, $SD = 1.07$, $F(1, 608) = 2.261$, $p = .1332$; Figure 2.4).

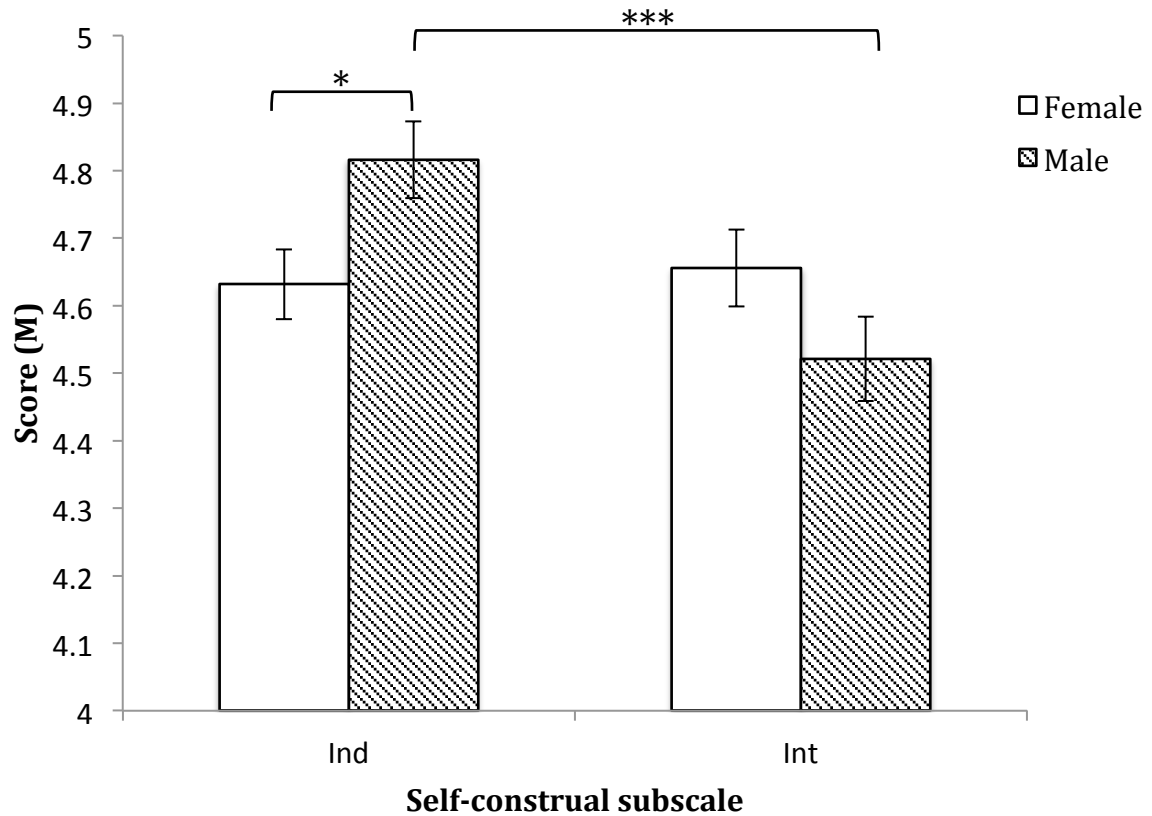


Figure 2.4 Mean (M) scores for the Independent and Interdependent subscales for each gender. Error bars indicate SE scores. * $p < .05$ *** $p < .001$.

Tests of simple main effects further revealed that while males were significantly more independent than interdependent, $F(1, 608) = 12.46$, $p < .001$, females showed no significant difference between independent and interdependent scores, $F(1, 608) = 0.32$, $p = .573$.

The small main effect found for FAS scores suggested that participants from more affluent backgrounds tended to report higher self-construal scores across subscales in general. Although there was no interaction between FAS and subscale in

the rm-ANCOVA, given this study's a priori hypothesis on the effect of social class on independence without affecting interdependence, the relationship between FAS and each subscale was examined separately using post hoc multiple regression. The same multiple regressions were used to decompose the age by subscale interaction, whilst accounting for gender and culture. These models significantly predicted independence, $F(5, 610) = 3.797$, $R^2 = .030$, Adjusted $R^2 = .022$, $p = .002$, and interdependence, $F(5, 610) = 6.130$, $R^2 = .048$, Adjusted $R^2 = .040$, $p < .001$. In line with predictions, there was a significant positive effect of FAS on independence ($\beta = 0.098$, $p = .032$), but not on interdependence, ($\beta = 0.063$, $p = .162$). Further, there was a non-significant positive relationship between age and independence ($\beta = .036$, $p = .383$) and a negative relationship between age and interdependence ($\beta = -.074$, $p = .072$).

2.5 Discussion

This study aimed to investigate whether self-construals in adolescents can be divided into independent and interdependent dimensions as in adults. Next, whether or not adolescents' independent and interdependent scores conformed to cultural norms was assessed. Finally, the effects of gender and SES on self-construal were investigated.

Results from this study suggest that adolescent self-construal can be characterised by the bi-dimensional model of the independent and interdependent self. Further, UK and Malaysian adolescents were more independent than interdependent, while Chinese adolescents showed the opposite pattern. Across cultures, Chinese adolescents were more interdependent than both Malaysian and UK adolescents. While adolescents from the UK were found to embrace the independent self-construal more than both Malaysian and Chinese adolescents, this

difference was not significant. In general, boys reported higher independent scores than girls, and higher independent than interdependent scores. Finally, participants from more affluent backgrounds reported higher self-construal scores generally, in particular higher independence ratings.

2.5.1 The independent vs. interdependent self in adolescence

Findings from the PCA lend support to the two-dimensional model of self-construal (Markus & Kitayama, 1991; Singelis, 1994, 1999; Imamoglu & Karakitapoglu-Aygun, 2004; Kam et al., 2012). Items that loaded onto the first two components in the PCA largely corresponded to Singelis' (1994) original independent and interdependent subscales, across the whole sample, as well as within each culture separately. Moreover the small but significant positive correlation between the Independent and Interdependent subscales was in line with Kwan et al.'s (1997) finding that the subscales correlated ($r = .19$) suggesting that these aspects of self-construal are not opposite constructs from each other (Hofstede, 1980; Triandis, 1995). However, this may reflect an acquiescence bias, which is a response bias where participants tend to agree with all statements when completing a survey. As the SCS contains no reverse-scored items, it is particularly susceptible to this effect.

Items that loaded strongly and consistently on the interdependent scale addressed opinions on group dynamics, such as maintaining group harmony and compromising self-interest and opinions for the sake of the group. Items that loaded strongly on the independent scale addressed various issues relating to uniqueness of identity, actions that are independent of others, and being comfortable with attention in public (see Figure 2.6 for final subscales with retained items only).

Some items were removed as they loaded strongly across both components. Items that involve parental advice and authority, which was originally part of the interdependent subscale, loaded strongly across both components in most cultures, except in China, where it loaded only onto the interdependent component (Table 2.2). This may be reflective of the fact that this is an adolescent sample, where parental and authority influence may be more salient than in adults (Steinberg, 2002; 2008). It may be that adolescents who embrace stronger self-construals in general (regardless of being independent or interdependent) rated statements on parental advice and authority highly. Other items that loaded strongly on both components were statements on health, taking care of oneself, cooperation and imagination, suggesting strong associations of these values with both self-construal types. In contrast, other excluded items, in particular those concerning how one acts in different social settings loaded poorly on both components across cultures, suggesting a weak relationship with either self-construal types. This may be due to adolescents still being in the process of learning how to conduct themselves during navigations of peer interactions and social situations (Dishion et al., 1999; Gavin & Furman, 1989), and this aspect of social behaviour not yet being consistently aligned with self-construal dimensions.

2.5.2 Adolescent self-construal across cultures

Cultural differences in self-construal were mostly in the expected direction (Hofstede, 1980; Markus & Kitayama, 1991). Adolescents from China, a collectivistic culture, reported the highest interdependence scores. Interestingly, while adolescents from the UK, an individualistic culture, reported the highest independence scores, differences between the cultures were not significant. This might be due to adolescence being a period when self-independence comes online

across all cultures (Steinberg, 2002; 2008; Erikson, 1968). The accentuated importance of self-independence might thus lead to elevated independent scores across all cultures. It would be interesting to examine whether or not this lack of cultural differentiation persists in adulthood, or whether individuals increasingly conform to cultural norms and expectations of the independent self-construal as they get older. However, it is noteworthy that while British adolescents showed a trend towards higher independence scores than Malaysian and Chinese adolescents, the latter two reported virtually no difference between each other ($p = 1.00$).

Malaysia's scores were particularly interesting. According to Hofstede (1980), Malaysia is identified as a collectivistic culture, scoring in between the UK and China on the individualism-collectivism (I-C) dimension. In line with this, Malaysian adolescents scored in between the UK and China for independence, reporting no significant differences with either culture. However, for interdependence, Malaysian adolescents scored comparably with their UK counterparts, and significantly lower than Chinese participants. Furthermore, while Chinese adolescents were significantly more interdependent than independent, Malaysian adolescents, like British ones, were more independent than interdependent.

This may be because adolescents in this study were from an affluent private school in Kuala Lumpur, the capital of Malaysia. Adolescents from this sub-culture may be very much exposed to Western media and ideologies. The advent of Internet and social media has made this possibility an inevitable eventuality (Biggs, 2000). Indeed, Malaysian adolescents in this sample reported high scores on the FAS, which includes an item on how many computers or laptops the adolescent's family owns (Malaysian adolescents' average FAS score of 7.49 is classed as high affluence; Boyce

et al., 2006). Consistent with this, a main effect of family affluence was found on independent scores across the whole sample. In the future, it would be interesting for data to be collected on less affluent adolescents from rural areas in Malaysia as well, to obtain a sample that is more nationally representative. This finding points to the complex and dynamic interplay between cultural and subcultural, in this case SES, influences.

Alternatively, this finding may reflect a genuine developmental difference in Malaysian adolescents compared to adults. While adolescents in Malaysia may be independent, this may change in adulthood, and they may increasingly adopt the interdependent self-construal as they are increasingly exposed to cultural norms. Studies using a wider age range are needed to disentangle the changes in self-construal across the whole life span. Further, unlike China and the UK, who have cultures rooted in centuries of history, multiracial Malaysia is a relatively young country in the midst of rapid development. Since gaining independence from Britain in 1957, Malaysia has been enveloped in a race of modernisation towards first world status. Caught between traditional Asian values (of three different races and religions, many of whom were brought over through the British during the second world war) and ever-increasing exposure to the Western ideals, it is also highly possible that Malaysian adolescents do not yet have consistent or strong cultural identities of the self to internalise. In line with this, they reported lower self-construal scores in general (Figure 2.4).

Clearly, more research (both in adolescents and adults) needs to be conducted in cultures that do not fall on the extreme ends of the I-C dimension. Continued empirical evidence needs to be collected to ensure cultural research does

not rely on out-dated stereotypes but on up-to-date cultural concepts that reflect the nuances of real-world changes.

2.5.3 Gender differences in self-construal

That boys had higher independent self-construal than girls was in line with predictions (Cross & Madson, 1997; Kashima & Hardie, 2000; Gabriel & Gardner, 1999). However, while girls showed a trend towards being more interdependent than boys, this was not significant. Moreover, while boys were significantly more independent than interdependent, girls' scores on both subscales were not significantly different from each other. Therefore, the hypothesis that females would be both more interdependent and less independent than males was partially supported.

Weak gender effects on the interdependent self-construal scale may be due to a definitional issue of interdependence across the variety of self-construal measures used in studies. Some research has sought to distinguish two subcomponents of interdependence, namely relational (RelSC) and collectivistic (CollSC) interdependence (Cross et al., 2010), which may relate to the two genders differently. RelSC is defined as the extent to which people define themselves in terms of close relationships, and is differentiated from the group-centric collective-interdependent self-construal described by Markus and Kitayama (1991). In other words, interdependence may be divided into two subcomponents: RelSC, which deals with close others, and CollSC, which deals with social roles within groups. Unfortunately very little research has been conducted with respect to teasing apart the two subcomponents, although those who have found that in America, women identified more with RelSC than men, but that men identified more with group collectives (Gabriel & Gardner, 1999). This concurs with developmental research

that suggest adolescent girls typically have fewer but more intimate relationships, while boys prefer to socialise in bigger groups (Maccoby, 1990). As such, the fact that Singelis' (1994) interdependent SCS contains mostly items on group dynamics (Figure 2.3) may explain the lack of gender differences in this study. In future, studies should use a measure that addresses this subdivision on adolescents across several cultures to obtain a clearer picture on where gender differences in self-construal may lie.

A secondary hypothesis about gender differences was the suggestion that differences would be accentuated in individualistic cultures such as the UK and less pronounced in collectivistic cultures such as China (Li, 2002; Watkins et al., 1998). While descriptive results do report the biggest differences between the genders for independence scores in UK adolescents, the interaction between gender, culture and subscale was not significant in these analyses. This may suggest that gender differences in independence are in fact invariant across all cultures, or that the effect is too small to detect in this sample.

2.5.4 SES effects on self-construal

The lack of interaction between FAS and subscales may be due to the difference in direction of association being too small to detect in this sample. However, the finding that adolescents from higher SES families reported higher independence scores without a concurrent decrease in interdependence is largely in line with existing theories (Triandis, 1989; 1995) and previous studies (Imamoglu, 1987; 2002; Imamoglu & Karakitapoğlu-Aygün, 2004). With increasing urbanisation and education, adolescents may be encouraged to embrace more self-directed goals and autonomy.

2.5.5 Limitations and future directions

The inconsistencies found in cross- and within cultural differences in self-construal (Matsumoto, 1999; Cross et al, 2010) may at least in part be due to a lack of consistent and validated measures, as well as a consistent working definition, used across studies and cultures. This study administered Singelis' (1994) scale to adolescents across three different cultures in an attempt to obtain culturally comparable results. In doing so, an adolescent appropriate measure that is comparable across the United Kingdom, Malaysia and China was developed, and will be used in further analyses in Chapter 5. However, there are certain caveats to this study that needs to be discussed.

First, it is worth noting that the adolescent sample in this study consisted of participants aged 9.02 to 20.76 years, and as such was made up of older children as well. However, as the bulk of participants were in their teenage years, and the mean age of this sample was 15.06 years, the term adolescents was used to describe them collectively. This represents a relatively restricted age range, and given cultural variability in terms of age groups, this study was unable to investigate age trends in self-construal development properly. Next, self-report ratings may be context dependent; people rate themselves relative to people around them. If the reference points for rating independence and interdependence are different across social groups, true effects may be masked. This may account for some of the unexpected findings in this study, for example the weak gender effects on the interdependent scale or Malaysian adolescents' unexpected self-construal ratings. Thus, future studies should collect behavioural data along with self-report measures, to investigate the relevance of self-identification with such values and actual behaviour.

To date, much research on the adolescent self regards the self as an individual unit, and neglect to address the side of one's self that we may regard as interlinked with others. Further, most studies have failed to take culture into account. How may culture affect other aspects of social cognition, such as the crucial social abilities that continue to improve during adolescence that facilitate increasingly complex peer interactions? Interdependent self-construal involves an increased propensity to view oneself through other people's eyes. In cultures where adolescents embrace more interdependent self-construals, might this in turn encourage better perspective taking abilities, and overall better socio-cognitive skills? Or would the weakened self-other distinction lead to a poorer ability to reason about mental states that are different from one's own? To date, little research has attempted to examine and disentangle the relationship between culture and socio-cognitive skills.

Importantly, culture is not a static entity; it is fluid and ever changing, in a state of constant flux. Many factors shape a culture, such as affluence, resources and urbanisation. In today's digital age, globalisation might also contribute to the breaking down of cultural barriers, making information about the world outside one's own culture readily available and experienced through means of the Internet (Biggs, 2000). It is thus crucial to collect up-to-date empirical evidence for differences in cultural values, so as to minimise cultural stereotyping in multi-cultural research.

2.6 Conclusion

This study has highlighted a complex interplay between cross- and within cultural influences on self-construal, which are evident and robust in adolescence. It would therefore be myopic for researchers to assume that the self develops in a

culturally invariant way. Future research on the adolescent self should address both the independent and interdependent aspects of it, as well as investigate links between culture and social cognitive abilities. In Chapters 3, 4, and 5, I will map out the potentially protracted development of social cognitive abilities in adolescents from the UK, China, and Malaysia, and will further investigate how culture may relate to this development in Chapters 4 and 5.

3. Cognitive and affective theory of mind in adolescence: age, gender, and cognitive predictors

3.1 Abstract

Recent research suggests that theory of mind (ToM) continues to undergo protracted maturation in adolescence. However, few studies have tracked these changes continuously, while taking into account development in other cognitive domains. Moreover, while ToM has partially separable cognitive and affective aspects, their respective developmental trajectories have rarely been examined. This chapter examined the cross-sectional development of cognitive and affective ToM alongside domain general cognitive abilities in adolescents from the United Kingdom (N = 188; age range = 10.25 to 19.83 years). ToM tasks included the Strange Stories (Happé, 1994) and the Silent Films tasks (Devine & Hughes, 2013), as well as a newly developed affective ToM measure – the Emotional Inference task. This novel task was designed to assess adolescents' ability to reason about other people's feelings by inferring emotional states from contextual information. Hierarchical regression analyses were used to determine whether cognitive and affective ToM abilities continued to develop during adolescence. Potential gender differences in and the contribution of developmental changes in domain-general cognitive abilities to ToM performance (and its trajectory) were also examined. Finally, given prior evidence for pubertal effects on social cognition, the association between puberty and ToM development was also investigated. Results show that, on tasks for which ceiling effects did not emerge within the studied age span, cognitive ToM followed a gender-specific developmental trajectory, with boys scoring

lower than girls in early adolescence but performing comparably in mid-late adolescence (~16 years). In contrast, affective ToM continued to improve across adolescence for both genders, with preliminary evidence for slight female superiority. Puberty, although initially correlated with both cognitive and affective ToM, did not predict either's performance once relevant cognitive abilities were taken into account. In future, cognitive and affective ToM tasks of the same difficulty levels should be developed and administered together to allow for direct comparison of the maturation of these abilities.

3.2 Introduction

Mentalising, or theory of mind (ToM), is the ability to infer other people's mental states, such as knowledge, beliefs, intentions, desires, and emotions (Frith & Frith, 2003; 2005; Premack & Woodruff, 1978), in order to facilitate an individual's social behaviour. Traditionally, ToM has been considered a unitary construct (Shamay-Tsoory et al., 2010), but more recently, subdivisions between cognitive and affective components have been suggested (Shamay-Tsoory & Aharon-Peretz, 2007; Baron-Cohen & Wheelwright, 2004). Whereas cognitive ToM requires an understanding of others' knowledge and beliefs, affective ToM requires the added ability to make inferences about emotions (Shamay-Tsoory et al., 2010; Shamay-Tsoory, 2011). Empirical support for this distinction comes from dissociations between impairments in affective and cognitive ToM in individuals with psychopathy and schizophrenia, who show impairments in affective but not cognitive ToM (Shamay Tsoory et al., 2007; Shamay-Tsoory et al., 2010), and in individuals suffering from mild relapse-remitting multiple-sclerosis, who show difficulties with cognitive but not affective ToM (Roca et al., 2014). Further, the two aspects of ToM may have slightly different (but

overlapping) profiles of neural activation (Shamay-Tsoory et al. 2006; Hynes, Baird, & Grafton, 2006; Kalbe et al., 2009; Vetter et al., 2014; Sebastian et al., 2012; Sebastian et al., 2011). While the medial prefrontal cortex (mPFC) is implicated in ToM in general, the ventromedial prefrontal cortex (vmPFC) might be especially recruited for affective ToM (Shamay-Tsoory et al., 2006; Shamay-Tsoory & Aharon-Peretz, 2007; Sebastian et al., 2011), while the dorsolateral prefrontal structures (dlPFC) might be uniquely important for cognitive ToM (Kalbe et al., 2009). Accordingly, participants with vmPFC damage showed impaired affective but intact cognitive ToM (Shamay-Tsoory & Aharon-Peretz, 2007), and interference in the right dlPFC using repetitive transcranial magnetic stimulation induced a selective effect on cognitive but not affective ToM task performance (Kalbe et al., 2009).

The study of ToM in adolescence has been driven in part by the large-scale changes that occur in the social domain of teenagers (Crone & Dahl, 2012). Whilst proposed ToM changes may equip adolescents to deal with new social situations; equally new social situations may contribute to development in ToM (Bagwell & Schmidt, 2011). Furthermore, research on the adolescent brain suggests protracted development, both structural and functional, in the “social brain” network (Burnett et al., 2011; Mills et al., 2014). Yet, despite these intuitions about continued development in adolescence, most behavioural research on ToM development focuses on early childhood. These studies have shown, for example, that visual perspective taking skills emerges in the first 18 months of life (Sodian, Thoermer, & Metz, 2007), that false belief tasks are passed by children aged four years old (Wellman, Cross, & Watson, 2001) or younger (Onishi & Baillargeon, 2005; Surian, Caldi, & Sperber, 2007), and that

second order cognitive metarepresentation can be achieved by children of six or seven years (Perner & Wimmer, 1985). Little is known about the continued maturation of these abilities beyond middle childhood (Devine & Hughes, 2013).

One of the obstacles in pursuing this line of research is the lack of suitable behavioural tasks, i.e. that do not exhibit ceiling effects in the later years of development. Thus, recent research has sought to develop a number of new measures to be used in behavioural studies in order to probe ToM development beyond early childhood. These studies suggest that aspects of ToM do continue to develop throughout middle childhood (Devine & Hughes, 2013) and well into adolescence (Dumontheil et al., 2010a; Vetter et al., 2013a; 2013b). The majority of these have investigated cognitive ToM.

3.2.1 Development of cognitive ToM

Initial evidence that online usage of cognitive ToM, i.e. the ability to reason about the knowledge, beliefs, and intentions of others, continues to develop across adolescence comes from a study on visual perspective taking (VPT). Using an adapted, computerised version of a task that reported no ceiling effects in adults (Keysar, Barr, Balin & Brauner, 2000; Keysar, Lin & Barr, 2003), Dumontheil et al. (2010a) showed that adolescents were poorer than adults at taking another's perspective into account in a communicative task. In this task, participants viewed (on a computer screen) a set of shelves with several objects, some of which could not be seen by a 'director' (a computer avatar), who gave instructions on which objects to move. Participants were thus required to take the director's perspective into account when moving objects, i.e. not move objects that could not be seen by the director. Researchers found that mid-late adolescents (14.0 to 17.7 years) made more errors than adults in taking the

director's perspective into account when completing the task, but performed comparably to adults when required to follow a simple rule ('don't move objects with a dark grey background'). These results indicate continued maturation of ToM abilities, or its interaction with executive functions, into early adulthood.

The social relevance of this task, and more generally, the relationship of VPT to other aspects of mentalising, is a subject of debate (Aichhorn, Perner, Kronbichler, Staffen & Ladurner, 2006; Hamilton, Brindley & Frith, 2009). For example, Santiesteban, Shah, White, Bird and Heyes (2015) found that participants' performance was unchanged when an inanimate object (a camera) replaced the director, and that performance of individuals with autism spectrum disorder (ASD) was unimpaired, relative to matched controls, in both the director and camera conditions. Similarly, Begeer, Malle, Nieuwland, and Keysar (2010) found that individuals ASD performed comparably to controls matched on intelligence on a VPT task, but used fewer mental state words when retelling a story about an interaction. However, fMRI studies with adolescents and adults have shown that responding to cues from an avatar (relative to an object) in VPT tasks activated the mentalising network (and not spatial processing regions; Dumontheil, Kuster, Apperly, & Blakemore, 2010b; Schurz et al., 2015), lending support to its validity.

Two ToM tasks that also may not exhibit ceiling effects in adolescence are the Silent Films (SF) task, developed by Devine and Hughes (2013), and Happé's (1994) vignette-based Strange Stories (SS; White, Hill, Happe, & Frith, 2009). These measures have been developed and validated to study age-related changes in ToM in middle childhood. They are considered mainly cognitive ToM tasks, as successful performance requires children to explain a character's behaviour with

reference to the character's knowledge, beliefs, intentions, and desires (Poletti, Enrici & Adenzato, 2012; Devine & Hughes, 2013; although both measures do include some items on affective ToM too). SS and SF extend basic ToM tasks by the additional demands it places on the understanding of mental states in contextualised social scenarios (Devine & Hughes, 2013). SS is a well-established task and has been used extensively in autism research to study the ToM impairments often found in those with ASD (White et al., 2009) and more recently in studies of typically developing school-aged children (Lecce, Zocchi, Pagnin, Palladino, & Taumoepeau, 2010). Administering these tasks to 230 middle-class children in the United Kingdom aged between 8 and 13 years, Devine and Hughes (2013) revealed that both the SS and SF tasks were sensitive to age-related differences in performance in middle childhood, and neither task exhibited marked ceiling effects in this age group. The appropriateness of these tasks for adolescents, and whether this age group would show ceiling effects, is not yet known. **Thus, the first aim of the current study was to investigate whether cognitive ToM, as assessed using the Strange Stories and Silent Films tasks, developed cross-sectionally across adolescence.**

3.2.2 Development of affective ToM

According to Shamay-Tsoory et al.'s (2010) model, cognitive ToM is a prerequisite for affective ToM, and may develop earlier than affective ToM, which requires an added understanding of and reasoning about emotional states. Given evidence that cognitive ToM might continue to mature throughout adolescence (Dumontheil et al., 2010a), affective ToM might also be expected to show protracted development across this period. Functional neuroimaging studies have found developmental differences across the period of adolescence

activity in the vmPFC during affective ToM tasks, indicating developmental changes in the neural processing of affective ToM across adolescence and into adulthood (Sebastian et al., 2012; Sebastian et al., 2011; Vetter et al., 2014). Yet, few behavioural studies have investigated changes in the understanding of emotions in adolescence, the key underlying aspect of affective ToM. The small number that has suggests continued development (Sebastian et al., 2011; Vetter et al., 2013a). For example, the time required to think about emotional state from another person's perspective decreases throughout adolescence (Keulers, Evers, Stiers, & Jolles, 2010; Choudhury et al., 2006). However, reaction time (RT) data offers only limited insight into ability and the cognitive strategies used, and could arise due to a host of cognitive mechanisms (Salthouse & Hedden, 2002).

In a recent study, Vetter et al. (2013a) found that the accuracy at identifying actors' facial emotions in short video clips improved across adolescence. However, the "facial scale" of the Cambridge Mindreading Face-Voice Battery (Golan, Baron-Cohen, & Hill, 2006), which was used in this study, comprised solely of adult actors, which may not represent social interactions that are natural to adolescent experiences. It is thus possible that poorer performance in the younger compared to the older participants might be due to adolescents' a lack of familiarity with adult social contexts, instead of true differences in ToM abilities. Indeed, Selman, Beardslee, Schultz, Krupa, and Podorefsky (1986) found that adolescents scored higher when they reasoned about situations that involve peers rather than adults. Where social scenarios depicted are relatable to the adolescent context, how might this affect the developmental trajectory of adolescents' ToM?

This study introduces a new ToM task that is designed specifically to

examine affective ToM in adolescence. The Emotional Inference (EI) task is a story-based measure of adolescents' ability to infer emotions in peer related social situations. Unlike simple emotion recognition tasks, and similar to the SS and the SF, the EI task requires participants to use and integrate complex social information to make inferences about a character's mental states (Devine & Hughes, 2013). In contrast to the SS and the SF, the EI task aims to isolate affective ToM ability, by requiring inferences about emotions only. Moreover, this task was designed to be appropriate for adolescent populations and solely uses social scenarios that are closely related to adolescent real life situations.

The second aim of the study was thus to investigate whether affective ToM, assessed using the novel adolescent-appropriate Emotional Inference task, developed cross-sectionally across adolescence.

3.2.3 Summary of goals and hypotheses of current study

This study aimed to map out the developmental trajectory of cognitive and affective ToM skills during adolescence (age 10 to 20 years) using three mentalising tasks: the Strange Stories, the Silent Films and a new Emotional Inference (EI) task. In this study, the Interpersonal Reactivity Index (IRI; Davis, 1980), which contains two scales of cognitive empathy, a related construct to ToM (Shamay-Tsoory, 2011; Rogers et al., 2007), was used to establish the construct validity of these ToM tasks. As well as exploring the age-associated trajectory of cognitive and affective ToM, a number of additional questions were examined. Potential gender differences in ToM development (Calero et al., 2013; Bosacki & Wilde Astington, 1999; and see Baron-Cohen, 2004; Hall, 1978; Kirkland et al., 2013 for persisting differences in adulthood) were examined by investigating differences between males and females in performance within this

age range, as well as the interaction between gender and age. The degree to which changes in domain general cognitive abilities such as verbal ability, fluid intelligence and working memory (which has been shown to be associated with ToM abilities in past literature; Watson et al., 2001; Ruffman et al., 2003; Huepe et al., 2011; Ibanez et al., 2013; Hughes, 1998; Davis & Pratt, 1995; Keenan et al., 1998; Vetter et al., 2013b) explained age-associated effects on ToM performance was also investigated by including these as additional predictors in regression analyses. Finally, as studies have presented conflicting results about whether puberty may also be a marker for social development during adolescence, the degree to which ToM abilities varied with pubertal stage was also investigated (Lawrence, Campbell & Skuse, 2005; Vetter et al., 2013b).

The main hypotheses were:

- i. There would be age-associated improvements during adolescence in performance on the cognitive ToM tasks (Devine & Hughes, 2013), i.e. the Strange Stories and Silent Films tasks.
- ii. There would also be age-associated improvements in performance on the affective ToM task (Vetter et al., 2013a), i.e. the Emotional Inference task.

3.3 Methods

3.3.1 Participants

188 participants (age range: 10.25 to 19.83 years, $M = 15.77$, $SD = 2.47$, 97 females; Table 3.1) took part in this study. Participants attended British schools or a British university and were fluent in English. A minority of participants reported another language as their first language ($N = 10$). There was no significant difference in performance on any of the tasks between these participants and the rest of the sample whose first language was English. As

such, they were included for all analyses. Of note, excluding these participants from the analysis made no difference to the pattern of significance for results.

Informed consent was obtained from participants 18 years and above and parental or guardian consent was obtained for those under this age, who signed assent forms. Participants and their families were compensated with Amazon vouchers for their time.

The task battery was extensive and due to time constraints, not every participant completed the full task battery. To maximise the sample size across analyses, participants with missing data were excluded case-wise from analysis, leading to slightly different numbers of participants across analyses.

Table 3.1. Sample demographics (N = 188)

	Age (years)		N	Ethnicity	First language	Educational institution
	Range	Mean (SD)				
All Participants	10.25 to 19.83	15.77 (2.47)	188	Caucasian (68.09%), South Asian (14.36%), Black or African (8.51%), East Asian (4.26%), Mixed (3.19%), Other (1.06%), Missing (0.53%)	English (94.68%), Other (5.32%)	State (52.66%), Independent (40.96%), University (6.38%)
Female	10.25 to 19.83	16.09 (2.40)	97			
Male	10.25 to 19.67	15.43 (2.51)	91			

3.3.2 Materials

3.3.2.1 Theory of mind tasks

3.3.2.1.1 Strange stories task

Five mental state stories and five physical state stories were selected from White et al. (2009)'s total stimulus set of eight stories per condition - an updated version of Happé's (1994) original Strange Stories (SS) task set. The stories were displayed on a computer or laptop using Matlab R2013a. Four of the mental states stories were selected based on a study that showed they did not give rise to ceiling effects in a sample of eight to 13 year olds (Devine & Hughes, 2013). The other mental state story and all physical state stories were randomly selected from White et al.'s (2009) set.

Mental state stories required participants to reason about complex social concepts such as double bluffs, deceit, eliciting sympathy and misunderstanding of knowledge, beliefs, and intentions. Physical stories were chosen as a control for general comprehension abilities, and did not explicitly require participants to mentalise (Figure 3.1a; White et al., 2009). These depicted similar stories about people as the mental states stories, and differed only in that they did not require reasoning about mental states, thus controlling for ToM ability only.

Participants read each short vignette presented on screen, before answering an open-ended question with reference to the story. Participants had one chance to read the stories, which did not remain on screen when the question appeared. Participants gave their answers orally, which were written down by hand by the experimenter as well as recorded as audio files. There was one practice question administered at the start to ensure participants' understanding. This item was not scored.

Participant responses were scored on a 0 to 2 point system following the established marking scheme (White et al., 2009). Thus, the maximum score for the mentalising task (SSM) and physical task (SSP) was 10 each. All responses were double scored independently by two experimenters and reported a high inter-rater reliability (SSM: $r_s = .889$, $p < .0001$; SSP: $r_s = .906$, $p < .001$).

In this sample, internal consistency as indicated using Cronbach's alpha was $\alpha = .471$ for the SSP and $\alpha = .485$ for SSM. These internal consistency scores are low compared to a previous study in children, which reported $\alpha = .953$ in a group of six to 12 year old males for the eight SSM stories (Velloso, Duarte, & Schwartzmann, 2013). In another study, this ToM latent factor exhibit excellent test-retest reliability, $r = .83$, $p < .001$ (Devine & Hughes, 2015). A longitudinal study showed that performance on a battery of false-belief tasks at age six significantly correlated with later performance on the SS and SF tasks (described below) at age 10 (Devine, White, Ensor & Hughes, 2016), providing good construct validity. Furthermore, Devine and Hughes (2013) reported a strong association between performance on the SS and the SF, and used confirmatory factor analysis to show that the two tasks loaded onto a unidimensional ToM latent factor.

3.3.2.1.2 Silent films task

The Silent Films (SF; Devine & Hughes, 2012) task is a film-based task consisting of five video clips (mean length = 25.4s) selected from a comedic silent film (*Safety Last*; Newmeyer & Taylor, 1923). The silent nature of the task aimed to minimise the reliance on verbal ability in ToM reasoning, although participants were still required to give their answers orally to the experimenter.

The clips were displayed on a laptop or computer screen using Superlab v5.0 (Abboud, 2014), and were followed by questions that were displayed immediately after the clip. There were five clips and six questions in total (two questions after the first clip and one each after the remaining clips). Questions required participants to reason about characters' intentions, emotions, beliefs and deception (Figure 3.1b). There were no practice questions for this task. Participants were shown the clips only once. Again, participants' answers were written down by hand as well as recorded as audio files by the experimenter.

As with SS, participant responses were scored on a 0 to 2 point system following the marking scheme provided by Devine and Hughes (2013). A 2 point answer required a correct reference to mental state terms; a 1 point answer was a factually accurate answer with no reference to a mental state element; and a 0 point answer would be factually incorrect or irrelevant. The maximum score for this task was 12. All responses were double scored independently by experimenters and showed high inter-rater reliability ($r_s = .871$, $p < .0001$).

In this sample, the SF task showed a low Cronbach's alpha of $\alpha = .290$. No further information on the internal consistency of the SF was available. Available information about the reliability and validity of the SF can be found above (Devine & Hughes, 2013; Devine et al., 2016).

3.3.2.1.3 Emotional inference task

The Emotional Inference (EI) task is an affective ToM task developed by the author for use in adolescents. It specifically concerns inferences about emotions. The multiple-choice nature of the task was designed to circumvent the subjectivity and time consuming nature of scoring open-ended answers, as required by many other ToM tasks. The task was run using Matlab R2013a.

Participants were asked to read a story whilst imagining themselves as a character in that story, in which they interacted with fictional friends within various social situations on a day out. Along the way, they were asked to make inferences about the emotions of the characters in the story, or about non-emotional facts (Figure 3.1c). There was one practice question at the start to check participants' understanding.

The task consisted of 22 emotional inference (EI) questions and seven factual inference (FI) questions, which served as controls. After certain scenes in the story, questions would appear on screen along with four answer choices (Figure 1c). Participants were instructed to choose the most suitable option on display using the mouse pad.

Answers were coded according to a simple binary system with 1 point for correct items and 0 for incorrect items. This task reported a Cronbach's alpha of $\alpha = .639$ for its EI items and $\alpha = .352$ for its FI items. This is comparable to other affective ToM tasks, such as the "facial scale" of the Cambridge Mindreading Face-Voice Battery (Golan et al., 2006) which reported a Cronbach's alpha of $\alpha = .60$ in Vetter et al.'s (2013a) study.

As this is a newly developed task there are currently no data on validity. However data gathered from this study was used to validate this task in relation to other aspects of ToM (e.g. cognitive ToM), and other related constructs (e.g. cognitive empathy). The full EI task is included in Appendix B.

a) Strange Stories

Mental State

During the war, the Red army captures a member of the Blue army. They want him to tell them where his army's tanks are; they know they are either by the sea or in the mountains. They know that the prisoner will not want to tell them, he will want to save his army, and so he will certainly lie to them. The prisoner is very brave and very clever, he will not let them find his tanks. The tanks are really in the mountains. Now when the other side asks him where his tanks are, he says, "They are in the mountains."

Why did the prisoner say that?

Physical State

Two enemy powers have been at war for a very long time. Each army has won several battles, but now the outcome could go either way. The forces are equally matched.

However, the Blue army is stronger than the Yellow army in foot soldiers and artillery. But the Yellow army is stronger than the Blue Army in air power. On the day of the final battle, which will decide the outcome of the war, there is heavy fog over the mountains where the fighting is about to occur. Low-lying clouds hang above the soldiers. By the end of the day the Blue army has won.

Why did the Blue army win?

b) Silent Films



Why did Harold pick up the cat?

c) Emotional Inference Task

Pretend you are a character in the following story.
You are heading to the shops with some friends...

Emotional Inference

As you are walking, there is a loud, sudden bang. Amy jumps up and grabs Alex's hand, letting out a tiny squeal.

Amy does this because she is
Surprised
Excited
Friendly
Happy

Factual Inference

As you walk, people around you start putting their hoods up and looking down as they walk.

"Ooh, it's so cold!" Amy scrunches up her face as she speaks, but you can barely hear her over the howling around you.

You all speed up to escape indoors.

What do you think the weather is like?
Sunny
Rainy
Snowing
Windy

Figure 3.1 Example items from the ToM tasks completed by participants.

3.3.2.2 Cognitive tasks

3.3.2.2.1 Vocabulary

The Vocabulary subtest of the Wechsler Abbreviated Scale of Intelligence II (WASI-II; Wechsler, 2011; Wechsler & Hsiao-pin, 2011) was used to determine each participant's word knowledge and understanding of verbal concepts, or verbal ability. The WASI II was developed as a measure of cognitive abilities for individuals from the ages of 6 to 90 years. Participants were required to give verbal definitions for 26 words selected from this subtest. Their answers were scored on a 0 to 2 point system and administration was discontinued after four consecutive incorrect answers according to the WASI II scoring guidelines.

In a representative sample of 2300 examinees from the United States, the Vocabulary subtest showed excellent ($r = .94$ to $.95$) inter-rater reliability (Wechsler, 2011; Zhou & Raiford, 2011a; 2011b). Furthermore, in this large sample, the verbal IQ component of the WASI correlated highly with that of the Wechsler Intelligence Scale for Children III (WISC III; $r = .82$) and Wechsler Adult Intelligence Scale III (WAIS III; $r = .88$; Wechsler, 1991; 1999).

As age is measured and accounted for explicitly in the analyses, the scores were not age normed. Raw total scores were calculated for this subset of the Vocabulary test (max = 52) and used for analyses. Items selected were appropriate for all ages in this sample. A third of the data was independently double-coded by two experimenters and inter-rater reliability in this sample was excellent ($N = 42$, $r = .96$).

3.3.2.2.2 Matrix Reasoning

The Matrix Reasoning (MR) subtest of the WASI-II (Wechsler, 2011; Wechsler & Hsiao-pin, 2011) was used to measure fluid intelligence. Participants

were shown an incomplete matrix series and asked to select an option that correctly completed the series. Each item was scored according to a simple binary system, with 1 point for correct items and 0 for incorrect items. Participants were given 30s to answer each question. The performance IQ, which is made up of the Matrix Reasoning and Similarities component of the WASI also correlated highly with that of the WISC III ($r = .76$; Wechsler, 1991) and WAIS III ($r = .84$; Wechsler, 1999), although the Similarities subtest was not used in this study due to time constraints.

Again, raw total scores were calculated for this subset of the MR test (max = 26) and used for analyses. However, the two subtests selected (Vocabulary and Matrix Reasoning) can be combined to estimate of Full Scale Intelligence Quotient-2 (FSIQ-2; Wechsler, 2011), an indication of age-standardised general cognitive abilities.

3.3.2.2.3 Digit memory test

The forward and backward digit span components of the Digit Memory Test (Turner & Ridsdale, 2004) were administered as a measure of verbal working memory. The experimenter read out a series of digits in a temporally consistent and monotonous manner (1s per digit), and participants were required to repeat the digits at the end of the sequence. The same procedure was followed for the backwards digit span, but this time, participants had to recite the digits in reverse order.

There were two trials for each sequence length, and administration of the task was discontinued if participants made mistakes on both series of digits for a given sequence length, or when the maximum sequence length was achieved.

As per guidelines, the highest sequence length for which participants completed at least one trial correctly was used as their forward (max = 9) and backward digit span (max = 8). These two scores were then summed to obtain an overall verbal working memory score (max = 17; Turner & Ridsdale, 2004).

3.3.2.3 Self-report measures

3.3.2.3.1 Pubertal development scale

This is a self-report measure of pubertal status designed to be non-intrusive and easy to administer (PDS; Petersen, Crockett, Richards, & Boxer, 1988). It consists of five questions. Three questions are for both genders: occurrence of a growth spurt, changes in complexion, and the development of body hair. The remaining two questions are gender-specific. Girls are asked about breast development and the onset of menarche, while boys are asked about changes in voice and facial hair growth.

Participants rated their development using a four-point scale, ranging from “...not yet begun” = 1 to “...seems completed” = 4, with the exception of the menarche question (“Yes” = 4 points or “No” = 1 point). An average score was calculated for the five questions.

The PDS has shown a good correlation (median $r = .7$) with other pubertal questionnaires and interview ratings suggesting it has good concurrent validity. Longitudinal findings reported showed good internal consistency for the PDS for both boys and girls ($\alpha = .68$ to $.83$; Petersen et al., 1988). In this study, the PDS reported good internal consistencies of $\alpha = .84$ for girls and $\alpha = .88$ for boys.

3.3.2.3.2 Interpersonal reactivity index

The Interpersonal reactivity index (IRI) is a self-report measure of empathy, originally developed by Davis (1980), which consists of 28 items

comprising four subscales (seven items per subscale): Two cognitive empathy subscales, perspective taking (PT) and fantasy (FS), and two emotional empathy scales, empathic concern (EC) and personal distress (PD). The IRI was used in this study to examine the validity of the ToM measures, which were expected to correlate with the cognitive empathy scales in particular (Shamay-Tsoory, 2011; Rogers et al., 2007). The two emotional empathy subscales were thus not included for analysis.

Cognitive empathy has been reported to be a related construct to ToM (Shamay-Tsoory, 2011). PT measures the self-reported propensity for an individual to adopt other people's psychological point of view ('When I'm upset at someone, I usually try to "put myself in his shoes" for a while'). FS is a measure of the extent to which someone experiences what it is like to be and feel like a character in fictional contexts ('I daydream and fantasize, with some regularity, about things that might happen to me').

Each item was scored on a 5-point Likert scale from "A = Does not describe me well" to "E = Describes me very well"). The answer "A" was given 0 points, whereas "E" was given 4 points. Eight items were scored in reverse. The total score calculated for each subscale (max = 28) indicated an individual's level for different aspects of empathy. Due to the distinct nature of each subscale, an overall total score for the scale was not calculated and each subscale was used individually in analyses (Davis, 1983).

In a sample of 435 college students from Chile, Fernández, Dufey and Kramp (2011) found that Davis' (1980) four factor model was a good model fit when factor analysis was conducted, $\chi^2 = 781.74$ (344), $p < .001$, for the total sample. The IRI also reports good internal consistency ($\alpha = .68$ to $.79$; Davis,

1983; Christopher, Owens, & Stecker, 1993). The PT and FS scales significantly correlated with the Interpersonal component of the Emotional Quotient Inventory, which measures the ability to be aware of and understand another's feelings ($r = .32$ and $.16$ respectively; EQ-I; Bar-On, 1997; De Corte et al., 2007).

3.3.2.3.3 Family affluence scale

The Family Affluence Scale II (FAS-II; Currie et al., 2006) was administered to account for potential SES effects (see Chapter 2 for details).

These tasks were administered within a battery of several other social affective and cognitive tasks, as well as self-report measures (Appendix C).

However, it is not within the scope of this thesis to discuss them all.

3.3.3 Procedure

Participants completed the task battery in controlled, quiet conditions at their schools in Oxford, London or Suffolk, at the Department of Experimental Psychology, University of Oxford or at the Institute of Psychiatry, King's College London.

Participants were tested either by the lead investigator or by one of five research assistants, all of whom were undergraduate or graduate psychology students and had been trained by myself using a standardised instruction booklet (Appendix C) prepared by myself. Participants were encouraged to take short breaks throughout the experiment, which lasted between one and a half to two hours, to minimise fatigue. Analysis of effects of location (Oxford, London or Suffolk) and experimenter (1 to 6) revealed no significant main effects of either on any ToM variable (Location: $p = .39$ to $.52$; Experimenter: $p = .11$ to $.53$).

The majority of participants ($N = 156$) were tested individually (alone in a quiet room with the experimenter) on all the tasks. A further 32 participants

(age range = 16.66 years to 19.42 years) from a London 6th Form College were tested on a subset of tasks (ToM tasks and questionnaires) in groups of 16 students under exam-like conditions by the lead investigator at the Department of Experimental Psychology, University of Oxford. For the Strange Stories and Silent Films tasks, group-tested participants wrote down their own answers after reading the short vignettes displayed through a teleprompter on a big screen at the front of the class. They completed the Emotion Inference task on individual computers in the undergraduate laboratory. The lead investigator invigilated the testing session to ensure privacy was respected.

Independent t-tests between group and individually tested participants within the same age range revealed no significant differences in performance for any of the ToM tasks ($p = .10$ to $.56$). As such, data were analysed together.

3.3.4 Data analysis overview

The data were first examined for outliers. For each task (all three ToM measures, SSP, FI, and cognitive tests), scores that were more than 3SD from the mean were removed from further analyses. According to this, two participants for SF and SS each, and three for EI, were identified and removed case-wise. This resulted in a final sample of $N = 178$ for the SF task, $N = 182$ for the SS task and $N = 173$ for the EI task.

Next, the suitability of the ToM tasks for this age range was examined by determining if there were ceiling effects. To do so, the percentage of participants scoring at ceiling (highest possible score) was calculated for the SSM, SF and EI. Descriptive analyses were performed across the whole sample and by gender, and correlations between the ToM measures and all other individual differences measures (cognitive predictors, FAS, puberty) were examined to determine

potential predictors of ToM. To further investigate the appropriateness of these tasks for measuring social cognitive capacity in adolescents, validity was tested by also computing correlations between the three ToM measures and with the measures of cognitive empathy, i.e. the FS and PT scales.

To investigate the two main hypotheses of continued improvements in both cognitive and affective ToM across adolescence, two sets of hierarchical multiple regression analysis were performed for each ToM measure, as follows:

- i. In the first set of analyses, the effects of age and gender were investigated at the first step, whilst controlling for FAS. At the second step, the age by gender interaction term was included to determine if it added significantly more variance. If gender, or its interaction with age, was significant, further analyses were conducted for boys and girls separately. If the interaction was not significant, the interaction term was removed from the final model and subsequent analyses were done collapsed across both genders. If FAS was not significant in both steps, it was removed from further analyses.
- ii. In the second set of analyses, the effects of age and domain-general cognitive factors were examined. To obtain the final model of ToM predictors, all non-significant predictors were removed through backwards elimination, and only significant terms were retained. Backwards elimination was selected in order to minimise the chances of making Type II errors, i.e. missing predictors involved in suppressor effects that do in fact predict the outcome (Field, 2000).

Of note for SS and EI, the effect of the control items was first regressed from the effect of interest (ToM items) to obtain residuals that measure the

special variance accounted for by the experimental condition only (i.e. ToM). The residuals, an indication of pure ToM as measured by SS and EI, were then used in regression analyses.

Finally, to test the effect of puberty on social cognition, the same analysis steps were conducted with PDS score instead of age to investigate if it also predicted ToM development.

3.3.4.1 Missing data

Self-report measure scores for participants with missing data were scale corrected, i.e. the raw score was divided by the maximum score that could be obtained given the missing items, and multiplied by the maximum score of the full scale. Participants with more than 25% of missing items were excluded from analysis for that measure.

3.3.4.2 Data assumptions

All regression models were checked using established parameters. Ensuring there was no multicollinearity, all variables reported a tolerance of more than 0.1 and Variance Inflation Factors of less than 10, except when interaction terms were included in the model. Assumptions of independent errors for each model were also met (Durbin-Watson = 2.038 to 2.480). Furthermore, examination of the scatterplot of standardised residuals against standardised predictors revealed no violations of homoscedasticity or linearity, and the histograms and normal P-P plots revealed no concerns over normality of standardised residuals in any analysis.

3.4 Results

3.4.1 Ceiling effects

The Strange Stories mentalising (SSM) task showed a moderate ceiling effect, with 20.33% of participants scoring at the highest possible mark. As such, this task was thought less suitable for investigating continued improvement across age. On the Silent Films task, 2.25% scored at ceiling while 9.25% scored at ceiling for the Emotional Inference task. Lower ceiling effects suggest that, according to the criteria outlined in this study, the SF and EI tasks may be more suitable for assessing continued developmental change within this age range.

3.4.2 Descriptive analyses

As can be seen in Table 3.2, the sample was matched in age across both genders. As is usual in this age range (Giedd et al., 2006; Yousefi et al., 2013), females reported higher pubertal scores than males. Both genders performed comparably on most ToM and cognitive tasks, with the exception of the EI task, where females outperformed males overall (Table 3.2). Furthermore, females reported significantly higher scores on the perspective taking scale on the IRI than males, which is consistent with previous studies (Baron-Cohen & Wheelwright, 2004).

Table 3.2 Age and average scores for all measures across the whole sample and split by gender.

	All		Males		Females		Males-Females Diff	
	Mean (SD)	N	Mean (SD)	N	Mean (SD)	N	<i>t</i> (df)	Cohen's <i>d</i>
Age (years)	15.77 (2.47)	188	15.43 (2.51)	91	16.09 (2.40)	97	1.83 (186)	0.27
Puberty	3.03 (.84)	159	2.72 (.81)	74	3.31 (.77)	85	4.70 (157)***	0.75
Strange Stories Mentalising (SSM)	8.12 (1.57)	182	8.18 (1.54)	90	8.05 (1.60)	92	-0.54 (180)	0.08
Strange Stories Physical (SSP)	6.82 (1.96)	182	6.84 (1.97)	90	6.80 (1.96)	92	-0.14 (180)	0.02
Silent Films (SF)	9.41 (1.50)	178	9.36 (1.48)	86	9.46 (1.52)	92	0.43 (176)	0.06
Emotional Inference (EI)	18.50 (2.40)	173	18.11 (2.39)	85	18.88 (2.36)	88	2.13 (171)*	0.33
Factual Inference (FI)	4.90 (1.36)	172	4.88 (1.41)	85	4.91 (1.33)	87	0.12 (170)	0.02
Working Memory (WM)	11.77 (2.20)	145	12.07 (2.18)	75	11.46 (2.20)	70	-1.68 (143)	0.28
Vocabulary	40.75 (6.77)	152	39.97 (6.09)	77	41.55 (7.36)	75	1.43 (143.50)	0.24
Matrix Reasoning	20.33 (.31)	145	20.26 (3.59)	74	20.42 (4.00)	71	0.26 (143)	0.04
Perspective Taking (PT)	15.56 (.43)	140	13.90 (4.35)	69	17.18 (5.18)	71	4.05 (138)***	0.69
Fantasy (FS)	17.22 (.51)	140	16.42 (5.51)	69	18.01 (6.35)	71	1.59 (138)	0.27
Family Affluence Scale (FAS)	6.49 (.13)	163	6.74 (1.40)	78	6.26 (1.84)	85	-1.90 (155.78)	0.30

* $p < .05$ ** $p < .01$ *** $p < .001$. Levene's test for equality of variance was significant for verbal ability and FAS, as such, equal variances were not assumed in the independent t-tests for these measures.

Bivariate correlations revealed small but significant correlations between the three ToM tasks, providing support for their convergent validity (Table 3.3). Partial correlations between the three ToM tasks were still significant when controlling for age (EI and SF: $r = .158$, $p = .044$; EI and SSM: $r = .214$, $p = .001$; SF and SSM: $r = .185$, $p = .014$). SF and EI were positively correlated with age and puberty but SSM was not, possibly due to the aforementioned ceiling effects. As such, no further analysis was carried out for SSM.

As expected, performance on all three ToM tasks was correlated with the WASI vocabulary measure of verbal ability as well as the verbal working memory span. Surprisingly, only SF showed a correlation with fluid intelligence, as measured by the matrix-reasoning subtest. Furthermore, EI correlated positively with FS and PT, the cognitive empathy scales of the IRI, again providing support for its construct validity.

Table 3.3 Correlations between ToM and potential predictors in British adolescents.

	Age	Puberty	SSM	SF	EI	WM	Verbal	Matrix	PT	FS	FAS
Age	-										
<i>N</i>											
Puberty	.796***	-									
<i>N</i>	159										
SSM	.060	.051	-								
<i>N</i>	182	153									
SF	.262***	.341***	.194**	-							
<i>N</i>	178	150	177								
EI	.322***	.283**	.221**	.228**	-						
<i>N</i>	173	146	168	165							
WM	.181*	.243**	.193*	.262**	.200*	-					
<i>N</i>	145	126	143	142	136						
Verbal	.477***	.484***	.324***	.321***	.393***	.204*	-				
<i>N</i>	152	132	150	149	141	143					
Matrix	.179*	.186*	.069	.194*	.158	.227**	.141	-			
<i>N</i>	145	127	144	143	134	137	144				

	Age	Puberty	SSM	SF	EI	WM	Verbal	Matrix	PT	FS	FAS
PT	.032	.143	-.016	.094	.195*	-.054	.175	.026	-		
<i>N</i>	<i>140</i>	<i>129</i>	<i>135</i>	<i>133</i>	<i>129</i>	<i>102</i>	<i>107</i>	<i>104</i>			
FS	.012	.088	.124	.064	.270**	.042	.233*	-.156	.211*	-	
<i>N</i>	<i>140</i>	<i>129</i>	<i>135</i>	<i>133</i>	<i>129</i>	<i>102</i>	<i>107</i>	<i>104</i>	<i>140</i>		
FAS	-.062	-.031	.006	-.079	.002	.217*	.139	-.009	-.091	-.016	-
<i>N</i>	<i>163</i>	<i>152</i>	<i>157</i>	<i>154</i>	<i>151</i>	<i>124</i>	<i>130</i>	<i>125</i>	<i>138</i>	<i>138</i>	

* $p < .05$ ** $p < .01$ *** $p < .001$

3.4.3 Silent films performance across age

3.4.3.1 Gender differences in SF performance across age

Table 3.4 Age and gender effects on SF performance.

	B	SE B	β	R ²	ΔR^2
<i>Step 1</i>				.085**	
Constant	7.717	0.790			
Age	0.041	0.011	.281***		
Gender ¹	-0.006	0.239	-.002		
FAS	-0.055	0.073	-.060		
<i>Step 2</i>				.115***	.031*
Constant	6.409	0.970			
Age	0.067	0.016	.459***		
Gender	3.245	1.452	.843*		
Age*Gender	-0.208	0.091	-.890*		
FAS	-0.051	0.072	-.055		

¹ Males were coded as 0 while females were coded as 1.

* $p < .05$ ** $p < .01$ *** $p < .001$

At Step 1, age but not gender significantly contributed to SF performance. However, at Step 2, there was a significant main effect of gender as well as a significant interaction between gender and age, which significantly accounted for more variance than the model at the first step ($\Delta R^2 = .031$, $p = .0247$). FAS did not significantly predict SF performance at either step, and was subsequently dropped from further analyses ($p = .484$). This model explained 9.1% of the variance in the data, $F(4,149) = 4.849$, Adjusted $R^2 = .091$, $p < .001$ (Table 3.4).

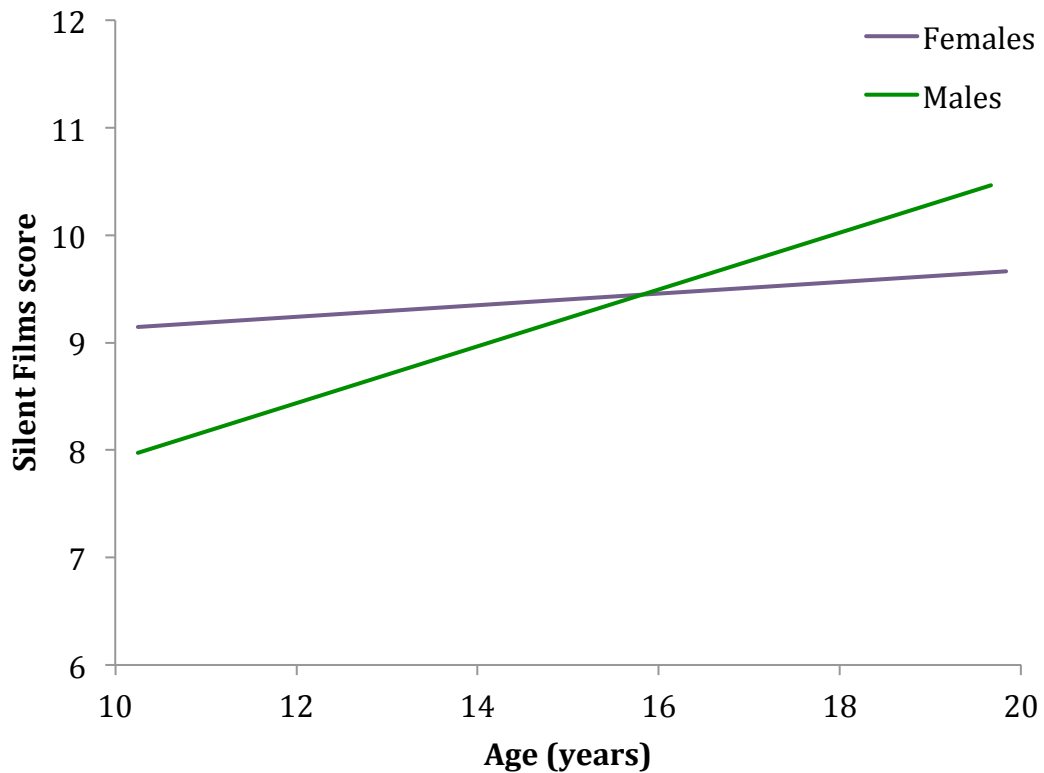


Figure 3.2 SF performance across age for males and females.

Figure 3.2 illustrates the cross-sectional developmental trajectories in SF performance for males and females separately. Post hoc one-way analysis of variance (ANOVA; $N = 57$; 31 Female) revealed that adolescents 16 years and above did not report significant gender differences in SF performance, when age and the cognitive predictors verbal ability, fluid intelligence, and matrix reasoning was controlled for ($p = .521$). Subsequently, separate analyses were conducted for males and females to examine gender-specific predictors of SF performance across age.

3.4.3.2 Cognitive predictors of SF

3.4.3.2.1 Cognitive predictors of SF in females

At Step 1, age did not significantly contribute to the model. At Step 2, verbal ability, matrix reasoning and working memory were added to the model, which significantly accounted for more variance (Table 3.5).

Table 3.5 Predictors of SF performance in females.

	B	SE B	β	R ²	ΔR^2
<i>Step 1</i>				.007	
Constant	8.576	1.286			
Age	0.055	0.079	.086		
<i>Step 2</i>				.186*	.178**
Constant	5.314	1.544			
Age	-0.085	0.087	-.135		
Verbal ability	0.066	0.029	.318*		
Working memory	0.174	0.084	.252*		
Matrix reasoning	0.038	0.046	.101		
<i>Final model</i>				.165**	
Constant	5.046	1.234			
Verbal ability	0.054	0.024	.263*		
Working memory	0.187	0.079	.271*		

* $p < .05$ ** $p < .01$ *** $p < .001$

The final model was obtained through backwards elimination of all variables, first removing matrix reasoning ($p = .413$) and then age ($p = .346$), retaining only items that significantly contributed to the model. The final model, which consist only of verbal ability and working memory, accounted for 14.0% of variance, $F(2,66) = 6.534$, Adjusted $R^2 = .140$, $p = .0026$.

3.4.3.2.2 Cognitive predictors of SF in males

At Step 1, age significantly contribute to the model. As before, at Step 2, verbal ability, matrix reasoning and working memory were added to the model, which did not significantly improve it (Table 3.6).

Table 3.6 Predictors of SF performance in males.

	B	SE B	β	R ²	ΔR^2
<i>Step 1</i>				.200***	
Constant	5.295	0.993			
Age	0.263	0.064	.447***		
<i>Step 2</i>				.242***	.042
Constant	3.259	1.477			
Age	0.204	0.071	.346**		
Verbal ability	0.038	0.029	.157		
Working memory	0.062	0.078	.091		
Matrix reasoning	0.034	0.046	.082		
<i>Final model</i>				.200***	
Constant	5.295				
Age	0.263	0.064	.447***		

* $p < .05$ ** $p < .01$ *** $p < .001$

Through backwards elimination, matrix reasoning ($p = .460$), working memory ($p = .353$), and verbal ability ($p = .126$), were removed from the model. The final model contained only age and accounted for 19.0% of variance, $F(1,84) = 20.936$, Adjusted $R^2 = .190$, $p < .001$.

3.4.4 Emotional inference performance across age

3.4.4.1 Gender differences in EI performance across age

Table 3.7 Age and gender effects on EI performance.

	B	SE B	β	R ²	ΔR^2
<i>Step 1</i>				.107***	
Constant	-3.956	1.217			
Age	0.065	0.018	.291***		
Gender ¹	0.645	0.371	.138 ^a		
FAS	0.063	0.114	.044		
<i>Step 2</i>				.112***	.005
Constant	-3.224	1.482			
Age	0.051	0.025	.225*		
Gender	-0.876	1.792	-.187		
Age*Gender	0.031	0.035	.343		
FAS	0.063	0.114	.044		
<i>Final model</i>				.103***	
Constant	-4.335	1.072			
Age	0.256	0.068	.277*		
Gender	0.605	0.337	.132 ^a		

¹ Males were coded as 0 while females were coded as 1.

^a $p < .10$ * $p < .05$ ** $p < .01$ *** $p < .001$

At Step 1, age significantly predicted EI, while gender was significant at the one-tail level. At Step 2, the interaction between age and gender did not significantly contribute to the model (Table 3.7). FAS did not significantly predict EI performance at either step. Age*gender ($p = .387$) and FAS ($p = .579$) were thus removed through backwards elimination. The final model consisted of age and gender ($p = .074$). This model accounted for 9.2% of the variance, $F(2,169) = 9.693$, Adjusted $R^2 = .092$, $p < .001$.

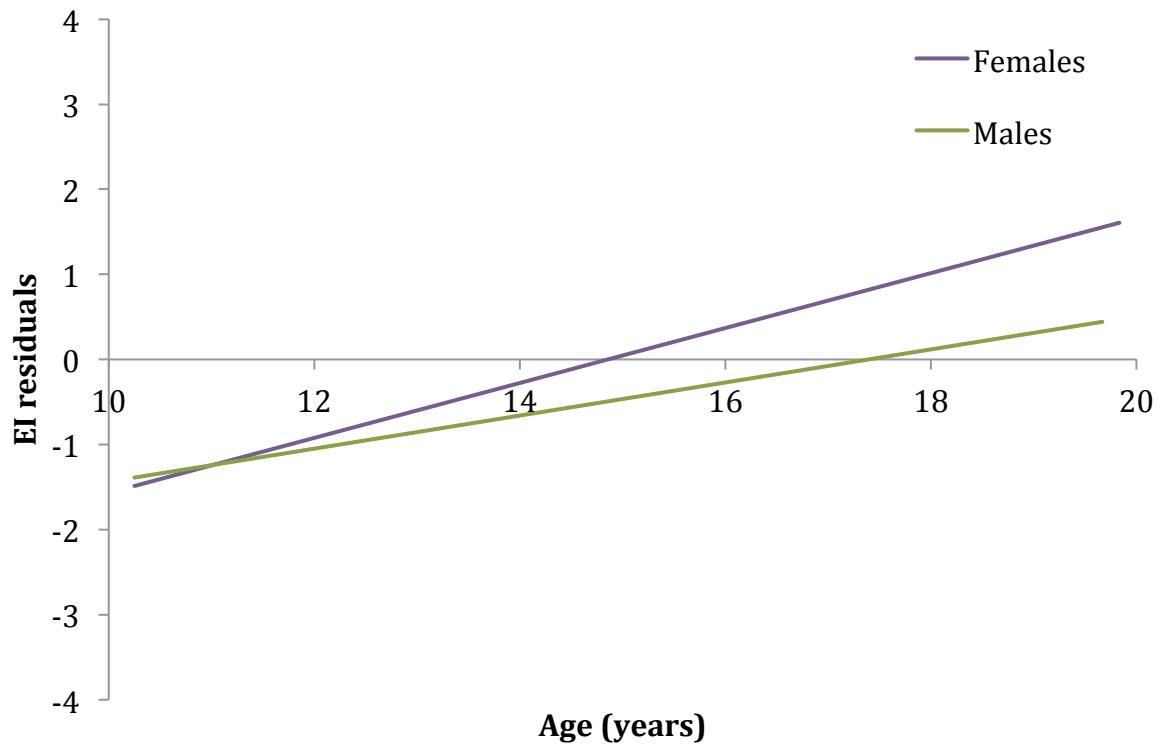


Figure 3.3 Regression lines for EI residuals across age for males and females.

Figure 3.3 illustrates the cross-sectional developmental trajectories in EI performance for males and females separately. Slopes suggest that while both gender started off with comparable scores in later childhood and early adolescence, a gender gap emerges between mid-late adolescence. However, as this effect of gender was not significant at the two-tail level, subsequent analyses were conducted for the whole sample whilst controlling for gender.

3.4.4.2 Cognitive predictors of EI across the whole sample

Table 3.8 Predictors of EI performance.

	B	SE B	β	R ²	ΔR^2
<i>Step 1</i>				.119***	
Constant	-4.639	1.236			
Age	0.281	0.079	.300***		
Gender ¹	0.752	0.395	.161 ^a		
<i>Step 2</i>				.177***	.058*
Constant	-7.489	1.706			
Age	0.153	0.091	.164 ^a		
Gender	0.782	0.394	.168*		
Verbal ability	0.079	0.035	.218*		
Working memory	0.150	0.093	.142		
Matrix reasoning	-0.011	0.052	-.018		
<i>Final model</i>				.156***	
Constant	-6.774	1.347			
Age	0.204	0.084	.215*		
Gender	0.680	0.371	.144 ^a		
Verbal ability	0.082	0.032	.227*		

¹ Males were coded as 0 while females were coded as 1.

^a $p < .10$ * $p < .05$ ** $p < .01$ *** $p < .001$

At Step 1, both age and gender significantly contributed to EI performance. Adding verbal ability, working memory and matrix reasoning significantly improved the model at Step 2. The final model was obtained through backwards elimination of matrix reasoning ($p = .837$), working memory ($p = .102$). Age, verbal ability, and gender ($p = .069$) predicted EI performance in the final model, which accounted for 15.6% of the variance, $F(3,136) = 9.583$, Adjusted $R^2 = .156$, $p < .001$ (Table 3.8). Again, the effect of gender was non-

significant at the two-tail level, indicating only a weak female advantage on EI performance.

3.4.5 Effects of puberty on ToM

Using the same analysis steps as above, there was no gender by puberty interaction for the SF or EI tasks (SF: $p = .396$; EI: $p = .140$) in the first set of analyses, although puberty significantly predicted ToM performance even when accounting for FAS and gender (SF: $p < .001$; EI: $p = .0053$). In the second set of analyses, when cognitive predictors were included, puberty was eliminated through backwards elimination for both tasks (SF: $p = .096$; EI: $p = .279$).

3.5 Discussion

This study aimed to map out the developmental trajectory of both cognitive and affective ToM across adolescence, using purportedly adolescent-appropriate tasks. First, the relationship between cognitive empathy and ToM performance was investigated to provide construct validity for these tasks. Age effects were then examined while accounting for potential gender differences in ToM. Next, depending on whether there were gender differences, age effects were investigated whilst also examining the underlying cognitive predictors of ToM, either separately by gender or as a whole sample. Lastly, puberty, instead of age, as a predictor of ToM maturation, was also investigated.

When there were no ceiling effects, cognitive ToM, as measured by the Silent Films task, was found to improve with age, but specifically in boys and not in girls, providing partial support to the first hypothesis. In contrast, affective ToM performance on the Emotional Inference task reported protracted improvement across age in both boys and girls, supporting the second hypothesis, with preliminary evidence for a small female advantage. Puberty,

although initially correlated with performance on the SF and EI tasks, did not predict ToM ability once general cognitive factors were accounted for. All three ToM tasks significantly correlated with each other, suggesting they measure overlapping aspects of ToM. Furthermore, cognitive empathy, as measured by FS and PT of the IRI, both correlated with the EI task, providing it with additional convergent validity.

3.5.1 Cognitive ToM development in adolescence

This study contributes to the small but growing body of literature on the maturation of adolescent cognitive ToM (Dumontheil et al., 2010a; Devine & Hughes, 2013). First, this study reported large ceiling effects for the Strange Stories task, suggesting this task might be too simple for older adolescents, and may not be developmentally appropriate. However, only five stories were selected from the original battery, and this may not be representative of the difficulty level for all stories in the complete set (White et al., 2009; Happe, 1994). Second, and perhaps more interestingly, continued development of cognitive ToM as measured by the Silent Films task (Devine & Hughes, 2013) was found to follow a gender specific pattern.

Gender effects found in this study were in line with Devine and Hughes (2013), who found that eight to 12 year old girls outperformed boys on the SF, even when matched for age and verbal ability. Within the age range used in this study (10 to 20 year olds), there was an interaction between age and gender (Figure 3.2) on SF performance, suggesting differences in the trajectories of development. While boys may be poorer at cognitive ToM in early adolescence, in line with in previous studies on younger samples (Bosacki & Wilde Astington, 1999; Calero et al., 2013; Devine & Hughes, 2013), they start to perform

comparably to girls in mid-late adolescence (around 16 years). This stands in contrast to theories that indicate persisting female ToM advantage in adulthood (Baron-Cohen, 2004; Hall, 1978). This may be due to the distinct tasks used in these studies that tap into slightly different social abilities, or perhaps task difficulty levels, i.e. should a more difficult task be used, female advantage may persist.

Furthermore, while age alone accounted for variance in male SF performance, in females, cognitive ToM improved with increasing verbal ability and working memory, indicating differing markers for the ability across genders in this age group. The lack of age effects on adolescent girls might indicate fully developed cognitive ToM in this age range, or that improvements are mainly driven by domain general cognitive abilities. Alternatively, effects may also be due simply to differing task difficulty for females and males. Indeed, more females than males scored highly for SF (30.5% of girls scored the top two marks compared to 19.7% of boys). Given a more challenging task, continued improvements in cognitive ToM, above and beyond domain general cognitive abilities, may be found in adolescent girls too.

3.5.2 Affective ToM development in adolescence

This study introduced a novel, adolescent-appropriate measure of affective ToM, the EI task. This task correlated with not only the two cognitive ToM tasks, but also the two cognitive empathy scales (PT and FS), in line with previous research (Bosacki & Wilde Astington, 1999; Ibanez et al., 2012; Rogers et al., 2007), providing it with strong convergent validity. In line with Vetter et al. (2013a), performance on the EI task showed protracted improvement across

adolescence for both females and males, even when controlling relevant domain general cognitive abilities. This suggests that, even when social situations are adolescent-appropriate and domain general cognitive abilities are accounted for, the ability to infer emotions from contextual information continues to improve across adolescence. Furthermore, in line with Shamsay-Tsoory et al. (2010) and Sebastian et al. (2011), results from this study tentatively lend support to the theory that affective ToM might show more protracted development than cognitive ToM, as evidenced by a steeper slope in the regression lines (with no ceiling effects in either gender). However, these results may have arisen due to differences in task demand difficulties instead (discussed below).

While there was an initial female advantage for performance on the EI task compared to males, this was non-significant at the two-tail level when other factors such as age and verbal ability were taken into account. However, it is worth noting that the effect of gender was still close to significance in this model ($p = .069$). Slopes would suggest that female advantage in affective ToM might only emerge in mid adolescence and widen with age. However, this is only a preliminary (and weak) finding. A wider age span would need to be investigated to further probe potential gender effects.

Across the whole sample, age and verbal ability alone predicted affective ToM performance. Previous research has found similar associations between ToM and verbal ability (Devine & Hughes, 2013; Watson et al., 2001; Ruffman et al., 2003; Astington & Jenkins, 1999). However, as the EI is a story-based measure (as are many other ToM tasks), this association may also be driven by

verbal task demands. Dissociating the relationship between verbal and ToM ability from confounding task effects remains a challenge to overcome.

3.5.3 Limitations and future directions

This study was the first to investigate both cognitive and affective ToM developmental trajectories continuously across adolescence using purportedly adolescent appropriate tasks, whilst accounting for domain general cognitive abilities. It sheds important light on the protracted maturation of these skills in adolescence, which may be gender specific. However, there are a few caveats to keep in mind when interpreting the results.

While results from this study indicate ToM development could be uniquely social, i.e. showing improvements with age even when accounting for cognitive predictors (verbal ability, fluid intelligence, and working memory), there remains aspects of domain-general cognitive abilities that were not accounted for in this study, due to time and logistical constraints on testing. Further avenues of research should include other executive function abilities, such as response inhibition, which has been shown to be an important predictor of ToM ability in young children (Carlson & Moses, 2001; Carlson, Moses & Claxton, 2004). Should ToM continue to report improvements across age even when all domain general cognitive abilities and executive functions are exhaustively accounted for, we may begin to tease apart social cognitive development in adolescence that might be uniquely social.

Next, there were certain task limitations that need to be addressed. First, the internal consistencies for the SF and SS tasks, as well as the Factual Inference

control task, were low in this study. While there is no past internal consistency data available for SF, SS has reported much higher Cronbach's α when administered to young children (Velloso et al., 2013). This disparity may be due to the wide age range used in this study, which produces variability in performance levels, and the small number of items for each task. Importantly, both the SS and SF, although traditionally viewed as cognitive ToM tasks (Poletti et al., 2012; Devine & Hughes, 2013), also contain items that require reasoning about emotions, such as eliciting sympathy (SS) and feeling surprised (SF). As such, these tasks may not sufficiently isolate cognitive ToM. Encouragingly, the EI task, which measures exclusively affective ToM, reported an acceptable Cronbach's α , which was slightly higher than the Cambridge Face Scale (Vetter et al., 2013a). In any case, further studies are needed to test the reliability of these ToM tasks, including their cross-time stability.

Another caveat to note is that the three tasks used in this study differed from each other in several aspects, making direct comparisons difficult. SF and SS required open-ended answer coding while EI was multiple choice; EI and SS were story based while SF was film based. It is therefore difficult to determine if cognitive predictors that underlie these tasks were associated with ToM or task demands. The effects found in this study could also be due to differing levels of task difficulty, rather than inherent differences in the development of affective and cognitive ToM abilities. A cognitive empathy inferencing task, similar to the EI task, should be developed in future and administered together. This should be matched in style and difficulty to the EI, except probe only inferences about

intentions and desires instead of emotions, to isolate cognitive ToM, and to allow for direct comparison between the two ToM abilities.

As a secondary aim, this study attempted to probe the relationship between cognitive and affective ToM with cognitive empathy. The lack of association between cognitive empathy measures and the cognitive ToM tasks were unexpected (Shamay-Tsoory, 2011; Rogers et al., 2007). The high ceiling effects found in SS, which may have led to an inability to differentiate true ToM ability, might underlie this finding. However, the picture remains slightly unclear for the SF. First, the possibility of a dissociation between self-report (i.e. self-perceived) cognitive empathy and actual behaviour might have driven the lack of relationship between these two traditionally linked constructs within this sample using the SF task. It may also be that the SF taps into an aspect of cognitive ToM that is not directly linked to cognitive empathy (after all, the link between SF and cognitive empathy has yet to be established in previous literature). Alternatively, cognitive ToM might show a weaker link to cognitive empathy than affective ToM because of its weaker demands on emotional reasoning. Nevertheless, it is important to keep in mind that the IRI is a self-report measure and may be subject to response biases (Donaldson & Grant-Vallone). In the future, more studies should address these constructs together using more naturalistic measures of empathy, in order to form a clear understanding of how both cognitive and affective ToM and empathy might relate to one another (Shamay-Tsoory, 2011).

Finally, that chronological age, but not puberty, predicted cognitive and affective ToM once relevant cognitive abilities were accounted for (in line with

Vetter et al., 2013b) potentially suggests that the socio-cultural experience of adolescence might be more relevant for ToM development than biological programming. Of course, this result is merely tentative as the measure of puberty used here was a self-report measure, which as mentioned, may be subject to reporting bias. Future studies should include non-invasive biological markers of puberty, such as saliva swabs, which may be more objective and reliable. For example, Goddings et al. (2012) measured salivary concentrations of testosterone, oestradiol, and DHEA in 11 to 13 year old girls and found hormone levels to be positively associated with left ATC activity during social emotion processing, independent of chronological age.

Nevertheless, this study's finding that age was a better predictor of ToM development than puberty leads to the question: to what extent does experience play a role in shaping ToM maturation? In cultures where the demands and experiences of adolescence are different (Chen et al., 1997), might this then lead to differences in ToM development? Given stark differences in self-construal found between adolescents from the UK and China (Chapter 2), in Chapter 4, I will investigate the development of ToM in Chinese adolescents, and discuss this in relation to data from British adolescents, as presented in this Chapter.

3.6 Conclusion

The development of cognitive and affective ToM follows unique trajectories across adolescence. This may be gender specific, with boys 'catching up' to girls in later adolescence for cognitive ToM, and a weak female superiority persisting through mid-late adolescence for affective ToM. Age predicted cognitive and affective ToM above and beyond general cognitive abilities in boys,

but in girls this was only true for affective ToM. In contrast, cognitive ToM in girls improved with increasing verbal ability and working memory. Future studies should use tasks of similar difficulty levels to directly compare cognitive and affective ToM developmental trajectories. To address the role of socio-cultural experiences in shaping ToM maturation, Chapter 4 will investigate ToM ability in Chinese adolescents using the same tasks, and results will be discussed in relation to data from this Chapter.

4. Theory of Mind in Chinese adolescents: a comparison between East and West

4.1 Abstract

The development of advanced Theory of Mind (ToM) during adolescence has never been studied outside the Western context. Where the adolescent sociocultural experience differs, might this affect development of mentalising abilities? To answer this question, ToM tasks from the study in Chapter 3 were translated and administered to adolescents in China, along with equivalent Chinese cognitive tasks (N = 116, age range = 9.06 to 16.88 years). Hierarchical regression analyses were used to determine i) whether adolescents in China showed age-associated improvements in cognitive and affective ToM abilities, and ii) the extent to which abilities and developmental trajectories were the same or different across cultures, using an age-matched sample of British adolescents from Chapter 3 (N = 109, age range: 10.25 to 16.88 years) as comparison. Both cognitive and affective ToM showed protracted development across adolescence in China, although lower performance was found in Chinese compared to British adolescents overall. Chinese females performed better at the affective ToM task than males of the same age, but the effect of gender was mediated by puberty, for which females of similar ages to males reported higher stages. Cultural differences may be due to differences in self-construal, the language structures of Mandarin and English, and/or artefacts of the tasks, all of which were developed in the West. More naturalistic tasks that circumvent these limitations are needed for cross-cultural research on adolescent social cognitive development.

4.2 Introduction

What drives age-associated social cognitive development, namely Theory of Mind (ToM) maturation, during adolescence? While some behavioural changes, such as affective changes, may be the product of a genetically determined program (Lau & Eley, 2006), researchers of adolescence are now beginning to give due credence to the role of experience in influencing development (Nielsen & Haun, 2016), particularly in the social domain (Crone & Dahl, 2012; Ellis et al., 2012; Choudhury, 2010; Blakemore & Mills, 2014). In this respect, outstanding questions remain on how the wider social environment, such as socio-cultural variability in the nature and experience of adolescence, may affect the expression of adolescent-associated maturational changes in social abilities. It is clear that while some version of adolescence exists in virtually all human societies, including hunter-gatherers and pastoralists (Schlegel & Barry, 1991), its features are not universal, differing greatly from culture to culture. Whether cultural differences in the experience and nature of adolescence influence the trajectories of ToM development is unknown, although adolescent social behaviour in general, such as time spent with peers, has been shown to vary in a culture-specific manner (Chen et al., 1997; Darling & Steinberg, 1993; Ekblad, 1986). Cultural psychologists Kitayama and Uskul (2010) further argue that adolescence might be a sensitive period primed for the absorption of culture, possibly a means of biological adaptation (Kitayama & Park, 2010), as the learning of the most up-to-date culture could prepare one best for the reproductive market.

Despite this, remarkably few studies have sought to empirically map out adolescent ToM development outside of the Western world. Indeed, the bulk of

ToM research has been carried out exclusively in the West (Hughes & Devine, 2015), with a few notable exceptions (Wang et al., 2015; Callaghan et al., 2005; Liu et al., 2008; Ahn & Miller, 2012; Hughes et al., 2014; Lecce & Hughes, 2010; Lewis et al., 2009; Sabbagh et al., 2006). Even so, most of these cross-cultural studies have focused mainly on basic false belief understanding in early childhood (apart from Wang et al., 2015), and not on later development, such as during adolescence. Given the well-documented differences between the adolescent social experiences across cultures (Chen et al., 1997; Darling & Steinberg, 1993; Ekblad, 1986), including differences in construing the 'self', particularly in relation to others and in terms of social identities (Chapter 2), outstanding questions remain on whether this variability in experience also modulates the expression of adolescent-associated maturational changes in mentalising. Does advanced ToM development follow an invariant, universal pathway, or is it shaped by experience, displaying culturally specific developmental routes?

4.2.1 False belief understanding across cultures

Passing false belief tasks has long been considered the earliest hallmark of ToM ability. In Western societies, children typically master false belief understanding by five years of age (Wellman et al., 2001). However, research attempting to establish the age of onset for mental state reasoning across different cultures has produced mixed findings (Mayer & Trauble, 2013; Oberle, 2009), with many reporting a several year lag for non-Western children (Vinden, 1996; Mayer & Trauble, 2013; Naito & Koyama, 2006) and others reporting no difference (Avis & Harris, 1991; Callaghan et al., 2005). This may potentially be due to varying methods of experimentation used across cultures (Callaghan et

al., 2005). For example in an early study by Vinden (1996), four to eight year old Junin Quechua children performed poorly on false belief tasks. Strikingly, Mayer and Trauble (2013) found that even at 10 to 13 years old, one third of Samoan children still failed false belief tasks. However, when experimenters have been careful to use naturalistic procedures (confederates acting out scenes instead of simply describing hypothetical characters to children), these differences were all but eliminated (Avis & Harris, 1991; Vinden, 1999; 2002). Moreover, when the same naturalistic task was used across five diverse cultural settings (Canada, Peru, India, Thailand, and Samoa), researchers found that children across every culture passed the false belief milestone at approximately five years of age (Callaghan et al., 2005). Unsurprisingly, task appropriateness and relevance for children from particular cultures may have a large role to play when testing social abilities.

4.2.2 Culture and cognition of the East

There have been documented differences in the cognitive styles and value systems between individuals from Eastern and Western cultures. China is a collectivistic country that embraces the interdependent self-construal (Markus & Kitayama, 1991; Hofstede, 1980). The Chinese focus on persons as interconnected and sharing group commonalities stands in stark contrast to the Western ideal of independence – the focus on persons as individuals and different to one another (Markus & Kitayama, 1991). This distinction in self-construal has been shown to characterise even young adolescents across these cultures (Chapter 2). How differences in cultural values and self-construal may affect social cognitive development is little known.

The strong interdependent self-construal found in Chinese society may translate into cultural practices that entail a constant taking into consideration of other people's opinions from a young age, which may lead to superior social cognitive abilities, as posited by the Representational Hypothesis (Chapter 1; Wu & Keysar, 2007). However, a competing theory suggests that the weakened self-other distinction found to accompany individuals with strong interdependent selves (Zhu et al., 2007) may lead to less of an emphasis on the fact that other people have beliefs and opinions that are *different* from oneself, i.e. the Attentional Hypothesis (Wu & Keysar, 2007). Thus, this may in fact lead to poorer performance on ToM tasks that require attributing mental states such as opinions, beliefs and emotions to other people. Indeed, while Western children master an understanding of diverse beliefs before knowledge, the opposite pattern is found for Asian children (Wellman, Fang, Liu, Zhu, & Liu, 2006; Wellman, Fang, & Peterson, 2011).

Furthermore, anthropological accounts show that adolescents in China spend less time with peers and have stronger filial and academic obligations (Chen et al, 1997). Instead, Chinese adolescents spend more time and effort on mastering domain general cognitive abilities that are crucial for academic achievements, such as working memory, which improves with training (Olesen, Westerberg, & Klingberg, 2004). While ToM is undeniably associated with domain general cognitive and executive function abilities (Chapter 3), such as working memory and response inhibition (Carlson & Moses, 2001; Carlson, Moses, & Brenton, 2002), these might not capture the important social aspect of mentalising. Factors outside of cognitive skills have been shown to also predict ToM abilities, such as exposure to social or mental state references in

conversation (Sabbagh et al., 2006; Lu, Su, & Wang, 2008). Given that the adolescent social pressures that may drive social cognitive development in the West (Crone & Dahl, 2012) may not be as prevalent for Chinese adolescents, how might this affect their continued social cognitive development? To date, no study has investigated the continued maturation of social cognitive skills in Chinese adolescents. **Thus, the first aim of this study was to investigate whether or not social cognitive skills, such as cognitive and affective ToM, continued to develop across adolescence in China.**

4.2.3 Differences in ToM across the East and West

Data from childhood and adult studies report inconsistent results on whether or not differences in ToM abilities exist across East Asian and Western cultures. A meta-analysis of false belief data from over 3000 young children from Mainland China and Hong Kong showed that while children from Hong Kong lagged behind by up to two years in ToM age of onset, Mainland Chinese children showed little difference to North American children (Liu et al., 2008). However, many of these studies used varying types of tasks across different cultures, making comparison tricky. Nevertheless, reasons for this developmental difference (should it exist) remains an unsolved mystery, although research points to a complex interplay between cultural values, parental and peer interaction, number of siblings, linguistics, and pedagogical experiences (Tardiff & Wellman, 2000; Wang et al., 2015).

Do potential differences in ToM development across cultures exist in late childhood and adolescence? Wang et al. (2015) found that performance on an advanced ToM task by older Hong Kong children (10 to 12 years) in local but not international schools was poorer than their British counterparts. This may be

due to pedagogical or language factors (international school children in Hong Kong spoke mainly English or were bilingual, whereas local school children were native Cantonese speakers). Furthermore, while the local sample was predominantly Chinese, the international school children consisted of White and mixed-race ethnicities with potentially distinct cultural upbringing and which do not provide a homogenous culture for testing. Indeed, international schools are often a subculture that may not be very representative of the local culture within which they reside. As such that Hong Kong international students (but not local students) performed comparably to their UK counterparts might not be particularly surprising.

Interestingly, there is some evidence to suggest that Chinese adults might in fact be better at perspective taking than their Western counterparts. Wu and Keysar (2007) found that bilingual Chinese-American adults outperformed European Americans in a perspective-taking task. However, a later reanalysis of Wu and Keysar's (2007) data using a more time-sensitive approach found that Chinese participants made the same egocentric mistakes initially as the European American participants, but suppressed the interference earlier and more effectively (Wu et al., 2013). This suggests that instead of having a more advanced perspective taking ability, bilingual Chinese participants employed more advanced executive function in their reactions, consistent with the evidence supporting the advantage of Chinese children on executive function (Sabbagh et al., 2006). Further, as mentioned in Chapter 3, there is some question about the relationship between visual perspective-taking skills with other mentalising abilities (Aichhorn et al., 2006; Hamilton et al., 2009; Begeer et al., 2010). Given the disparity in existing data between childhood and adulthood,

it would be interesting to investigate whether or not cultural differences in the performance and developmental trajectories of ToM abilities exist in adolescence. To date, there has been no study (that I am aware of) that uses the same ToM tasks to compare performance between Mainland Chinese and UK adolescents. **As such, the second aim of this study was to compare the development of cognitive and affective ToM between Chinese and UK adolescents using the same tasks across both cultures.**

4.2.4 Summary of goals and hypotheses of current study

This study aimed to establish whether, using consistent measures across two different cultures, China and the UK, adolescents (9 to 17 years) would report similar performance and developmental trajectories in cognitive and affective ToM. The potential variance accounted for by gender and domain general cognitive abilities was also examined in China only and also across both cultures. Specifically, the same ToM and domain general cognitive tasks (verbal ability, working memory, and fluid intelligence), and self-report measures as in Chapter 3 were employed to investigate i) ToM development across adolescence in China ii) similarities and differences in ToM ability and development between Chinese and British adolescents. Given China's one-child policy, and as number of siblings has been shown to have a positive effect on ToM development in the early developmental years (McAlister & Peterson, 2007; Perner, Ruffman, & Leekam, 1994), number of siblings could be a confounding factor for cultural differences. Hence, this was controlled for. Finally, as in Chapter 3, the relationship between puberty and ToM in Chinese adolescents was also investigated.

The main hypotheses were:

- i. Similar to British adolescents, Chinese adolescents would report protracted development in both cognitive and affective ToM tasks.
- ii. Chinese adolescents would either report lower ToM scores overall (Wang et al., 2015; Sabbagh et al., 2006) or there may be an interaction between culture and age, with the Chinese ‘catching up’ to British participants during adolescence (Wu & Keysar, 2007).

4.3 Methods

4.3.1 Participants

116 participants (age range: 9.02 to 16.88 years; $M = 13.97$ years, $SD = 1.90$; 65 females; Table 4.1) from China took part in this study. All participants attended Chinese state schools and reported Chinese as their native language.

Informed consent was obtained from parents or teachers for all participants. This study received ethical approval from Oxford University’s Central Ethics Committee as well as Renmin University of China Ethics Committee. Participants and their families were compensated with Amazon vouchers or small gifts for their time. As in Chapter 3, the task battery was extensive and due to time constraints, not every participant completed the full task battery. To maximise the sample size across analyses, participants with missing data were excluded case-wise from analysis, leading to slightly different numbers of participants across analyses.

An age-matched subset of participants from the UK (from the sample in Chapter 3; $N = 109$, age range: 10.25 to 16.88 years; $M = 14.10$, $SD = 1.86$; 54 females) was selected as cross-cultural comparison (see Table 4.1 for full details).

Table 4.1. Sample demographics for all participants (N = 225).

	Total	Females	Males	Age (years)		Ethnicity	FAS	First language	Education institution	Siblings
				Range	Mean (SD)		Mean (SD)			
China	116	65 (56.03%)	51 (43.97%)	9.02 to 16.88	13.97 (1.90)	Han Chinese (92.24%), Other (Korean, Manchu, Hmong; 3.45%), Missing (4.31%)	4.70 (1.83)	Chinese	State	None (77.59%), One (10.34%), Two (3.45%), Three (1.72%), Four and more (6.90%)
United Kingdom	109	50 (45.87%)	59 (54.13%)	10.25 to 16.83	14.10 (1.86)	Caucasian (74.31%), South Asian (8.26%), Black or African (12.84%), East Asian (2.75%), Mixed (0.92%), Missing (0.92%)	6.58 (1.63)	English (97.25%), Other (2.75%)	State (50.46%), Independent (49.95%)	None (6.42%), One (44.04%), Two (23.85%), Three (4.59%), Four (3.67%), Missing (17.43%)

4.3.2 Materials

As in Chapter 3, the three ToM tasks (Silent Films, Strange Stories, Emotional Inference) and the digit memory test (see Chapter 3 for details) were administered. Participants also completed the same self-report measures (FAS, SCS, Chapter 2; PDS, IRI, Chapter 3).

All measures and tasks were translated and back translated from English to Chinese by myself, and three independent translators, for whom Chinese was their native language.

4.3.2.1 Theory of Mind tasks

4.3.2.1.1 Strange Stories task

SSM and SSP reported Cronbach's alphas of and inter-rater reliabilities of $r = .96$, $p < .001$ and $r = .93$, $p < .001$ and a internal consistency of $\alpha = .40$ and $\alpha = .26$ respectively in this sample. This was slightly lower than the internal consistency reported for the SS task in the British sample ($\alpha = .485$ for SSM and $\alpha = .471$ for SSP; Chapter 3).

4.3.2.1.2 Silent Films task

The SF reported low internal consistency of $\alpha = .25$ and an inter-rater reliability of $r = .94$, $p < .001$, in this sample. This was similar to that reported in the British sample ($\alpha = .29$; Chapter 3).

4.3.2.1.3 Emotional Inference task

The emotional inference (EI) items reported an internal consistency of $\alpha = .63$ while the factual inference (FI) items reported $\alpha = .30$. Again, this was comparable to the British sample ($\alpha = .64$ for EI and $.35$ for FI; Chapter 3).

4.3.2.2 Cognitive tasks

The Vocabulary and Matrix Reasoning subtests from the Wechsler Intelligence Scale for Children-4th Edition-Chinese version (WISC-IV-Chinese; Wechsler, 2007; 2003) were administered as measures of verbal ability and fluid intelligence.

The WISC-IV-Chinese has been validated and found to be reliable in a sample of 968 Taiwanese participants (age range 6 to 16 years). Confirmatory factor analysis supported the four-factor structure of the WISC, within which Vocabulary and Matrix Reasoning reported high factor loadings ($> .65$) for the Verbal Comprehension Index and Perceptual Reasoning Index respectively (Chen, Keith, Chen, Chang, 2009). Furthermore, according to Chen et al. (2009), this factor structure was stable across age.

As in Chapter 3, raw scores from both tests were used in analyses. However, for the cross-cultural analysis, as the Vocabulary and Matrix Reasoning tests employed were different across cultures, scores from these were standardised within cultures using T-scores so that each child's ability was measured against peers from their own culture.

4.3.3 Procedure

Participants completed the task battery in quiet, controlled conditions either at the University or at their own schools in Shanghai, Beijing or Jintan.

The majority of the participants were tested individually and a further subset of 20 participants (age range = 13.44 to 14.95 years) completed the ToM tasks as a class under exam-like conditions, due to time constraints. Independent t-tests between group and individually tested participants within the same age range ($N = 26$) revealed no significant difference in performance for SF ($p = .35$).

However, participants who were group-tested performed better than individually tested participants on the SSM (Group: $M = 7.65$, $SD = 1.53$; Individual: $M = 6.23$, $SD = 1.88$; $t(44) = 2.74$, $p = .009$) and the EI (Group: $M = 18.80$, $SD = 1.36$; Individual: $M = 14.92$, $SD = 2.76$; $t(38.30) = 6.25$, $p = <.001$, equal variances not assumed). Thus, the validity of these scores could be questionable (e.g. in groups, participants may have shared answers or copied, leading to unusually high scores for their age range). These 20 participants were dropped from all subsequent analyses, resulting in $N = 90$ for SS, $N = 86$ for SF, and $N = 96$ for EI.

All participants were tested by one of seven experimenters, who were either Psychology graduate students or full time research assistants in China. All experimenters were extensively trained by myself and followed a translated Chinese version of the instructions booklet (Appendix D) to standardise testing. There was no effect of Experimenter (1 to 7) or Location (Beijing, Shanghai or Jintan) on any ToM tasks (Location: $p = .129$ to $.595$; Experimenter: $p = .089$ to $.542$).

4.3.4 Data analysis overview

The data were first examined for outliers. One outlier ($> 3SD$ from the mean) was identified for working memory and removed from analyses. Next, ceiling effects were investigated by calculating the percentage of participants scoring at ceiling (maximum possible score) for each task. As in Chapter 3, descriptive analyses across the whole sample and by gender were performed, and correlations between the three ToM tasks with measures of cognitive empathy as well as with other cognitive and control predictors were examined.

Further, descriptive analysis was conducted to examine potential cultural differences on all measures.

To investigate the first hypothesis on age-related changes in ToM in Chinese adolescents, the same data analysis steps as in Chapter 3 were taken. Two sets of hierarchical regression were employed for each task. The first set included potential gender differences and its interaction with age, while the second examined potential domain general cognitive predictors of ToM development: verbal ability, matrix reasoning and working memory (see Chapter 3 for full details). As before, for SS and EI, residuals from regressing the control items from experimental (ToM) items were used in the regression analyses. Finally, puberty was used as a predictor instead of age using the same analysis steps.

Next, to address the second question of cultural differences in adolescent ToM development (i.e. whether there was an overall difference in performance or an interaction between culture and age), two sets of cross-cultural regression analyses were employed:

- i. Two models were run in the first set of analyses to investigate the effect of culture on ToM. In the first model, culture and age was used to predict ToM performance, while accounting for FAS and gender at Step 1. At Step 2, the interaction between culture and age was included to determine if it added significant additional variance. Non-significant predictors were then removed through backwards elimination. Should culture or its interaction with age be significant, in a second model, the significant predictors from Model 1 and number of Siblings were included to investigate whether Siblings mediated the

effect of culture. If Siblings was not significant, it was removed from the model, resulting a final model with only significant predictors of ToM performance.

- ii. In the second set of analyses to investigate the underlying cognitive predictors of ToM across both cultures, significant predictors retained in the final model from the first set of analysis were entered in Step 1. Next, at Step 2, domain general cognitive predictors were included in the model to examine any potential variance accounted for by them. Again, non-significant terms were removed through backwards elimination, resulting in a final model that retained only significant predictors of ToM across both cultures.

4.3.4.1 Data assumptions

All regression models were checked using established parameters (Field, 2000). Ensuring there was no multicollinearity, all variables reported a tolerance of more than 0.1 and Variance Inflation Factors of less than 10, except when interaction terms were included in the model. Assumptions of independent errors for each model were also met (Durbin-Watson = 1.680 to 2.038). Furthermore, examination of the scatterplot of standardised residuals against standardised predictors revealed no violations of homoscedasticity or linearity, and the histograms and normal P-P plots revealed no concerns over normality of standardised residuals in any analysis.

4.4 Results

4.4.1. Ceiling effects

There were no marked ceiling effects for any ToM task. 1.11% and 5.81% scored at ceiling for SSM and SF respectively, and no one scored at ceiling for EI. Post hoc observations did not find any evidence of floor effects either.

4.4.2 Descriptive analyses

Average scores for all tasks and measures across the whole sample and by gender are shown in Table 4.2. While there was no age difference between females and males, as with Chapter 3 and consistent with previous reports, females reported significantly higher pubertal status than males of the same age (Van de Graff et al., 2014; Yousefi et al., 2013). No significant gender differences were found on any other measure.

Table 4.3 shows correlations between all measures and tasks in Chinese adolescents. Similar to British adolescents in Chapter 3, SF and EI but not SS reported a positive correlation with age and puberty. Self-report cognitive empathy on both the PT and FS scales increased with age.

Unexpectedly, none of the ToM tasks correlated with one another. SS and EI correlated with one of the cognitive empathy subscales of the IRI, i.e. FS but not PT. Furthermore, while both SS and EI correlated with all three cognitive tasks, SF showed no relationship with any.

According to Table 4.4, Chinese adolescents performed worse than British adolescents of the same age and pubertal stages on all ToM tasks, but scored higher on the working memory task. Chinese adolescents also reported higher scores on the perspective taking cognitive empathy scale.

Table 4.2. Age and average scores for all measures and split by gender for Chinese adolescents.

	All		Males		Females		Male – Female Difference	
	Mean (SD)	N	Mean (SD)	N	Mean (SD)	N	<i>t</i> (df)	Cohen's <i>d</i>
Age (years)	13.89 (2.07)	96	13.79 (2.10)	43	13.98 (2.07)	53	0.45 (94)	0.09
Puberty	2.56 (0.77)	96	2.38 (0.69)	43	2.70 (0.81)	53	2.07 (94)*	0.42
SSM	6.58 (1.74)	90	6.23 (1.83)	39	6.84 (1.64)	51	1.67 (88)	0.36
SSP	5.58 (1.92)	90	5.49 (1.97)	39	5.65 (1.90)	51	0.39 (88)	0.08
SF	8.45 (2.17)	86	8.34 (2.22)	37	8.53 (2.16)	49	0.39 (84)	0.09
EI	14.26 (2.81)	96	13.67 (3.08)	43	14.74 (2.52)	53	1.86 (94)	0.38
FI	4.05 (1.48)	96	4.16 (1.59)	43	3.96 (1.39)	53	-0.66 (94)	0.14
WM	14.91 (2.00)	88	14.66 (2.27)	38	15.10 (1.76)	50	0.99 (67.97)	0.24
Verbal ability	28.01 (8.12)	89	27.05 (8.56)	39	28.76 (7.77)	50	0.99 (87)	0.21
Matrix	15.96 (4.17)	82	15.38 (3.69)	37	16.44 (4.52)	45	1.15 (80)	0.26
PT	17.65 (4.38)	96	17.53 (4.45)	43	17.74 (4.36)	53	0.22 (94)	0.05
FS	16.13 (5.03)	96	15.05 (4.86)	43	17.00 (5.04)	53	1.92 (94)	0.40
FAS	4.70 (1.83)	96	4.60 (2.03)	43	4.77 (1.67)	53	0.45 (94)	0.09

* $p < .05$ ** $p < .01$ *** $p < .001$. Equal variances could not be assumed for working memory scores.

Table 4.3 Correlations between ToM and potential predictors in Chinese adolescents.

	Age	Puberty	SSM	SF	EI	WM	Verbal	Matrix	PT	FS	FAS
Age	-										
<i>N</i>											
Puberty	.836***	-									
<i>N</i>	96										
SSM	.094	.064	-								
<i>N</i>	90	90									
SF	.341**	.339***	-.072	-							
<i>N</i>	86	86	86								
EI	.363***	.335***	.192	.188	-						
<i>N</i>	96	96	90	86							
WM	.381***	.338***	.278**	.187	.324**	-					
<i>N</i>	88	88	88	84	88						
Verbal	.486***	.398***	.393***	.193	.379***	.399***	-				
<i>N</i>	89	89	89	85	89	87					
Matrix	.351**	.285**	.289**	.182	.236*	.359***	.359***	-			
<i>N</i>	82	82	82	78	82	81	82				

	Age	Puberty	SSM	SF	EI	WM	Verbal	Matrix	PT	FS	FAS
PT	.190*	.037	.122	.097	.123	.197*	.272*	.171	-		
<i>N</i>	96	96	90	86	96	88	89	82			
FS	.252*	.185	.395***	.164	.251*	.187	.370***	.302**	.118	-	
<i>N</i>	96	96	90	86	96	88	89	82	96		
FAS	-.095	-.055	.121	.040	.185*	.151	.082	.049	.151	.042	-
<i>N</i>	96	96	90	86	96	88	89	82	96	96	
p < .05 ** p < .01 *** p < .001											

Table 4.4 Age and average scores for all measures for Chinese and British adolescents.

	Chinese		UK		Chinese-UK Difference	
	Mean (SD)	N	Mean (SD)	N	<i>t</i> (df)	Cohen's <i>d</i>
Age (years)	13.89 (2.07)	96	14.10 (1.86)	109	0.756 (203)	0.11
Puberty	2.56 (0.77)	96	2.65 (0.83)	97	0.814 (191)	0.12
SSM	6.58 (1.74)	90	8.02 (1.74)	108	5.803 (196)***	0.83
SSP	5.58 (1.92)	90	6.51 (2.01)	108	3.312 (196)**	0.47
SF	8.45 (2.17)	86	9.16 (1.59)	104	2.548 (152.28)*	0.41
EI	14.26 (2.82)	96	17.96 (2.62)	102	9.566 (196)***	1.37
FI	4.05 (1.48)	96	4.68 (1.46)	53	2.996 (196)***	0.43
WM	14.91 (2.00)	88	11.62 (2.10)	99	-10.94 (185)***	1.61
PT	17.65 (4.38)	96	15.19 (4.82)	77	-3.497 (171)***	0.53
FS	16.13 (5.03)	96	17.05 (5.55)	77	1.145 (171)	0.18
FAS	4.70 (1.83)	96	6.58 (1.63)	96	7.531 (190)***	1.09

* $p < .05$ ** $p < .01$ *** $p < .001$. Equal variances could not be assumed for SF scores.

4.4.3 ToM performance across age in Chinese adolescents

4.4.3.1 Strange stories performance

Hierarchical regression reported that age ($p = .776$), gender ($p = .550$), their interaction ($p = .755$) and FAS ($p = .274$) did not have a significant effect on SS performance, $F(4, 85) = 0.959$, Adjusted $R^2 = -.002$, $p = .435$.

Thus regression analysis was performed using potential cognitive predictors of SS alone and for both genders together (Table 4.5). Non-significant variables were removed using backwards elimination (matrix reasoning, $p = .334$; working memory, $p = .159$).

Table 4.5 Predictors of SS performance in Chinese adolescents.

	B	SE B	β	R^2
<i>Model 1</i>				<i>.107*</i>
Constant	-3.299	1.294		
Verbal ability	0.035	0.025	.172	
Working memory	0.110	0.096	.140	
Matrix reasoning	0.045	0.046	.115	
<i>Final model</i>				<i>.101**</i>
Constant	-1.829			
Verbal ability	0.065	0.021	.317**	

* $p < .05$ ** $p < .01$ *** $p < .001$

The final model contained only verbal ability, $F(1, 88) = 9.726$, Adjusted $R^2 = .090$, $p = .0025$ (Table 4.5).

4.4.3.2 Silent films performance

4.4.3.2.1 Gender differences in SF performance across age in Chinese

adolescents

Table 4.6 Age and gender effects on Chinese SF performance.

	B	SE B	β	R ²	ΔR^2
<i>Step 1</i>				.123*	
Constant	3.931	1.429			
FAS	0.099	0.134	.077		
Age	0.079	0.024	.349***		
Gender ¹	0.072	0.455	.016		
<i>Step 2</i>				.124*	.001
Constant	4.395	2.011			
FAS	0.093	0.136	.073		
Age	0.070	0.035	.310 ^a		
Gender	-0.726	2.463	-.228		
Age*Gender	0.016	0.048	.252		
<i>Final model</i>				.116**	
Constant	3.214	1.591			
Age	0.371	0.112	.341**		

¹ Males were coded as 0 while females were coded as 1.

^a $p = .051$ * $p < .05$ ** $p < .01$ *** $p < .001$

At Step 1, only age significantly predicted SF performance. At the second step, the interaction between age and gender did not significantly contribute to the model (Table 4.6). Age*gender ($p = .743$), gender ($p = .875$), as well as FAS ($p = .445$) were removed through backwards elimination. In the final model, age alone predicted SF performance, accounting for 10.6% of the variance, $F(1, 84) = 11.034$, Adjusted $R^2 = .106$, $p = .0013$. Adding in cognitive predictors in the second set of analysis did not significantly improve the model ($\Delta R^2 = .020$, $p =$

.668). Verbal ability ($p = .802$), matrix reasoning ($p = .565$), and working memory ($p = .416$) were removed using backwards elimination, and the final model in Table 4.6 containing only age was retained.

4.4.3.3 Emotional inference performance

4.4.3.3.1 Gender differences in EI performance across age in Chinese

adolescents

Table 4.7 Age and gender effects on Chinese EI performance.

	B	SE B	β	R ²	ΔR^2
<i>Step 1</i>				<i>.204***</i>	
Constant	-6.591	1.843			
FAS	0.339	0.135	.236*		
Age	0.088	0.025	.335***		
Gender ¹	1.059	0.491	.201*		
<i>Step 2</i>				<i>.216***</i>	<i>.012</i>
Constant	-8.273	2.043			
FAS	0.357	0.135	.248*		
Age	0.121	0.037	.458**		
Gender	3.969	2.515	.754		
Age*Gender	-0.058	0.049	-.582		

¹ Males were coded as 0 while females were coded as 1.

* $p < .05$ ** $p < .01$ *** $p < .001$

At Step 1, age, gender and FAS significantly predicted EI performance. The interaction between age and gender did not significantly contribute to the model (Table 4.7), and was thus removed ($p = .241$). Hence, the initial model at Step 1 was retained, which accounted for 17.8% of the variance, $F(3,92) = 7.856$, Adjusted $R^2 = .178$, $p < .001$.

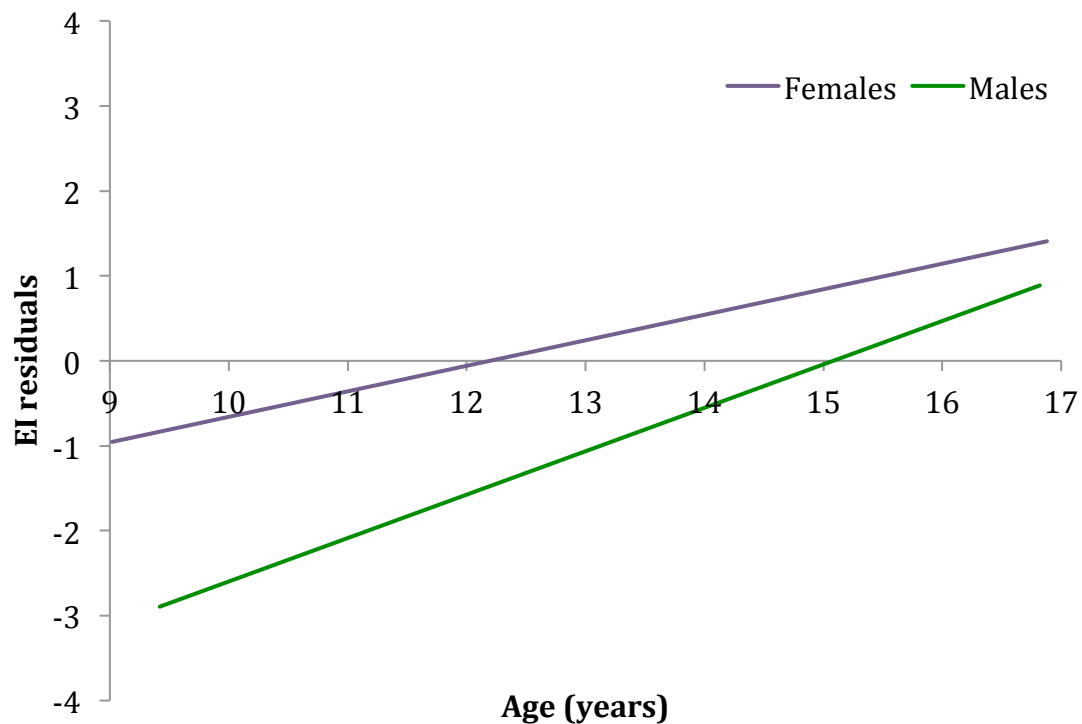


Figure 4.1 Regression lines for EI residuals across age for Chinese males and females.

Figure 4.1 illustrates the cross-sectional developmental trajectories in EI performance for males and females separately. While both showed improvements across age, males performed worse overall.

4.4.3.3.2 Cognitive predictors of EI in Chinese adolescents

Across the whole Chinese sample, none of the cognitive measures that were initially correlated with EI significantly predicted performance after accounting for age, gender, and FAS, and were thus removed through backwards elimination (matrix reasoning, $p = .853$; working memory, $p = .473$; verbal ability, $p = .324$). Age, gender and FAS alone predicted EI performance (Table 4.7).

Given differences in gender on EI performance, analyses of potential cognitive predictors were also conducted for each gender separately.

Cognitive predictors of EI in Chinese female adolescents

Table 4.8 Predictors of EI performance in Chinese females.

	B	SE B	β	R ²	ΔR^2
<i>Step 1</i>				.101	
Constant	-6.113	3.139			
Age	0.444	0.208	.314		
FAS	0.059	0.280	0.31		
<i>Step 2</i>				.149	.048
Constant	-7.688	3.810			
Age	0.129	0.322	.091		
FAS	-0.036	0.297	-.019		
Verbal ability	0.034	0.073	.101		
Matrix reasoning	0.030	0.101	.051		
Working memory	0.333	0.282	.229		
<i>Final model</i>				.119*	
Constant	-6.966	2.981			
Working memory	0.499	0.196	.344*		

* $p < .05$ ** $p < .01$ *** $p < .001$

At Step 1, neither age nor FAS predicted EI performance. Including the cognitive predictors at Step 2 did not significantly improve the model either. In the final model, only working memory predicted EI ability in Chinese females, $F(1,48) = 6.462$, Adjusted $R^2 = .100$, $p < .05$ (Table 4.8). Items removed through backwards elimination were FAS = .903, matrix reasoning ($p = .747$), age ($p = .800$), and verbal ability ($p = .430$).

Table 4.9 Predictors of EI performance in males.

	B	SE B	β	R ²	ΔR^2
<i>Step 1</i>				.369***	
Constant	-14.076	3.323			
Age	0.737	0.211	.488**		
FAS	0.692	0.217	.447**		
<i>Step 2</i>				.390**	.021
Constant	-14.618	3.856			
Age	0.722	0.233	.478**		
FAS	0.671	0.228	.433**		
Verbal ability	0.055	0.055	.148		
Matrix reasoning	-0.028	0.123	-.035		
Working memory	-0.017	0.207	-.014		

* $p < .05$ ** $p < .01$ *** $p < .001$

Including potential cognitive predictors at Step 2 did not significantly account for more variance. Hence, the model at Step 1 was retained as the final model, with age and FAS predicting EI ability in Chinese males, $F(2,33) = 9.651$, Adjusted $R^2 = .331$, $p < .001$ (Table 4.9). Items removed through backwards elimination were working memory ($p = .934$), matrix reasoning ($p = .683$), and verbal ability ($p = .496$).

4.4.4 Effects of puberty on ToM in Chinese adolescents

Using puberty to predict ToM performance produced largely similar results to age in Chinese adolescents. There was no gender by puberty interaction for the SF or EI tasks (SF: $p = .468$; EI: $p = .358$) in the first set of analyses, although puberty significantly predicted ToM performance even when controlling for gender and FAS, similar to age (SF: $p = .0013$; EI: $p = .0117$).

For SF, the final model contained only puberty, and accounted for a similar amount of variance as age, $F(1,84) = 10.890$, $R^2 = .115$, Adjusted $R^2 = .104$, $p = .0014$. For EI, puberty somewhat mediated the effect of gender ($p = .098$) that was found with age (Table 4.7) at the first step, which may be due to females reporting significantly higher pubertal scores than males within the same age range (Table 4.2). At the second step, the cognitive predictors did not contribute significant extra variance ($\Delta R^2 = .041$; $p = .303$). After backwards elimination of non-significant predictors (matrix: $p = .715$; working memory: $p = .321$; gender: $p = .173$; verbal ability: $p = .093$), the final model contained only puberty ($p = .0200$) and FAS ($p = .0038$), $F(2,93) = 6.834$, $R^2 = .128$, Adjusted $R^2 = .109$, $p = .0017$.

4.4.5 Cross-cultural analysis of adolescent ToM performance

4.4.5.1 SS performance across cultures

Table 4.10. Culture and age effects on SS performance.

	B	SE B	β	R ²	ΔR^2
<i>Model 1</i>					
<i>Step 1</i>				.104***	
Constant	-1.240	0.726			
FAS	0.028	0.072	.032		
Gender ¹	0.387	0.241	.114		
Culture ²	0.983	0.279	.290***		
Age	0.006	0.012	.038		
<i>Step 2</i>				.110***	.006
Constant	-0.593	0.917			
FAS	0.028	0.072	.032		
Gender	0.381	0.241	.112		
Culture	-0.401	1.231	-.118		
Age	-0.006	0.016	-.038		
Culture*age	0.028	0.024	.422		
<i>Model 2</i>				.096***	
Constant	-0.597	0.170			
Culture	0.785	0.331	.236*		
Siblings	0.169	0.175	.095		
<i>Final model</i>				.098**	
Constant	-0.572	0.168			
Culture	1.049	0.228	0.312***		

¹ Males were coded as 0 while females were coded as 1. ² China was coded as 0 and UK was coded as 1. * $p < .05$ ** $p < .01$ *** $p < .001$

At Step 1 for Model 1, only culture significantly predicted SS performance. Culture*age did not significantly improve the model at Step 2, $F(5,179) = 4.438$, Adjusted $R^2 = .085$, $p < .001$. FAS ($p = .743$), culture*age ($p = .297$), age ($p = .649$),

and gender ($p = .176$) were removed through backwards elimination. In Model 2, Siblings did not significantly predict SS performance, nor did it mediate the effect of culture, $F(2,176) = 9.311$, Adjusted $R^2 = .085$, $p < .001$. It was thus removed ($p = .337$). The final model contained only culture, $F(1,196) = 21.208$, Adjusted $R^2 = .093$, $p < .001$ (Table 4.10), with British adolescents outperforming the Chinese.

Table 4.11 Predictors of SS performance in UK and Chinese adolescents.

	B	SE B	β	R^2	ΔR^2
<i>Step 1</i>				<i>.089***</i>	
Constant	-0.513	0.371			
Culture ¹	0.982	0.240	.298***		
<i>Step 2</i>				<i>.139***</i>	<i>.050**</i>
Constant	-3.056	1.003			
Culture	0.868	0.410	.263*		
Verbal ability	0.037	0.016	.218*		
Matrix reasoning	-0.006	0.014	-.036		
Working memory	0.079	0.062	.126		
<i>Final model</i>				<i>.146***</i>	
Constant	-2.598	0.638			
Culture	0.495	0.283	.147 ^a		
Verbal ability	0.046	0.014	0.275***		

¹China was coded as 0 and UK was coded as 1.

^a $p < .10$ * $p < .05$ ** $p < .01$ *** $p < .001$

Including cognitive predictors significantly contributed additional variance at Step 2. Moreover, verbal ability partly mediated the effect of culture. According to the final model, $F(2,190) = 16.223$, Adjusted $R^2 = .137$, $p < .001$ (Table 4.11), verbal ability and culture ($p = .082$) predicted SS performance. Matrix reasoning ($p = .661$) and working memory ($p = .233$) were removed from the model through backwards elimination.

4.4.5.2 SF performance across cultures

Table 4.12 Culture and age effects on SF performance.

	B	SE B	β	R ²	ΔR^2
<i>Model 1</i>					
<i>Step 1</i>				.117***	
Constant	5.673	0.864			
FAS	-0.030	0.082	-.031		
Gender ¹	0.244	0.275	.064		
Culture ²	0.772	0.317	.202*		
Age	0.055	0.072	.280***		
<i>Step 2</i>				.125***	.008
Constant	4.813	1.105			
FAS	-0.027	0.082	-.027		
Gender	0.249	0.274	.065		
Culture	2.518	1.437	.660 ^a		
Age	0.071	0.019	.365***		
Culture*age	-0.035	0.028	-.472		
<i>Model 2</i>					
				.113***	
Constant	4.335	1.068			
Culture	0.741	0.393	.193 ^a		
Age	0.291	0.074	.286***		
Siblings	0.016	0.210	.008		
<i>Final model</i>					
				.117***	
Constant	4.402	0.991			
Culture	0.725	0.262	.190**		
Age	0.286	0.069	.286***		

¹ Males were coded as 0 while females were coded as 1. ² China was coded as 0 and UK was coded as 1. ^a $p < .10$ * $p < .05$ ** $p < .01$ *** $p < .001$

At Step 1, culture and age significantly predicted SF performance.

Culture*age did not significantly improve the model at Step 2, $F(5,172) = 4.894$,

Adjusted $R^2 = .099$, $p < .001$. FAS ($p = .743$), gender ($p = .382$), and culture*age ($p = .227$) were removed through backwards elimination. In Model 2, $F(3,167) = 7.116$, Adjusted $R^2 = .097$, $p < .001$, some effect of culture was mediated ($p = .061$) by Siblings. However, Siblings did not significantly predict SF performance ($p = .938$), and was thus removed. The final model contained only age and culture, $F(2,187) = 12.399$, Adjusted $R^2 = .108$, $p < .001$ (Table 4.12), indicating SF performance continued to improve across adolescence in both cultures, and that British adolescents outperformed the Chinese (Figure 4.2).

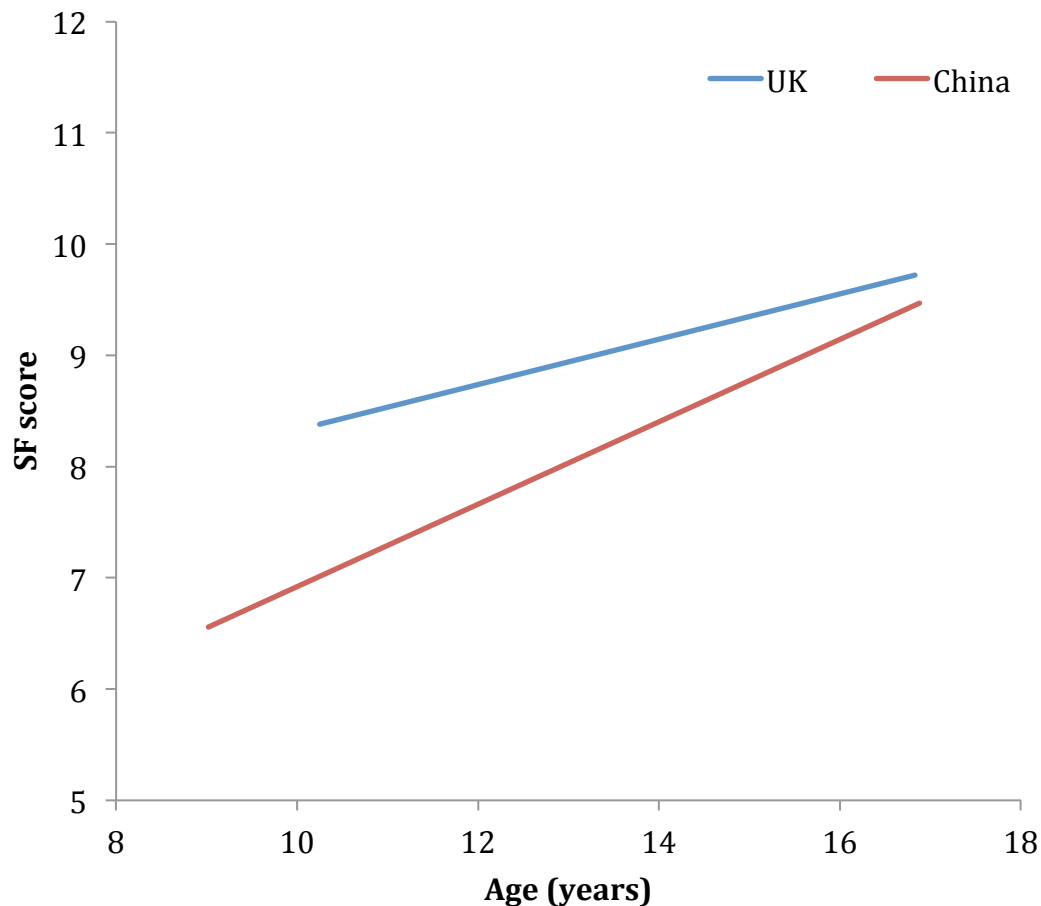


Figure 4.2 Regression lines for SF performance across age for British and Chinese adolescents.

Table 4.13 Predictors of SF performance in UK and Chinese adolescents.

	B	SE B	β	R ²	ΔR^2
<i>Step 1</i>				<i>.084***</i>	
Constant	4.989	1.155			
Culture ¹	0.749	0.282	0.199**		
Age	0.246	0.079	0.233**		
<i>Step 2</i>				<i>.134***</i>	<i>.051*</i>
Constant	2.634	1.394			
Culture	0.605	0.484	0.161		
Age	0.137	0.087	0.130		
Verbal ability	0.031	0.019	0.161		
Matrix reasoning	0.017	0.016	0.094		
Working memory	0.116	0.074	0.163		
<i>Final model</i>				<i>.138***</i>	
Constant	5.383	1.108			
Culture	1.277	0.350	0.337***		
Age	0.238	0.072	0.237***		
Working memory	0.149	0.068	0.208*		

¹China was coded as 0 and UK was coded as 1. * $p < .05$ ** $p < .01$ *** $p < .001$

Including cognitive predictors significantly contributed additional variance at Step 2, although none of the variables individually were significant, and the effect of culture was mediated through these variables. Matrix reasoning ($p = .266$) and verbal ability ($p = .131$) were removed from the model through backwards elimination. According to the final model, $F(2,176) = 9.365$, Adjusted $R^2 = .123$, $p < .001$ (Table 4.13), culture, age, and working memory predicted SF performance across both cultures. The effect of working memory was likely driven by the British sample (Chapter 3).

4.4.5.3 EI performance across cultures

Table 4.14 Culture and age effects on EI performance.

	B	SE B	β	R ²	ΔR^2
<i>Model 1</i>					
<i>Step 1</i>				.345***	
Constant	-6.282	1.118			
FAS	0.176	0.109	.111		
Gender ¹	0.761	0.375	.122*		
Culture ²	2.915	0.426	.470***		
Age	0.069	0.095	.224***		
<i>Step 2</i>				.346***	.001
Constant	-6.737	1.399			
FAS	0.178	0.109	.113		
Gender	0.765	0.376	.123*		
Culture	3.914	1.891	.631*		
Age	0.078	0.025	.253**		
Culture*age	-0.020	0.037	-.168		
<i>Model 2</i>				.312***	
Constant	-5.981	1.350			
Gender	0.561	0.374	.094		
Culture	3.527	0.533	.592***		
Age	0.293	0.095	.193**		
Siblings	-0.300	0.280	-.096		
<i>Final model</i>				.335***	
Constant	-6.623	1.294			
Gender	0.683	0.357	.112 ^a		
Culture	3.195	0.357	0.526***		
Age	0.332	0.091	0.220***		

¹ Males were coded as 0 while females were coded as 1. ² China was coded as 0 and UK was coded as 1. ^a $p < .10$ * $p < .05$ ** $p < .01$ *** $p < .001$

At Step 1, culture, age, and gender significantly predicted EI performance. Culture*age did not significantly improve the model at Step 2, $F(5,180) = 19.054$, Adjusted $R^2 = .328$, $p < .001$. Culture*age ($p = .588$) and FAS ($p = .107$) were removed through backwards elimination. In Model 2, $F(4,177) = 20.083$, Adjusted $R^2 = .312$, $p < .001$, Siblings did not significantly mediate the effect of culture; neither was there a significant effect of siblings. As such, Siblings was removed ($p = .341$). The final model contained only gender ($p = 0.057$), age and culture, $F(3,194) = 32.614$, Adjusted $R^2 = .325$, $p < .001$ (Table 4.14), indicating EI performance continued to improve across adolescence in both cultures, but that British adolescents outperformed the Chinese (Figure 4.3). Females also slightly outperformed males across both cultures (although this was a weak effect).

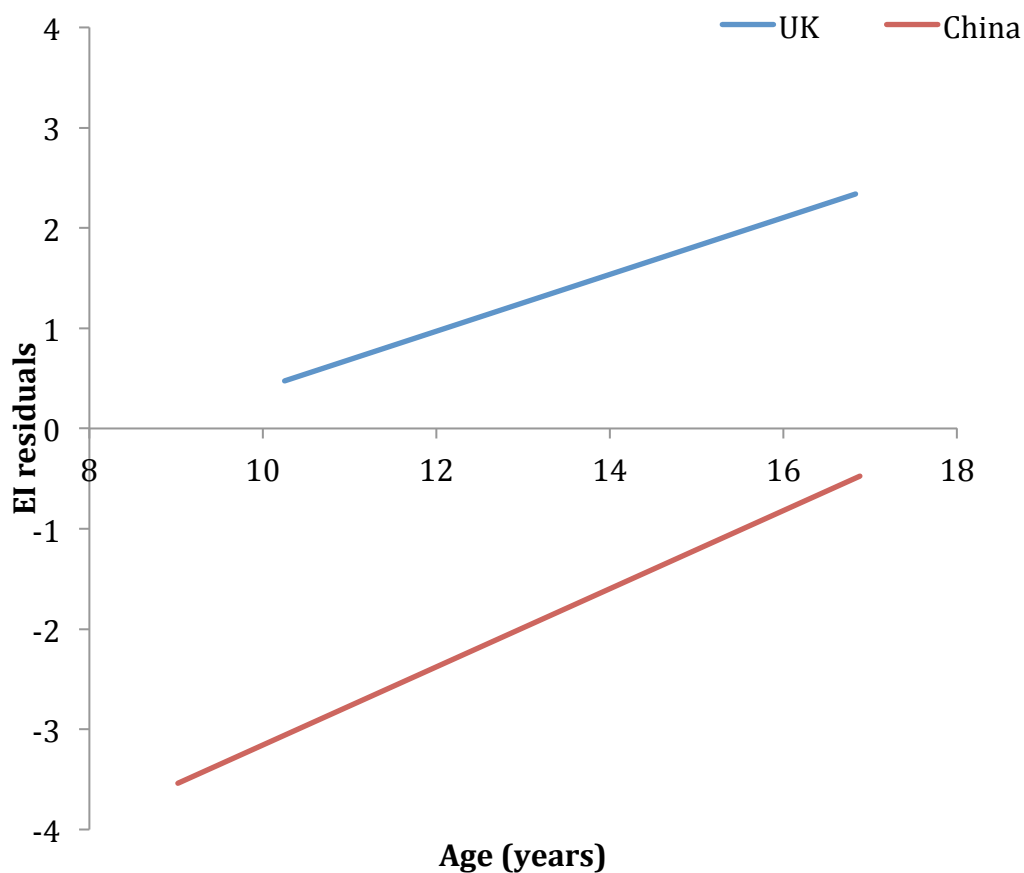


Figure 4.3 EI performance across age for British and Chinese adolescents.

Table 4.15 Predictors of EI performance in UK and Chinese adolescents.

	B	SE B	β	R ²	ΔR^2
<i>Step 1</i>				.326***	
Constant	-7.823	1.609			
Gender	0.724	0.399	.117 ^a		
Culture ¹	3.355	0.401	.542***		
Age	0.407	0.110	.239***		
<i>Step 2</i>				.356***	.031
Constant	-8.897	1.954			
Gender	0.697	0.394	.113 ^a		
Culture	2.994	0.694	.483***		
Age	0.255	0.122	.150*		
Verbal ability	0.066	0.028	.203*		
Matrix reasoning	-0.007	0.023	-.023		
Working memory	0.112	0.106	.095		
<i>Final model</i>				.360***	
Constant	-8.363	1.447			
Gender	0.697	0.368	.110 ^a		
Culture	2.526	0.482	.410***		
Age	0.249	0.106	.0155*		
Verbal ability	0.066	0.026	.0209*		

¹ China was coded as 0 and UK was coded as 1.

^a $p < .10$ * $p < .05$ ** $p < .01$ *** $p < .001$

Including potential cognitive predictors did not significantly contribute additional variance at Step 2, although verbal ability significantly mediated some of the effect of age. Matrix reasoning ($p = .759$) and working memory ($p = .229$) were removed from the model through backwards elimination. According to the final model, $F(4,181) = 25.474$, Adjusted $R^2 = .346$, $p < .001$ (Table 4.15), gender ($p = .067$), culture, age, and verbal ability predicted EI performance.

To check that culture by age interactions were not masked by significant cultural differences in performance, raw scores on each task were normalised into T-scores within each culture to eliminate the between-culture difference. I then reran the regression models to examine culture by age interactions using T-scores for each task. However, still no significant culture by age interaction emerged for any ToM task (SS: $p = .685$, SF: $p = .520$, EI: $p = .630$).

4.5 Discussion

This study aimed to examine the cross-sectional development of cognitive (Strange Stories and Silent Films) and affective theory of mind (Emotional Inference) in Chinese adolescents, and to compare this to that of an age matched sample of British adolescents (from Chapter 3). Age and culture effects were investigated while accounting first for potential effects of gender and siblings and second for the cognitive abilities that may underlie ToM. Finally, puberty, instead of age, was used to predict ToM performance.

While Chinese adolescents reported lower performance than British adolescents in general for all three ToM tasks, both cognitive (SF) and affective ToM (EI) were shown to improve cross-sectionally across adolescence in China. Similar to the British sample, SS did not improve across age in Chinese adolescents, even though there was no ceiling effect in this sample. There were no gender differences in performance on the cognitive ToM tasks, but Chinese females outperformed males on the EI task when age and SES were accounted for. Interestingly, puberty predicted ToM performance in a similar fashion to age in Chinese adolescents, but it mediated the effect of gender found on EI performance. Across the whole sample, number of siblings did not significantly predict ToM performance, nor did it fully mediate the effect of culture. The lack

of culture by age interaction indicates that development follows a similar path across both cultures. Curiously, none of the ToM tasks correlated with one another, although the EI and SS both correlated with a cognitive empathy scale, i.e. the FS.

4.5.1 Cognitive ToM development in Chinese adolescence

Cognitive theory of mind, as measured by SF, was shown to improve cross-sectionally in Chinese adolescents, in line with existing literature on adolescents from Western cultures (Chapter 3; Dumontheil et al., 2010a). Age effects remained even when accounting for gender and SES, as measured by the FAS. Contrary to the British sample (Chapter 3), there were no gender differences in the developmental trajectory of SF performance, nor were there gender differences in overall scores. This could be because both female and male Chinese adolescents found the task similarly difficult in general, and thus no gender differences emerged. Indeed, Chinese adolescents performed worse than the British overall. Similar to British males (but not females), none of the domain general cognitive predictors accounted for variance in SF performance across the whole sample of Chinese adolescents. This suggests that improvements across age on SF for Chinese adolescents could be due to factors that were not investigated in this study, for example, response inhibition, which has been shown to predict ToM (Carlson & Moses, 2001).

Similar to the British sample, there was no improvement in Strange Stories performance across age in Chinese adolescents. However, while this was attributed to ceiling effects in Chapter 3, there were neither marked ceiling nor floor effects in the Chinese sample for SS. In fact, only 1.11% scored at ceiling and distribution of scores were normal. The lack of developmental changes in SS

performance in both cultures is thus puzzling. It could be that distinct reasons underlie the lack of age effects in each culture. While ceiling effects may have accounted for the British sample, it may be that the SS was not culturally appropriate for this Chinese sample.

4.5.2 Affective ToM development in Chinese adolescence

Affective theory of mind, as measured by EI, was shown to improve cross-sectionally with age in Chinese adolescents, in line with studies on adolescents from Western cultures (Chapter 3; Vetter et al., 2013a). Age effects remained even when accounting for potential gender and SES effects, both of which were significant. Chinese female adolescents outperformed males and those from higher SES performed better. The effect of SES is in line with past research that shows SES is related to a wide range of cognitive, social emotional, and health outcomes (Bradley & Corwyn, 2002; White, 1982). The same effect of SES was not found in the British sample (Chapter 3), although it is important to note that the Chinese sample was from a significantly lower SES background (Table 4.4). It is possible that affluence plays a stronger role in social cognitive development in particular for those from lower SES backgrounds, but that past a certain threshold, this may not exert as much of an influence. Further, Chinese adolescents reported a wider range of FAS scores than the British, as indicated by a slightly larger standard deviation (China: $SD = 1.83$; UK: $SD = 1.63$), and hence the effect may be driven by the larger variance in SES present within the Chinese sample.

Results suggest that female adolescents in China may have earlier maturation of affective ToM ability than males. The lack of interaction between gender and age suggest that female superiority persists across adolescence, or at

least until the age of 17 years (the oldest age group tested by this study). In contrast to the British sample (who trend towards a widening gender gap across age), regression lines in Figure 4.1 indicate a slightly (but not significantly) steeper slope for males than females, suggesting a narrowing gender gap with age in Chinese adolescents on affective ToM. However, the British sample represented a wider age range (until 20 years) than the Chinese sample (until 17 years). A wider age range (in particular older age groups) thus needs to be examined to determine whether the gap between Chinese males and females' performance may be closed or widened in the later adolescent years.

Further analysis by gender revealed gender specific predictors of affective ToM development across age in this sample of Chinese adolescents. First, the age effect in Chinese males was robust, and remained even when controlling for and potential cognitive predictors, none of which significantly accounted for variance in EI performance, and for SES, which remained significant. In Chinese females, performance on the EI was fully accounted for by working memory, and not age. Again, the lack of age effect could be due to the sample size being too small to detect it ($N = 53$ for females only). Notably, the initial correlation between EI and age in Chinese females was nearly significant ($r = .267, p = .054$). Finally, puberty somewhat mediated the effect of gender, suggesting that female superiority in affective ToM could be related to biological development. However, this result should be interpreted with caution, as females reported significantly more advanced pubertal stages compared to males within the same age range. Taken together, results suggest that affective ToM continues to improve across adolescence in China, with females faring better than males, and possibly gender specific markers driving development.

4.5.3 Theory of Mind across Eastern and Western adolescents

Adolescents from both cultures followed similar cross-sectional developmental trajectories for both cognitive and affective ToM, but Chinese adolescents reported lower scores than British adolescents for all three ToM tasks (although for SF and SS this was partially mediated by cognitive predictors). Conversely, Chinese adolescents reported better working memory scores than their British counterparts (Table 4.4). This pattern of results is consistent with previous literature that shows superiority in executive function in Chinese children (Sabbagh et al., 2006) but a lag in ToM ability (Wang et al., under submission). However, it stands in contrast to studies that have found no difference in ToM abilities between Chinese and Western children (Sabbagh et al., 2006), and a Chinese advantage in perspective taking abilities in adults (Wu & Keysar, 2007).

Several reasons could account for the disparity in performance across cultures, none of which are mutually exclusive. First, lower ability to reason about other people's mental states, or in the case of the tasks used in this study, about characters' mental states, may be due to a possibly weakened self-other distinction found in Chinese adolescents, in accordance to the Attentional Hypothesis, and in contrast to the Representational Hypothesis, which posited superior social cognitive skills due to higher perspective taking tendencies in East Asians (Wu & Keysar, 2007). According to Chapter 2, Chinese adolescents were indeed characterised by significantly more interdependent self-construals than British adolescents, which has been consistently found to be accompanied by a weakened self-other distinction, a robust effect found even on a neural level (Zhu et al., 2007).

Interestingly, while Chinese adolescents reported higher perspective-taking tendencies than the British, as measured by the PT scale, this did not correspond to better ToM abilities, nor did PT significantly predict Chinese ToM performance on any task. Tentatively, this might provide reconciliation to Wu and Keysar's two competing theories, by suggesting that although interdependent Chinese adolescents may be more likely to overtly consider others in everyday social situations (i.e. self-report scores on the PT), their weaker self-other distinction may still lead to inaccurate attribution of others' mental states (i.e. performance on ToM tasks).

Alternatively, the social pressures that may drive development of ToM skills during adolescence in the West (Crone & Dahl, 2012), which are not so pronounced in the East, may have led to the lower performance in ToM found in Chinese adolescents overall. The lack of culture by age interaction suggests that development follows similar trajectories across cultures, but it could be that the age range here (9 to 17 years) was too restricted for the interaction to emerge. Given past studies that suggest superior ToM abilities in Chinese adults (Wu & Keysar, 2007), it may be that Chinese individuals overtake their Western counterparts only later in life, possibly when they establish their independent social groups at University or when they start work.

However, it is an important point of consideration that studies discussed above utilised distinct tasks that may measure different aspects of ToM (mental state reasoning vs. visual perspective taking). In particular, the task used by Wu and Keysar (2007) in adults required an attribution of knowledge (objects on a shelf) to others, rather than more abstract mental states such as beliefs, intentions, and emotions, such as is present in tasks used here. It is possible that

the different aspects of ToM are shaped and elicited in a culture-bound fashion. This is in line with research that reliably found young children from collectivistic societies such as China and Iran acquired the basic ability to attribute different knowledge events to others before different ideas and opinions, while those from Western societies report the opposite pattern (Wellman et al., 2006; Shahaeian, Nielsen, Peterson, & Slaughter, 2014; Shahaeian, Nielsen, Peterson, Aboutalebi, & Slaughter, 2014).

There also exist linguistic differences between English and Mandarin that may have led to differences in scores on these tasks, all of which relied on verbal ability (Tardiff & Wellman, 2000). For example, many verbs in the Chinese language are polysemous, meaning they often carry several different meanings, at times both mentalising and non-mentalising. These linguistic differences might have led to arbitrary scoring practices, in particular for the SS and SF, for which scoring was often distinguished by the presence or absence of mental state terms, such as ‘found’ – mentalising, vs. ‘seen’ – non-mentalising. For example, the characters ‘发现’ – fa1xian4 – and ‘找到’ – zhao3dao4 – could be interpreted as ‘found’, ‘discovered’ – mentalising, or ‘located’, and ‘detected’ – non-mentalising. Moreover, the prevalence of idioms in the Chinese language (which were often used by this study’s sample of adolescents to answer questions), might have led to further ambiguity in scoring.

Furthermore, all ToM tasks used in this study was initially developed in English before being translated into Chinese. While careful steps were taking to maximise cultural validity of the tasks, there remains a possibility that the story-based social situations depicted in each of these tasks were not familiar to Chinese adolescents. For example, the characters portrayed in the SF were of

Caucasian descent, albeit from an era (1960's) that may not be familiar to today's Western adolescents either. However, clear culture-specific patterns of answers were found during the scoring process. For example, in a scene in the SF, a male character Harold was depicted as fanning a female character, Mildred, profusely as other people walked into the room, in order to "pretend she had fainted". The question that followed was "Why did Harold fan Mildred?" According to Devine and Hughes (2013)'s scoring scheme, the answers 'to pretend she was sick' or 'to deceive others' were scored at the maximum 2 points. However, a high number of answers from Chinese adolescents cited only the inappropriateness of their relationship as the intention behind the characters' action (e.g. 'afraid others would see that they are talking' or 'to because they are in a relationship'), which did not explicitly state the deceptive intent of their actions and thus was scored at 1 point accordingly (Devine & Hughes, 2013). It is possible that certain aspects of these social situations may have played a more salient role in the answers of Chinese adolescents simply because of its unfamiliarity and novelty (such as the taboo of a man being alone with a woman in a room), potentially masking an underlying understanding of mental states.

4.5.4 Limitations and future directions

This was the first study to map out cross-sectional development of cognitive and affective ToM across adolescence in China, showing that these continue to improve across age in a similar fashion to British adolescents. However, interpretation of results from this study is constrained by certain limitations. Apart from task confounds that may have elicited mean differences in performance across cultures, the fact that none of the ToM measures correlated with each other in the Chinese adolescent sample brings into question

the validity of these tasks at measuring aspects of the same construct. However, both EI and SS correlated with a self-report cognitive empathy scale, i.e. FS, in Chinese adolescents, which measures the extent to which individuals immerse themselves into a story, providing some evidence for validity (Shamay-Tsoory, 2011; Rogers et al., 2007). More naturalistic tasks that are able to circumvent both cultural and language differences are needed for future cross-cultural research on social cognitive development.

Finally, due to time constraints, this study did not examine the effects of other executive functions on ToM apart from working memory, such as response inhibition. Given the strong association between executive functions and ToM (Carlson & Moses, 2001; Davis & Pratt, 1995; Carlson, Moses, & Brenton, 2002; Vetter et al., 2013), and the cultural differences found in these abilities between the East and West (Sabbagh et al., 2006), further research on this area is warranted. Might response inhibition predict ToM abilities in both cultures, and might similar cultural differences in abilities exist? It would be interesting for future studies to map out more exhaustively the relationship between executive function and ToM abilities across different cultures.

4.6 Conclusion

This study found that both cognitive and affective ToM continued to develop across adolescence in China, with lower performance found in Chinese compared to British adolescents overall. Chinese females reported an advantage on affective ToM compared to males of the same age, but less so to males of similar pubertal stages. Cross-cultural differences in adolescent ToM ability may be due to differences in self-construal, distinctions between the linguistic structures of Mandarin and English, and/or arise from task artefacts, all of which

were developed in the West. More naturalistic tasks that circumvent these limitations are needed for cross-cultural research on social cognitive development. To address the issue of ecological validity, Chapter 5 explores the maturation of social understanding within the context of authentic adolescent peer networks across different cultures.

5. Impact of social reciprocity on cooperative investment in adolescence: a developmental study across two cultures

5.1 Abstract

Recent research highlights an increasing impact of social reciprocity on cooperative investments between mid to late adolescence, presumably driven by the continued development of social-cognitive skills and protracted maturation of responsible brain regions. However, the extent to which this social development is universal, or varies according to differing cultural expectations and experiences of adolescence is as yet little known. To answer this question, this Chapter investigated the extent to which social reciprocity predicted cooperative investment in adolescents from a Western and an Asian culture. To examine age trends, bidirectional social ties were mapped exhaustively in classes with students (mean class age 13 to 17 years) in the United Kingdom (5 classes, $N = 70$) and Malaysia (7 classes, $N = 147$) using an adapted social network paradigm, which assessed multiple aspects of peer relationships (Harrison et al., 2011). From this, a composite social tie strength score was obtained for each participant towards every network member and vice versa. The difference in reported social tie strength between a pair of network members was used as an empirical measure of relationship reciprocation. A modified Dictator Game (with one 'Dictator' and multiple recipients) played with all network members yielded a behavioural measure of cooperative investment. Multiple regression with quadratic assignment procedure (MRQAP), which takes into account the interdependence among observations in social network data, was employed to

assess the relationship between social ties and cooperative investment. Across age and culture, all adolescents invested more in individuals to whom they reported stronger ties. However, while social reciprocity predicted cooperative investment overall across both cultural samples, the predicted increase in the impact of social reciprocity on investment decisions with age was not found in either culture. Furthermore, there was also no cultural difference in the extent to which social reciprocity predicted investments in an age-matched sample, but there was a non-predicted cultural difference in the impact of social tie strength. Future research should examine a wider range of age groups to determine the age at which the impact of social reciprocity on cooperative investment begins to emerge and eventually stabilise.

5.2 Introduction

One notable social development that occurs during adolescence is that of prosociality, defined as voluntary behaviour that benefits others (Eisenberg, Lennon, & Roth, 1983; Eisenberg, 2007), accompanied by an increasingly nuanced understanding of social reciprocity (Burnett Heyes et al., 2015). Recent research has shown an age-associated increase in the impact of social reciprocity, i.e. how much another likes you given how much you like them, on strategic cooperative investments (Burnett Heyes et al., 2015). This may be driven by the continued development of perspective-taking or social-cognitive skills (Chapter 3; Dumontheil et al., 2010a; Vetter et al., 2013b), underpinned by the protracted maturation of responsible brain regions (Blakemore et al., 2007; Burnett et al., 2008), during adolescence. However, recent theories suggest that social development may also occur due to the gain in peer interactions and experience with age, or to facilitate behaviour consistent with societal

expectations that arise with increasing independence (Bagwell & Schmidt, 2011; Crone & Dahl, 2012; Blakemore & Mills, 2014). The extent to which these milestones in social development are universal, or vary according to differing cultural expectations and experiences of adolescence is increasingly becoming a focus of developmental research (Wang et al., 2015; Liu et al., 2008; Ahn & Miller, 2012; Hughes et al., 2014; Lecce & Hughes, 2010; Lewis et al., 2009; Sabbagh et al., 2006).

The few studies examining the development of social cognitive skills, such as advanced theory of mind (ToM), across different cultures, indicate continued maturation of these abilities during late childhood and adolescence (Wang et al., 2015; Chapter 4). However, the same studies suggest a delay or overall lower performance in non-Western children and adolescents. For example, Chinese adolescents reported lower performance on several social cognitive tasks, which involved making inferences about the emotions and the intentions of story or movie characters, compared with British adolescents (Chapter 4). However, this difference may be an artefact of the experimental paradigms not being ecologically valid in non-Western cultures. Importantly, all social cognitive tasks administered in these studies depicted Western-constructed social vignettes or videos (Devine & Hughes, 2013; Chapter 3), which were then translated into Chinese. Thus, the lower performance in Asian adolescents may simply be due to the lack of familiarity with these social situations. Using a more ecologically valid task that covers real-life authentic exchanges, might cultural differences in adolescent social development still be found?

A more nuanced empirical picture of social development may emerge when behaviour is investigated in the context of authentic, established

relationships. In authentic relationships, social interactions unfold across extended periods of time, and individuals gain long-term benefits of cooperation via future direct or indirect reciprocation from others (Gardner & Foster, 2008; Leimar & Hammerstein, 2001; 2010). Furthermore, during child and adolescent development, peer relationships provide a channel through which an individual is able to practise and refine complex social skills such as cooperation, competition, and compromise (Smollar & Youniss, 1982). Therefore, investigating social behaviour in the context of authentic peer relationships may enable not only more ecologically-valid assessments of social cognitive abilities, but may also show greater sensitivity to subtle changes within a developmental period, or across distinct cultures. To tap into differences in social development in a culturally sensitive manner, studies need to use paradigms that are able to quantify features of real-world peer relationships relevant to all cultures, and to relate these to controlled experimental measures of social behaviour.

A recently adapted quantitative social network paradigm (Dekker, Krackhardt, & Snijders, 2007) may represent such an ecologically valid way to tap into social development across different cultures. Burnett Heyes et al. (2015) adapted the Social Network Questionnaire (SNQ; Harrison, Sciberras, & James, 2011) to map real life social dynamics (social relationships and reciprocity within relationships) in mid to late British adolescents (14 to 17 year olds), along with an experimental measure of cooperative investment. In this study, adolescents from a real-life school-based social network anonymously completed the SNQ, which contained questions assessing feelings of closeness and companionship towards network peers. Responses from the SNQ were

summed to yield a continuous measure of the perceived strength of social ties linking pairs of individuals (dyads) within the network, calculated as In-link (how much someone likes you) and Out-link scores (how much you like someone), as well as the degree to which perceived social tie strength was reciprocated (Harrison et al., 2011). Adolescents were also required to distribute money or 'points' amongst themselves and other network members in a one-shot modified Dictator Game, which provided an experimental measure of cooperative investment. Using information derived from their social network, this study showed that while all adolescents donated more points to individuals they reported stronger ties with, only older adolescents additionally invested in those who *positively* reciprocated these ties, i.e. to those who liked the individual more than the individual liked them.

Presumably, the increasing impact of social reciprocity on cooperative investment decisions with age occurs due to protracted maturation in perspective taking or ToM abilities (Chapters 3 & 4; Dumontheil et al., 2010a; Vetter et al., 2013). Indeed, results from other studies that utilise Game Theory paradigms would suggest that children and adolescents increasingly take into account the perspectives and motives of others when making cooperative decisions across age (Almås et al., 2010; Güroğlu et al., 2009; van den Bos et al., 2010; Fett et al., 2014). However, it could also be that individuals in early to late adolescence already have the same level of social reciprocity understanding or perspective taking abilities, but that only older adolescents use this information when making cooperative investment decisions. To disentangle these two possibilities, an item on the explicit awareness of how much another network

member liked an individual could be included. Should the task tap into a developmental difference in the understanding of social reciprocity (and not just the propensity to use this information when making decisions), this explicit awareness should predict real-life In-link scores (how much someone reports liking you), and this relationship might be expected to increase across age. Nevertheless, by using a Game Theory paradigm in the context of real-life adolescent peer networks, this task represents an ecologically valid way to assess changes in social behaviour during adolescence (Burnett Heyes et al., 2015). As peer relationships assessed by this paradigm are authentic to the adolescent in any culture, this naturalistic task may be better able to circumvent potential cultural confounds than other story-based social cognitive tasks (Devine & Hughes, 2013; Chapters 3 & 4). **The first aim of the study was thus to replicate Burnett Heyes et al.'s (2015) developmental effects of reciprocity on cooperative investment in another UK sample, and to extend the investigation to 13 to 17 year old adolescent networks in Malaysia.**

5.2.1 Cultural differences in social reciprocity

Malaysia, a country located in South East Asia, is a culture that stands distinct from the UK as a collectivistic society, characterised by allocentric values such as relatedness (Watkins et al., 1998; Hofstede, 1980; Bochner, 1994; Markus & Kitayama, 1991; Markus, Mullaly & Kitayama, 1997; Oyserman, Coon, & Kemmelmeier; 2002). Similar to China (Chen et al., 1997) and their other Asian counterparts, strong traditional Asian values mean that Malaysian adolescents may experience stronger filial and academic obligations. Indeed, a study conducted on 209 Malaysian adolescents indicated academic issues as their

primary source of stress, followed by relationships at home, before relationships at school (Hashim, 2007). Watkins et al. (1998) also reported that Malaysians rated family values as highly important, relative to individualistic cultures such as the United States and Canada. As such, the social pressures faced in the West that may drive and shape social development in adolescents may not be as strongly felt in Malaysia. Very little is currently known about development in the social domain in Malaysian adolescents, but it may likely reflect similar levels to other Asian countries, such as China.

It is important to note here that Chapter 2 reported no difference in self-reported self-construal between Malaysian and British adolescents (who are the same sample investigated in this chapter). Indeed, Malaysian adolescents reported significantly higher independence than interdependence scores, contrary to expectations. However, self-report measures are often plagued with reporting bias (Donaldson, & Grant-Vallone, 2002) and may not reflect reality or real life decisions. As such, by examining the practical impact of social understanding on decision-making, the social network paradigm as described above would be well poised to tap into nuanced cultural differences in social cognition, should it be present. Using this task, might differences in adolescent social cognition be found across the different cultures of UK and Malaysia? To date, there has been no known study comparing social development between Malaysian and Western adolescents, or indeed, any known empirical study on adolescent social cognition in Malaysia. **Thus, the second aim of this study was to investigate whether, using an ecologically valid paradigm that takes into account authentic peer relationships, i.e. the social network questionnaire**

with the Dictator Game, there would be cultural differences in the impact of social reciprocity on cooperative investment in adolescence between the UK and Malaysia.

5.2.2 Individual differences in adolescent cooperative investment

A myriad of individual differences has also been shown to affect cooperative investment decision-making. Of particular note and relevance to this study are individual differences in prosociality and self-construal. In adults, higher prosociality has been shown to lead to higher cooperative investment to others. In particular, high scores on the Social Values Orientation Slider Measure (SVO Slider Measure; Murphy, Ackermann & Handgraaf, 2011) indicate a preference for prosocial decisions while low scores indicate a tendency towards competitive decision-making (Murphy et al., 2011; De Dreu & Boles, 1998; Roch, Lane, Samuelson, Allison, & Dent, 2000; Roch & Samuelson, 1997). Furthermore, past studies have shown that the interdependent self-construal predicts higher cooperative investments, i.e. high resource allocation to others, while the independent self-construal is thought to predict lower cooperation, i.e. low resource allocation to others (Cristina-Corina, 2012; Utz; 2004; Arnocky, Stroink, & DeCicco, 2007). However, many of these cooperative tasks were conducted with strangers (at times imaginary) and not real life peers. Furthermore, little is known about whether and how these individual differences might impact cooperative investment decisions in adolescents, either in the UK or in Malaysia. **As such, the third aim of this study was to examine the association between individual differences in prosociality and self-construal (independence and interdependence) with cooperative investment towards peers in adolescents across both cultures.**

5.2.3 Summary of goals and hypotheses of current study

This study sought to replicate Burnett Heyes et al.'s (2015) developmental effects of reciprocity on cooperative investment in another UK sample, and to extend the investigation to 13 to 17 year old adolescent networks in Malaysia, to establish whether or not the same developmental trends exist in across different cultures. Within the same age range, cultural differences in the impact of reciprocity on resource allocation were also explored. In addition to individual difference measures of prosociality (SVO Slider measure; Murphy et al., 2011) and self-construal (SCS; Singelis, 1994), I also investigated the association between an individual's explicit awareness about how much someone liked them with real-life reported network In-link scores, as measured by the SNQ (Harrison et al., 2011), and how this changed with increasing age. If the SNQ tapped into true changes in understanding of social reciprocity (and not just the propensity to use it), explicit awareness of how other network members felt about an individual would reflect real-life In-link scores, and this association would become stronger with increasing grade (as a proxy for age).

The main hypotheses were:

- i. There would be a developmental increase in the impact of social reciprocity on investment decisions, in both the UK and in Malaysian adolescents, as a function of grade (Burnett Heyes et al., 2015).
- ii. In line with Chapter 4, which reported overall lower social-cognitive performance in Chinese adolescents, Malaysian adolescents might report a smaller impact of social reciprocity on investment decisions than British adolescents in general (Wang et al., 2015).

- iii. Across the whole sample, the more prosocial and interdependent, the higher the individual's investment to their classmates (at cost to themselves); the more competitive and independent, the less they would invest in other network members (Murphy et al., 2011; De Dreu & Boles, 1998; Roch et al., 2000; Roch & Samuelson, 1997; Cristina-Corina, 2012; Utz, 2004; Arnocky et al., 2007).

5.3 Methods

5.3.1 Participants

217 participants from two coeducational private schools, one in Cheltenham, UK (5 classes, N = 70; 46 females; age range: 13.33 to 18.33 years, M = 15.72 years, SD = 1.49; Table 5.1) and one in Kuala Lumpur, Malaysia (7 classes, N = 147, 70 females; age range: 10.81 to 17.68 years, M = 14.69 years, SD = 1.74; Table 5.2) took part in this study. Parent or guardian consent was obtained for all participants, who also signed assent forms.

To circumvent confusion in different terminology and ages used to classify grades between the two countries, the Grade system was standardised in this study according to the mean age of each class, as follows: Grade 1 = 13 years, Grade 2 = 14 years, Grade 3 = 15 years, Grade 4 = 16 years and Grade 5 = 17 years. All classes were included in the analyses for developmental effects of reciprocity in each culture. For the between-culture analysis, the sample was age-matched so that only classes with a mean age of 14 to 17 years (Grades 2 to 5; Malaysia: 5 classes, N = 88, 42 females; age range = 13.76 to 17.68 years, M = 15.86, SD = 1.20; UK: as above) were included. There was no difference in age between the UK and Malaysian adolescents in this age-matched sample ($p = .4995$, equal variances not assumed).

Table 5.1 Sample demographics and descriptives for UK adolescent class networks.

Class	E2A		E2B		E4		E5A		E5B	
N	18 (11 Female)		10 (4 Female)		15 (10 Female)		15 (12 Female)		12 (8 Female)	
Ethnicity	14 Caucasian, 1 East Asian, 3 Other		8 Caucasian, 2 South Asian		13 Caucasian, 1 East Asian, 1 Other		14 Caucasian, 1 Other		9 Caucasian, 3 East Asian	
	M (SD)	Range	M (SD)	Range	M (SD)	Range	M (SD)	Range	M (SD)	Range
Age (years)	14.00 (0.39)	13.33 to 14.56	14.18 (0.70)	13.45 to 15.35	16.33 (0.68)	15.45 to 17.86	17.03 (0.50)	16.15 to 18.19	17.15 (0.55)	16.59 to 18.33
SVO ¹	31.88 (20.75)	-7.94 to 61.39	28.69 (15.99)	-3.81 to 45.00	29.80 (10.97)	7.81 to 45.89	23.61 (15.65)	-13.25 to 36.63	22.65 (10.72)	7.82 to 38.97
Independence	4.27 (1.13)	2.13 to 6.75	4.46 (0.83)	2.88 to 5.63	4.52 (1.01)	2.38 to 6.00	4.78 (0.85)	2.88 to 5.88	5.19 (1.06)	2.25 to 6.50
Interdependence	4.49 (1.12)	2.50 to 6.63	4.88 (0.65)	3.75 to 6.00	4.65 (0.72)	3.50 to 6.13	4.38 (0.56)	3.00 to 5.00	4.38 (0.38)	3.75 to 5.13
FAS	8.06 (1.21)	5 to 9	8.22 (1.09)	6 to 9	8.00 (1.36)	4 to 9	7.93 (1.16)	6 to 9	7.75 (1.14)	6 to 9
mDG points ^a (self)	32.18 (34.00)	0 to 100	19.5 (18.92)	10 to 60	41.04 (48.04)	0 to 100	43.57 (32.57)	0 to 100	34.08 (37.63)	0 to 100
	Density M (SEM)	Range	Density M (SEM)	Range	Density M (SEM)	Range	Density M (SEM)	Range	Density M (SEM)	Range
mDG ² : points ^a (others)	3.90 (.35)	0.00 to 33.33	8.94 (.83)	0.00 to 50.00	4.21 (.40)	0.00 to 35.00	4.03 (.40)	0.00 to 40.00	5.99 (.67)	0.00 to 50.00
Social tie strength	0.25 (.02)	-0.33 to 1.00	0.27 (.03)	-0.11 to 1.00	0.32 (.02)	-0.33 to 1.00	0.19 (.02)	-0.22 to 1.00	0.21 (.02)	-0.33 to 0.89
Reciprocation	0.19 (.01)	-1.11 to 1.11	0.16 (.01)	-0.50 to 0.50	0.17 (.01)	-0.78 to 0.78	0.17 (.01)	-0.67 to 0.67	0.23 (.01)	-0.67 to 0.67
Duration known (years)	3.62 (.14)	0.33 to 12.00	0.50 (.00)	0.50	2.73 (.10)	1.00 to 10.00	1.12 (.14)	0.00 to 15.00	1.76 (.15)	0.25 to 7.00

Note. The upper half of the table shows non-network descriptives, i.e. mean and standard deviation, while the lower half the table shows descriptives for network data, i.e. bootstrapped mean density and standard error. Higher network density indicates higher values in general reported by members to another individual for a given variable within a network. ¹ Social Values Orientation. ² Modified Dictator Game. ^a mDG points shown are corrected so that the sum of distribution equals £100.

Table 5.2 Sample demographics and descriptives for Malaysian adolescent class networks.

Class	M1A		M1B		M2		M3A		M3B		M4		M5	
N	32 (16 Female)		27 (12Female)		10 (1 Female)		22 (13 Female)		12 (6 Female)		16 (7 Female)		28 (15 Female)	
Ethnicity	9 Malay, 16 Chinese, 5 Indian, 1 Mixed Asian, 1 Half Caucasian		7 Malay, 15 Chinese, 3 Indian, 1 Half Caucasian, 1 Mixed Asian		3 Malay, 5 Chinese, 2 Mixed Asian		3 Malay, 17 Chinese, 1 Indian, 1 Other		2 Malay, 10 Chinese		5 Malay, 9 Chinese, 1 Indian, 1 Mixed Asian		4 Malay, 20 Chinese, 3 Indian, 1 Other	
	M (SD)	Range	M (SD)	Range	M (SD)	Range	M (SD)	Range	M (SD)	Range	M (SD)	Range	M (SD)	Range
Age (years)	12.87 (0.61)	10.81 to 13.63	13.05 (0.49)	11.81 to 13.63	14.09 (0.28)	13.76 to 14.54	14.95 (0.51)	14.02 to 15.68	15.18 (0.28)	14.83 to 15.57	16.28 (0.28)	15.74 to 16.65	17.27 (0.33)	16.39 to 17.68
SVO	28.09 (15.13)	-16.26 to 64.49	23.46 (12.70)	-7.82 to 40.88	28.48 (14.63)	0.00 to 48.49	26.97 (15.24)	-7.82 to 38.05	35.24 (12.89)	7.51 to 54.78	33.76 (7.12)	23.00 to 48.09	27.40 (14.07)	-7.82 to 41.50
Independence	4.74 (1.19)	1.63 to 6.40	4.83 (0.95)	2.63 to 6.38	4.76 (0.71)	3.75 to 6.13	4.42 (0.96)	2.50 to 5.63	4.8 (1.19)	2.25 to 6.38	4.99 (0.83)	3.63 to 6.63	4.67 (0.85)	3.13 to 6.00
Interdependence	4.08 (1.15)	1.00 to 5.75	4.75 (1.21)	1.75 to 6.63	4.83 (1.01)	3.00 to 6.25	4.63 (1.28)	1.38 to 6.50	4.94 (1.48)	2.00 to 6.50	4.25 (1.09)	2.63 to 6.13	4.62 (0.92)	2.75 to 6.38
FAS	7.28 (1.20)	5 to 9	7.62 (1.17)	4 to 9	7.2 (1.14)	5 to 9	7.14 (1.42)	4 to 9	7.5 (1.38)	5 to 9	7.81 (1.05)	6 to 9	7.30 (1.03)	4 to 9
mDG points ^a (self)	20.43 (28.29)	0 to 100	23.57 (22.93)	0 to 100	24.87 (26.82)	10 to 100	12.83 (25.66)	0 to 100	6.69 (14.82)	0 to 50	9.92 (8.31)	0 to 25	10.94 (21.48)	0 to 100

Class	M1A		M1B		M2		M3A		M3B		M4		M5	
	Density M (SEM)	Range	Density M (SEM)	Range	Density M (SEM)	Range	Density M (SEM)	Range	Density M (SEM)	Range	Density M (SEM)	Range	Density M (SEM)	Range
mDG points ^a (others)	2.57 (.10)	0.00 to 28.57	2.91 (.20)	0.00 to 80.00	8.35 (.62)	0.00 to 90.00	4.17 (.14)	0.00 to 25.00	8.48 (.88)	0.00 to 50.00	6.00 (.18)	0.00 to 30.00	3.30 (.12)	0.00 to 100.00
Social tie strength	0.22 (.01)	-0.33 to 1.00	0.22 (.01)	-0.33 to 1.00	0.33 (.04)	-0.33 to 1.00	0.47 (.01)	-0.11 to 1.00	0.40 (.13)	-0.22 to 1.00	0.39 (.02)	-0.33 to 1.00	0.37 (.01)	-0.33 to 1.00
Reciprocation	0.18 (.01)	-1.00 to 1.00	0.25 (.01)	-1.00 to 1.00	0.19 (.02)	-0.67 to 0.78	0.16 (.01)	-0.56 to 0.56	0.28 (.02)	-0.89 to 0.89	0.16 (.01)	-0.67 to 0.67	0.18 (.01)	-0.67 to 0.67
Duration known (years)	2.21 (.06)	0.00 to 8.00	2.44 (.06)	0.00 to 13.00	2.25 (.13)	1.00 to 8.00	3.73 (.09)	2.00 to 15.00	3.49 (.09)	1.00 to 7.00	4.11 (.18)	0.00 to 11.00	3.85 (.08)	1.00 to 17.00

Note. The upper half of the table shows nonnetwork descriptives, i.e. mean and standard deviation, while the lower half the table shows descriptives for network data, i.e. bootstrapped mean density and standard error. Higher network density indicates higher values in general reported by members to another individual for a given variable within a network. ^a mDG points shown are corrected so that the sum of distribution equals RM100.

5.3.2 Materials

5.3.2.1 Modified Dictator game

In a modified Dictator Game (mDG) participants were told to imagine they had 100 coins (£100 in the UK or RM100 in Malaysia), and that they could distribute it in any way between themselves and their classmates. The task, which was used in Burnett Heyes et al. (2015), is structurally equivalent to a one-shot Dictator game (Goeree, McConnell, Mitchell, Tromp & Yariv, 2010) with multiple recipients. The use of hypothetical rather than real money was motivated by the preferences of the schools from which the sample was recruited and based on evidence that hypothetical money effectively motivates participant behaviour (Miyapuram, Tobler, Gregorios-Pippas, & Schultz, 2012).



Imagine someone just gave you £100.

Your task is to divide this money among your classmates. You can divide the money in any way that you like.

Please enter amount of money you wish to give each of the people listed below:

Name	Amount of money to give to this person
Classmate A	5
Classmate B	25
Participant X	50
...	...

Figure 5.1 Example of the one-shot mDG for Participant X, who distributed points between his/herself and his/her classmates.

Participants were provided with a table within which all network members were listed (Figure 5.1). There was no minimum point limit that had to be allotted to other individuals; participants could choose to keep 100 points to themselves or to share their points with others in class. The mDG measures how much individuals are willing to give to other members of their group, at cost to themselves. Previous literature has shown that giving behaviour is strongly predicted by social distance, i.e. relationship closeness between individuals, revealing a simple ‘inverse distance law of giving’ (Goeree et al., 2010).

5.3.2.2 Social networks questionnaire

As in Burnett Heyes et al. (2015), an adapted version of Harrison et al.'s (2011) Social Networks Questionnaire (SNQ) for adolescent populations was used. The questionnaire contained six network items on participants' relationships with other members of their class. Three of these provided binary matrix data (Yes = 1, No = 0) while three further items provided ordinal matrix data. The six network items assessed various constructs (e.g. trust, conflict resolution, companionship) that contribute to relationship strength (Bagwell & Schmidt, 2013; see Table 5.3 for details). Versions of the SNQ have been used effectively to establish social proximity within a social group, which is found to be positively associated with cooperative investment (Harrison et al., 2011; Burnett Heyes et al., 2015).

Table 5.3 Social network items for the SNQ. Responses were scored and summed in accordance to Burnett Heyes et al. (2015) to create a composite social tie strength score for each participant towards all network members (max = 9, min = -3).

Item	Responses (Score)
Do you spend time outside of school with any of the people listed below (for e.g. in free time)?	Yes (1) No (0)
Which answer best describes your relationship with the people listed below?	Best friend (4) Good friend (3) Friend (2) Acquaintance (1) No relationship (0) Negative relationship (-1)
How much do you trust the people listed below?	More than an average person (1) The same as an average person (0) Less than an average person (-1)
If you received some personal bad news (for example, a family tragedy) and you had to tell ONE person from the list below, who would it be? Please circle.	Chosen individual (1) Non-chosen individuals (0)
Have you ever chosen to academically work with any of the people listed below (for class work where you choose your own partner)?	Yes (1) No (0)
How important is it for you to resolve conflicts (disagreements) with the people listed below?	We would try really hard to sort it out (1) We would make a small effort to sort it out (0) I wouldn't care (-1)

A new, additional item assessed participants' explicit awareness of how other network members felt about them (Like: "How much do you think the following people like you?") rated on an ordinal scale, similar to existing items (Much more than an average person = 2, A little more than the average person = 1, The same as the average person = 0, Less than the average person = -1). Control items included duration of acquaintance (years) and familial ties. As there were only three familial ties across the whole sample (one in Malaysia two in the UK), this variable was dropped from subsequent analysis. Participants completed each item about all other network members in class, all of whom were listed in the SNQ. A composite score for the six "network relationship" items was used as indication of each network member's social tie strength score for everyone else in class (out-links), as in Harrison et al. (2011).

5.3.2.3 Social values orientation

The Social Values Orientation (SVO) Slider Measure (Figure 5.2; Murphy et al., 2011) was administered as an indication of prosociality in decision-making. The measure has six primary items, with each item being a resource allocation choice over a well-defined continuum of joint payoffs between the participant and an imagined "other" player. The instructions indicated that the "other" person is someone the student does not know and will remain mutually anonymous.

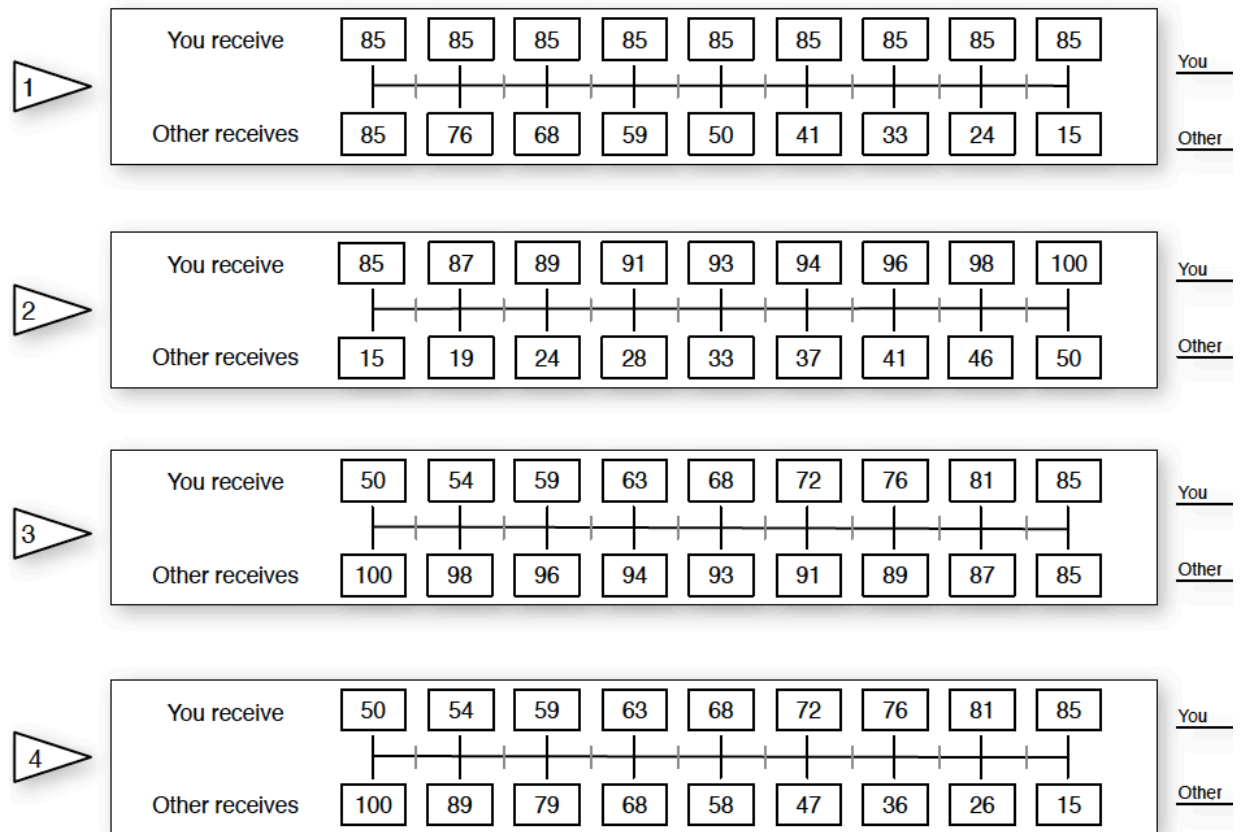


Figure 5.2 SVO Slider Measure Items 1-4. Participants indicated their allocation choice by marking the point that defines their most preferred joint distribution, and wrote the corresponding payoffs to the right of the item.

A single index of SVO was calculated for each participant following Murphy et al. (2011). Using responses from the six primary items, the mean allocations for self (A_s) and other (A_o) were computed. 50 was then subtracted from each of these means in order to “shift” the base of the resulting angle to the centre of the circle (50, 50) rather than having its base start at the Cartesian origin. Finally, the inverse tangent of the ratio between these means was computed, resulting in a single index of a participant’s SVO.

$$SVO^\circ = \arctan \left(\frac{(\bar{A}_o - 50)}{(\bar{A}_s - 50)} \right)$$

Scores can range from -16.26° to 61.39° . A higher score indicates prosocial orientation (where the maximum score indicates perfect altruism), while low scores indicate competitive decision-making.

The SVO is reported to have test-retest reliability of $r = .92$ and good convergent validity with the Ring Measure ($r = .72$), another measure of social values orientation (Murphy et al., 2011). Further, a previous study has shown participants' SVO angles were also positively correlated with their choices on a one-shot Prisoner's Dilemma game ($r = .24$), showing the expected positive association with cooperation (Murphy et al., 2011).

The FAS and SCS were also administered (see Chapter 2 for details).

5.3.3 Procedure

Participants completed the task battery in groups of school-based class networks using pen and paper. Individuals within each network spent class time together each week as a group. The study took place in exam-like conditions during lessons at school. I invigilated each testing session with a teacher, which lasted about 25 minutes. First, participants completed the mDG, during which they had to divide points between themselves and their classmates. Participants then completed the SNQ to map social ties between all individuals in a given network. Finally, they completed the SVO Slider Measure (Murphy et al., 2011), the FAS (Currie et al., 2006) and the SCS (Singelis, 1994; Chapter 2).

5.3.4 Data analysis overview

To conduct network analysis, data was first processed to create matrices for the dependent (mDG points) and independent variables (Social tie strength, Reciprocation, SVO, Independence, Interdependence, Like), and additional items that measured potentially confounding effects (Duration known, Gender,

Ethnicity, FAS) for each network. Each matrix contained information capturing all possible dyadic relationships in the network. In a social network diagram, authentic social relationships are mapped within a population. Individuals are represented as nodes, which are connected by an edge that denotes social tie strength between individuals. These matrices were concatenated to create full sample matrices for each variable, which contained all relevant classes, for the multi-group analyses.

Multi-group multiple regression with quadratic assignment procedure (MG-MRQAP; Burnett Heyes et al., 2015) was then conducted in each culture separately (Malaysia N = 7 classes; UK N = 5 classes) to evaluate the impact of Social tie strength, Reciprocation and individual differences in SVO and Self-construal (Independence and Interdependence) on investment decisions across groups, and to pinpoint whether the impact of Reciprocation varied as a function of Grade, as a proxy for developmental age. This procedure entailed a fixed effects approach by class, which allowed the examination of a fixed network level variable (i.e. Grade), for interactions with explanatory variables (e.g. Reciprocation). In the first step, Social tie strength, Reciprocation, and their interaction with Grade were entered into the model to test the first hypothesis of increasing impact of Reciprocation on resource allocation with increasing Grade. The interaction between Social tie strength and Grade was also tested in accordance with Burnett Heyes et al. (2015), who found that Social tie strength increasingly predicted resource allocation with increasing Grade. Additional items that controlled for potentially confounding effects of gender, ethnicity, duration known and FAS were also included in the model. Specifically, these were included to address the possibility of one gender giving or receiving

more/less in general, of individuals of the same gender or ethnicity giving more to each other (gender/ethnicity homophilous behaviour; based on Goeree et al., 2010), and of those who have known each other longer to give more to each other, as well as any potential effects of socio-economic status on giving and receiving. In the second step, individual differences in self-construal and SVO were added into the model to investigate any extra variance accounted for by these items on resource allocation, i.e. to test the third hypothesis. Items were then removed through backwards elimination to retain only significant predictors in the final model. Single group multiple regression with quadratic assignment procedure (MRQAP; Dekker et al., 2007; Hemelrijk, 1990; Krackhardt, 1988) was used for post hoc analyses of each class network individually.

Next, using an age-matched sample (14 to 17 year olds only; Malaysia N = 5 classes, UK N = 5 classes; 5.1), cultural differences in the impact of reciprocation on giving behaviour were examined, again using MG-MRQAP analysis. Social tie strength, Reciprocation and their interaction with Culture were entered into the model to test the second hypothesis. As before, individual differences in SVO, SCS and all additional potentially confounding items were also included in this model. Again, non-significant items were removed through backwards elimination to retain only significant predictors.

Finally, to examine whether or not a participant's explicit awareness of how much other network members liked them (Like) predicted real life social tie strength reported towards an individual by other network members (In-links), a final MG-MRQAP analysis was conducted collapsed across both cultures (12 classes). The model included all control items, Like, and Social tie strength as IVs,

and In-link scores (transposed social tie strength scores) as the DV. The interaction between Like and Grade was also examined to investigate whether the association between Like and In-links became stronger with increasing Grade.

5.3.4.1 Data processing

5.3.4.1.1 Creation of explanatory matrices

Social tie strength

The six network item scores were first summed to create a composite score (max = 9, min = -3), which was then divided by 9 to create a value for social relationship strength: values closer to 1 (maximum) reflected strong friendships, while values closer to -0.33 (minimum) reflected negative relationships, and values centring around 0 indicated neutral relationships. These values (i.e. link weights) were then used to create a “social tie matrix” for each class, with out-links (how strong a relationship an individual feels towards others) represented in rows, and in-links (how strong a relationship other network members feel towards an individual) represented in columns.

Reciprocation

The reciprocation matrix for each class was created by deducting the out-link matrix (social tie matrix) from the in-link matrix (transposed social tie matrix). A positive reciprocation score indicated a well-reciprocated relationship (in-link exceeds out-link) while a negative score indicated a poorly reciprocated one (out-link exceeds in-link); a perfectly reciprocated relationship would yield a score of 0. This matrix is a measure of how well relationships were reciprocated in the social network. The reciprocation matrix is symmetrical with inverted sign, i.e. for every positive entry there is a negative entry with the same absolute

value on the other side of the diagonal of the matrix, and the sum of all elements of the matrix is zero.

Individual differences

Individual differences matrices were created to examine whether individual variables such as SVO and self-construal would affect cooperative investment decisions. These matrices contained individuals' SVO and SCS (independent and interdependent) scores across matrix rows in a given network (SVO-giving, Independent-giving, Interdependent-giving). Matrix columns contained repetitions of the rows of individual scores. Diagonals were left blank.

Like

A matrix containing information about how much an individual thinks other network members like them was also created. In this matrix, how much an individual thinks other network members like them is represented in rows, while columns represent how much other network members think an individual likes them.

Additional independent items

Matrices were created containing information on the duration network members have known each other (years). Further, to account for the potential effects of gender and FAS scores on an individual would give to others (-giving) and the amount of points an individual would receive from others (-receiving), gender-giving, gender-receiving, FAS-giving, FAS-receiving matrices were also created. For gender-giving and FAS-giving, dummy coded gender values (0 = male, 1 = female) and FAS scores were entered across matrix rows, while for gender-receiving and FAS-receiving, these were entered across matrix columns.

Finally, to examine whether pairs of individuals of the same gender and ethnicity gave more to each other, “same-different” (-SD) matrices were also computed where 1 denoted pairs of the same gender or ethnicity and 0 indicated heterogeneous pairs (gender-SD, ethnicity-SD).

5.3.4.1.2 Creation of dependent variable matrices

mDG points

Point allocations by each network member to other members were entered into dependent variable matrices. The amount given by an individual was represented in rows and the amount received in columns.

In-links

The social tie strength matrix (out-links) was transposed to create an In-link matrix for each class. As the inverse of the social tie matrix, the rows represented social tie strength scores reported by other network members to an individual.

5.3.4.1.3 Creation of multi-group matrices

MG-MRQAP entailed the creation of full-sample matrices for each of the dependent and explanatory variables described above. These data have a multilevel structure, with participants nested in classes. This was created for the seven Malaysian classes and five UK classes for the developmental analysis of each culture separately. 10 classes (Malaysia = 5 classes; UK = 5 classes) were concatenated to create full samples for the cross-culture analysis, while all 12 classes were concatenated for the analysis on explicit awareness.

5.3.4.2 Multiple regression within networks

Multiple regression with quadratic assignment procedure (MRQAP; Dekker et al., 2007; Hemelrijk, 1990; Krackhardt, 1988) was conducted post hoc

to evaluate the relationship between social network and individual difference variables and mDG point allocation in each class network. This entailed the use of a statistical procedure capable of accounting for statistical dependence among observations, since dyadic interaction data in social networks are based upon non-independent observations: Measuring an individual's relationship with all members in the network requires repeat observations of that individual. Thus, these observations are non-independent. MRQAP, executed in UCINET (version 6.415; Borgatti, Everett, & Freeman, 2002), implements linear regression for matrix data. This procedure regresses a dependent variable matrix upon explanatory variable matrices to obtain regression coefficients. Regression coefficients can be interpreted as in ordinary least squares regression, although standard errors are calculated differently. The rows by columns positions of the residuals resulting from the regression are randomly permuted 10000 times and partial regression coefficients of the permutations are obtained. The random permutation data sets generate a sampling distribution under the null hypothesis, which are compared against the original regression coefficients to obtain p values of variables in the regression.

Using this method, each network's mDG point allocation matrix was regressed against their respective network's explanatory variables (social tie strength, reciprocation) and additional potentially confounding items (gender giving, gender receiving, gender same-different, ethnicity same different and duration of acquaintance).

5.3.4.3 Multiple regression across networks

Multi-group multiple regression with quadratic assignment procedure (MG-MRQAP; Burnett Heyes et al., 2015) was conducted to test directly for interactions between Grade and Social tie strength and Reciprocity on mDG point allocation, as well as the effect of other explanatory variables explained above for British and Malaysian adolescents separately. The MG-MRQAP analyses were carried out in R (R Development Core Team, 2011).

Regression parameters of interest were estimated using linear regression with pooled data from all classes, and standard errors were calculated by permuting each of the matrices. For the estimation of multiple classes simultaneously, a permutation method was chosen that tends to overestimate the size of the standard errors. To account for nesting of participants in classes, the procedure allowed permutation of rows and columns within classes only. In addition, the procedure allowed intercepts for the different classes to vary independently (i.e. a fixed effects approach by class). Thus, we could examine a network level variable (e.g. Grade) for interactions with explanatory variables (e.g. Reciprocation). Multiplying all explanatory matrix values by the appropriate network level variables enabled us to test whether the effect size of an explanatory variable depended on a network level variable. For the analysis of developmental effects, the network level variable was coded as Grade: 0, 1, 2, 3, and 4 for participants in Grades 1 to 5 respectively. For the cross-culture analysis, the network level variable was coded as Culture: 0 = UK and 1 = Malaysia.

5.4 Results

5.4.1 Developmental effects of social reciprocity on cooperative investment in UK adolescents

Table 5.4 Multiple regression models predicting investment decisions across Grades in UK adolescents.

Independent variables	B	SE B
Grade 2A intercept	-2.77***	0.64
Grade 2B intercept (reference Grade 2A) ¹	2.64**	0.83
Grade 4 intercept (reference Grade 2A)	-2.76***	0.64
Grade 5A intercept (reference Grade 2A)	-1.25*	0.62
Grade 5B intercept (reference Grade 2A)	2.77**	NA
Social tie strength	11.30***	0.64
Reciprocation	1.81*	0.84
SVO	0.11***	0.01
Independence	0.59**	0.19
Interdependence	-1.22***	0.26
Intercept	2.75	1.47

* $p < .05$ ** $p < .01$ *** $p < .001$. ¹ In a fixed effects approach, the intercepts of each class are allowed to vary independently against a single reference point, i.e. the intercept of a chosen class network.

The final model, obtained through backwards elimination of non-significant predictors, from the MG-MQAP is shown in Table 5.4 ($R^2 = .36$, $R^2_{adj} = .36$, $p < .001$). Independent variables removed due to non-significance through backwards elimination were gender-giving ($b = -0.07$, $p = .8966$), duration known ($b = -0.04$, $p = .7558$), FAS-receiving ($b = 0.08$, $p = .6198$), FAS-giving ($b = -0.10$, $p = .5489$), Social tie strength x Grade, ($b = -0.46$, $p = .3720$), gender-SD ($b = -0.41$, $p = .3621$), ethnicity-SD ($b = -0.47$, $p = .2796$), Reciprocation x Grade ($b = -0.96$, $p = .1049$), and gender-receiving ($b = 0.76$, $p = .0589$). Both Social tie

strength and Reciprocation significantly predicted cooperative investment in British adolescents. While SVO predicted cooperative investment in the expected direction, the impact of independence and interdependence scores were in the opposite direction.

To investigate the lack of the expected Reciprocation x Grade interaction, post hoc MRQAP analyses were run using UCINET (version 6.415; Borgatti et al., 2002) for each individual network with the same predictors. This revealed that the impact of reciprocation on points-allocation showed no clear pattern with respect to age group in the UK (Table 5.5).

Table 5.5 Individual class network models (UK).

Class (mean age)	2A (14.00 years)		2B (14.18 years)		4 (16.33 years)		5A (17.03 years)		5B (17.15 years)	
	$R^2 = .43$		$R^2 = .54$		$R^2 = .46$		$R^2 = .43$		$R^2 = .50$	
	$R^2_{adj} = .39^{***}$		$R^2_{adj} = .44^{***}$		$R^2_{adj} = .43^{***}$		$R^2_{adj} = .40^{***}$		$R^2_{adj} = .44^{***}$	
Explanatory variables	B	β	B	β	B	β	B	β	B	β
Social tie strength	12.28***	0.63***	26.12***	0.75***	8.45***	0.45***	12.38***	0.70***	17.86***	0.64***
Reciprocation	5.27***	0.19***	1.64	0.04	4.20**	0.17**	3.29*	0.14*	-2.26	-0.08
SVO giving	0.12***	0.31***	0.00	-0.00	0.28***	0.52***	0.03	0.07	0.35**	0.47**
Independence giving	-0.67	-0.10	-2.37*	-0.22*	1.60**	0.27**	1.23*	0.18*	2.19**	0.30**
Interdependence giving	-0.10	-0.02	0.73	0.06	-0.92	-0.11	0.66	0.06	-2.93	-0.14
SES giving	0.35	.07	-0.37	-0.04	-0.36	-0.08	0.31	0.06	-1.57	-0.22
SES receiving	0.22	.039	0.27	0.04	0.16	0.037	-0.39	-0.08	0.72	0.10
Duration known	0.10	.027	5.75	0.00	0.63*	0.16*	-0.42**	-0.14**	-0.18	-0.04
Gender ¹ giving	0.37	.025	-6.46*	-0.36*	0.25	0.02	1.22	0.09	-6.79*	-0.39*
Gender receiving	3.91***	.278***	-2.71*	-0.15*	1.69*	0.14*	1.77*	0.13*	1.40	0.09
Gender SD	-1.24	-.092	-1.47	-0.08	-1.99**	-0.17**	-0.89	-0.07	0.09	0.01
Ethnicity SD	-1.50*	-.110*	-1.63	-0.09	1.47*	.11137*	-0.83	-0.05	-0.16	-0.01
Intercept	-6.52***		11.49***		-11.31***		-7.77***		5.82***	

* $p < .05$ ** $p < .01$ *** $p < .001$. B and β denote unstandardised and standardised regression coefficients respectively. B, which indicates the average change in dependent variable associated with one unit change in the predictor variable, is generally used in social network analyses. β permits a rough judgement of the impact of variables in relation to each other within a model, and represents the amount of SD change in the dependent variable per SD change in the predictor variable. ¹Males were coded as 0 and females were coded as 1.

5.4.2 Developmental effects of social reciprocity on cooperative investment in Malaysian adolescents

Table 5.6 Multiple regression models predicting investment decisions across Grades in Malaysian adolescents.

	B	SE B
M1A intercept	0.25	0.2
M1B intercept (reference M1A) ¹	0.76**	0.22
M2 intercept (reference M1A)	6.89***	0.49
M3A intercept (reference M1A)	0.02	0.27
M3B intercept (reference M1A)	4.82***	0.37
M4 intercept (reference M1A)	2.52***	0.3
M5 intercept (reference M1A)	-0.25***	NA
Social tie strength	6.75***	0.26
Reciprocation	1.09***	0.31
SV0	0.03***	0.01
Interdependence	-0.15*	0.07
FAS giving	-0.16**	0.06
Gender giving ²	0.30*	0.15
Gender receiving	0.53***	0.14
Intercept	1.50**	0.56

* $p < .05$ ** $p < .01$ *** $p < .001$. ¹ In a fixed effects approach, the intercepts of each class are allowed to vary independently against a single reference point, i.e. the intercept of a chosen class network. ² Males were coded as 0 and females were coded as 1.

The final model is shown in Table 5.6 ($R^2 = .32$, $R^2_{adj} = .31$, $p < .001$).

Independent variables removed due to non-significance through backwards elimination were gender-SD ($b = 0.09$, $p = .5640$), ethnicity-SD ($b = -0.09$, $p = .5580$), reciprocation x Grade ($b = 0.12$, $p = .5543$), FAS-receiving ($b = 0.05$, $p =$

.4709), social tie strength x Grade, ($b = 0.12$, $p = .4043$), independence ($b = 0.12$, $p = .1445$), and duration known ($b = -0.07$, $p = .0646$).

Both Social tie strength and Reciprocation significantly predicted cooperative investment in Malaysian adolescents. Additionally, the effect of gender suggests that females gave and received significantly more, whilst participants with higher FAS scores (higher SES) invested less in others. Similar to the UK sample, SVO predicted cooperative investment in the expected direction, while the impact of interdependence found was in the opposite direction.

Again, post hoc MRQAP analyses for each individual class network with the same predictors revealed that the impact of reciprocation on point-allocation did not show a clear pattern with respect to grade in Malaysia (Table 5.7).

Table 5.7 Individual class network models (Malaysia).

Class (mean age)	M1A (12.87 years)		M1B (13.00 years)		M2 (14.09 years)		M3A (14.95 years)		M3B (15.18 years)		M4 (16.28 years)		M5 (17.27 years)	
	$R^2 = .23$		$R^2 = .23$		$R^2 = .45$		$R^2 = .44$		$R^2 = .51$		$R^2 = .30$		$R^2 = .23$	
	$R^2_{adj} = .22^{***}$		$R^2_{adj} = .22^{***}$		$R^2_{adj} = .34^{***}$		$R^2_{adj} = .42^{***}$		$R^2_{adj} = .46^{***}$		$R^2_{adj} = .26^{***}$		$R^2_{adj} = .22^{***}$	
Explanatory variables	B	β	B	β	B	β	B	β	B	β	B	β	B	β
Social tie strength	4.84***	0.48***	9.10***	0.53***	10.82***	0.69***	4.50***	0.45***	21.92***	0.78***	5.13***	0.52***	6.38***	0.51***
Reciprocation	0.54	0.04	1.64*	0.09*	4.30*	0.19*	-0.50	-0.04	3.23 ^a	0.12 ^a	-1.10	-0.08	1.94**	0.13**
SVO	0.01	0.05	0.02	0.05	0.01	0.03	0.06***	0.38***	0.073	0.09	0.08***	0.18***	0.02	0.10
Independence	0.04	0.01	-0.15	-0.03	-0.76	-0.07	0.43*	0.17*	3.54*	0.40*	-0.28	-0.08	-0.07	-0.02
Interdependence	0.03	0.01	-0.48*	-0.11*	-0.70*	-0.12*	-0.11	-0.05	-1.01	-0.14	0.38**	0.14**	-0.18	-0.05
SES giving	0.02	0.01	-0.38*	-0.08*	-1.08**	-0.17**	-0.20	-0.11	-2.09*	-0.27*	-0.32*	-0.10*	-0.18	-0.05
SES receiving	0.11	0.04	0.21	0.04	-0.62	-0.13	-0.01	-0.00	-1.35*	-0.18*	-0.11	-0.04	0.08	0.02
Duration known	-0.10	-0.05	-0.21*	-0.06*	0.00	0.00	-0.08	-0.06	-0.85	-0.09	0.03	0.03	0.09	0.06
Gender ¹ giving	0.86*	0.13*	0.15	0.01	6.73	0.42	0.37	0.07	-2.55*	-0.13*	-0.24	-0.04	0.13	0.02
Gender receiving	0.50*	0.07*	0.73	0.07	6.30	0.35	0.48*	0.09*	3.69*	0.18*	-0.18	-0.03	0.20	0.03
Gender SD	0.43*	0.07*	-0.22	-0.02	5.92***	0.47***	0.86**	0.17**	1.37	0.07	-0.14	-0.02	-0.53*	-0.07*
Ethnicity SD	0.44*	0.06*	0.38	0.03	0.32	0.03	-1.33**	-0.24**	0.70	0.03	-0.34	-0.06	-0.48	-0.07
Intercept	-0.82***		4.66***		18.95***		0.09***		12.18***		4.91***		2.14***	

^a $p < .10$ * $p < .05$ ** $p < .01$ *** $p < .001$. B and β denote unstandardised and standardised regression coefficients respectively. B, which indicates the average change in dependent variable associated with one unit change in the predictor variable, is generally used in social network analyses. β permits a rough judgement of the impact of variables in relation to each other within a model, and represents the amount of SD change in the dependent variable per SD change in the predictor variable. ¹Males were coded as 0 and females were coded as 1.

5.4.3 Cultural differences in the impact of social reciprocity on cooperative investment

First, it is interesting to note that in general Malaysian adolescents kept less points for themselves than British adolescents (Table 5.2; Table 5.3), although this pattern is only descriptive. The between culture MG-MRQAP revealed no cultural differences in the impact of Reciprocation on investment decisions in Malaysian compared with British adolescents in Grades 2 to 5 (Table 5.8; $R^2 = .35$, $R^2_{adj} = .35$, $p < .001$). However, there was a significant non-predicted interaction between Social tie strength and Culture, in that Social tie strength accounted for more variance in cooperative investment decisions for British than for Malaysian adolescents.

Table 5.8 Multiple regression models predicting adolescent cooperative investment decisions across cultures.

	B	SE B
E2A intercept	0.41	0.41
E2B intercept (reference E2A)	5.51***	0.61
E4 intercept (reference E2A)	0.29	0.43
E5A intercept (reference E2A)	1.69***	0.41
E5B intercept (reference E2A)	3.01***	0.49
M2 intercept (reference E2A)	6.78***	0.57
M3A intercept (reference E2A)	-0.02	0.31
M3B intercept (reference E2A)	4.43***	0.44
M4 intercept (reference E2A)	2.08***	0.36
M5 intercept (reference E2A)	-0.41	NA
Social tie strength	10.97***	0.51
Reciprocation	1.72***	0.44
SVO	0.07***	0.01
FAS giving	-0.28**	0.09
Independence	0.35**	0.11
Interdependence	-0.29**	0.11
Social tie strength x Culture	-3.02***	0.65
Gender receiving ¹	0.41*	0.2
Intercept	0.06	0.84

* $p < .05$ ** $p < .01$ *** $p < .001$. ¹Males were coded as 0 and females were coded as 1.

Independent variables removed due to non-significance through backwards elimination were gender-SD ($b = -0.01$, $p = .9594$), gender-giving ($b = 0.04$, $p = .8552$), FAS-receiving ($b = -0.03$, $p = .69522$), duration known ($b = -0.02$, $p = .6139$), Reciprocation x Culture ($b = -0.76$, $p = .3995$), and ethnicity-SD ($b = -0.30$, $p = .1500$). There was small gender effect in that females received more from others. Higher SVO scores predicted higher cooperative investment, while

higher FAS (high SES) predicted lower cooperative investment. Furthermore, the more independent and the less interdependent, the more the adolescent invested in their peersⁱ.

To investigate the unexpected finding of self-construal predicting cooperative investment in the opposite direction, post hoc correlational analyses between SCS and prosociality (as measured by the SVO) were conducted. Intriguingly, this showed that self-construal correlated with SVO scores in the expected direction, although this was only significant between interdependence and prosociality in the UK (Table 5.9).

Table 5.9 Correlations between self-construal and prosociality scores in each culture separately.

	SVO	
	United Kingdom	Malaysia
Independence	-.189	-0.098
Interdependence	.349**	0.118

** $p < .01$

5.4.4 Like predicting In-links

The MG-MQAP model predicting In-link scores using Like, along with social tie strength and all control items, accounted for 50.24% of the variance ($R^2_{adj} = .50$, $p < .001$). Collapsed across all 12 classes and both cultures, social tie strength ($b = 0.52$, $p < .001$) and Like ($b = 0.07$, $p < .001$) significantly predicted In-link scores, but contrary to predictions there was no Like x Grade interaction ($b = -0.004$, $p = .1752$). Control items that were significant included FAS-

ⁱ Analyses conducted with only self-construal scores (independence and interdependence) to predict cooperative investments produce results in the same direction. As such, it is unlikely that effects are due to confounding variables present in the model.

receiving ($b = 0.01, p < .001$), gender-receiving ($b = 0.03, p < .001$), gender-SD ($b = 0.07, p < .001$) and duration known ($b = 0.001, p < .001$).

5.5 Discussion

This study sought to investigate the developmental impact of social reciprocity on cooperative investment in authentic adolescent networks across two cultures: the United Kingdom and Malaysia. Administering a Game Theory paradigm within authentic peer networks, potential cultural differences in the impact of social reciprocity on cooperative investment decisions in adolescence were also investigated. Finally, the association between individual differences in prosociality and self-construal with cooperative investment towards peers in adolescence was examined.

Contrary to expectations (Burnett Heyes et al., 2015), there was no effect of Grade (as a proxy for age) on the impact of social reciprocity on investment decisions in either Malaysia or British adolescents. Furthermore, consistent with the findings of Chapter 2, where no difference in the interdependent self-construal was found between the two cultures, but in contrast to past cross-cultural studies on adolescent social cognition (Chapter 4, Wang et al., 2015), no cultural difference emerged between Malaysian and British adolescents in terms of the impact of social reciprocity on cooperative investment. In line with past research (Murphy et al., 2011; De Dreu & Boles, 1998; Roch et al., 2000; Roch & Samuelson, 1997; Samuelson, 1993), prosociality predicted higher investments towards peers. However, surprisingly, independence and interdependence predicted investment decisions in the opposite expected directions (Cristina-Corina, 2012; Utz, 2004; Arnocky et al., 2007), i.e. the more independent, the more individuals invested in their peers (at cost to themselves), and the more

interdependent, the less they invested in their peers. While adolescents explicit awareness of how much someone else liked them predicted real-life reported relationship strength, this relationship did not grow stronger with increasing grade.

5.5.1 Developmental impact of social reciprocity on adolescent cooperative investment

That this study did not find a developmental increase in the impact of social reciprocity on cooperative investment when Burnett Heyes et al. (2015) did across two studies using fewer classes and similar age ranges (mean class age range: 14 to 17 years) is puzzling, especially considering that the methods used were also similar. However, results strongly suggest that the impact of social reciprocity might emerge earlier than was initially expected. Indeed, classes from the youngest grades in both cultures (mean class age of 13 years in Malaysia and 14 years in the UK) reported a significant effect of social reciprocity on cooperative investment. Burnett Heyes et al. (2015) included fewer class networks across similar age ranges (two in Study 1 and four in Study 2). As such, it is possible that the lack of effect of social reciprocity on cooperative investment in younger adolescents found in that study was a false negative, and the propensity to use social reciprocation information in decision making may start earlier in adolescence, as indicated in this study. What's even more intriguing is that the effect of social reciprocity on cooperative investment was not consistent across classes, even in the older grades. This suggests that the propensity to use social reciprocation information in cooperative investment decisions may not stabilise until early adulthood. It is also possible that change in the impact of social reciprocity on cooperative behaviour is not linear across

adolescence. A developmental effect might still be found should a wider age range of grades be included.

There may also be factors related to social ties in specific class networks that were not captured by the SNQ that affected cooperative investment. After all, peer relationships in adolescence are nothing if not complex (Bagwell & Schmidt, 2011). For example, temporary quarrels or secret 'crushes' might have contributed to inconsistent effects in the older years. Furthermore, there is evidence that males and females develop social understanding at different rates (Devine & Hughes, 2013; Chapters 3 & 4), as well as socialise differently (Bagwell & Schmidt, 2011). As Burnett Heyes et al.'s second study consisted only of females, representing a more homogenous sample, this might have led to more consistent results, especially in the older age groups.

Finally, the sample size of this study, whilst large in numbers of individual participants, may have been too small in terms of number of class networks to detect developmental trends. The significant impact of social reciprocity when collapsed across grades within both cultures and across the whole sample assuages doubt that participants did not complete the tasks properly. However, it is still possible that students from certain classes did not put as much thought into completing the task, leading to inconsistent effects of social reciprocity across the sample. Given this amount of variability as well as the complexity of authentic adolescent networks, perhaps the number of classes surveyed represented insufficient data points to reveal the developmental impact of social reciprocity in cooperative investment. With a bigger sample of class networks, developmental effects may be found.

Moreover, adolescents did not significantly get better at predicting how much another person liked them with age (as measured by Like and In-Link scores). However, given that Like was a simple one item with a 4-point scale, it may simply not be refined or sophisticated enough to detect such a change. Future studies should employ multiple items to assess this aspect of social understanding in a more valid way.

5.5.2 Cultural differences

There was no difference in the impact of social reciprocity on cooperative investment between Malaysian and British adolescents. This finding is in line with the finding in Chapter 2 that there was no difference in self-construal between the same sample of Malaysian and British adolescents. Taken together, these two studies provide evidence that suggest very little difference in social cognition between adolescents from these two cultures, even though cultural theories would presume distinctions (Hofstede, 1980; Markus & Kitayama, 1991). As mentioned in Chapter 2, this could be due to a variety of reasons, not least that both samples were from affluent private schools with similarly high SES backgrounds (see FAS scores in Tables 5.2 & 5.3). Malaysian adolescents from high SES backgrounds in Kuala Lumpur, the capital of Malaysia, might experience a high level of globalisation and exposure to Western values through media and the Internet (Biggs, 2000). In any case, studies like these remind researchers not only that culture is fluid (ever changing) and complex (not simply East vs. West), but also that within culture factors such as SES might also play a big role in affecting social cognition and behaviour.

Interestingly, there was a significant non-predicted interaction between social tie strength and culture, in that social tie strength affected cooperative

investment decisions in British more than in Malaysian adolescents.

Furthermore, descriptive results suggest that Malaysian adolescents in general kept less for themselves than British adolescents. While there may not be cultural differences in social cognition between Malaysian and British adolescents, there does seem to be a cultural difference in the factors that influence cooperative investment decision-making. It may be that Malaysian adolescents are driven more by fair and equal distributions (dividing up money between themselves and others equally, thus keeping less for themselves) than British adolescents, whose cooperative investment decisions may be driven more by personal social ties.

5.5.3 Individual differences

Prosociality (as measured by participants' investment decisions towards an imaginary stranger) predicted investment decisions towards peers in an authentic network in the expected direction. This replicates previous findings in adults that suggest prosociality results in cooperative behaviour (Murphy et al., 2011; De Dreu & Boles, 1998; Roch et al., 2000; Roch & Samuelson, 1997; Samuelson, 1993). Furthermore, it provides strong construct validity for the paradigm used in this study.

However, the fact that self-construal predicted cooperative investment towards peers in the opposite direction (the effect of interdependence was particularly robust, and especially in the UK) was unexpected (Cristina-Corina, 2012; Utz; 2004; Arnocky et al., 2007). This finding is even more fascinating when considering the correlations between independence and interdependence with prosociality (as measured by the SVO slider measure) were in the expected direction (although this was not always significant) across both cultures (Table

5.9), i.e. the more independent, the less prosocial their choices on the SVO slider measure, and vice versa.

Taken together, this indicates that factors that underlie cooperative investment decisions in adolescents may change depending on context. Results tentatively suggest that independent adolescents may make less prosocial decisions when considering the wider public (i.e. strangers) but in fact invest more in those who are close to them (i.e. peers), whereas those who are interdependent may embrace more prosocial attitudes towards strangers but invest less in their peers. It is also possible that self-construal may interact with other factors in adolescent peer relationships (e.g. peer selection, other personality traits) that affect cooperative investment decisions within a network. This highlights the importance of administering these paradigms within authentic peer networks, as factors driving an individual's behaviour and decision-making may change drastically when dealing with strangers instead of known others (friends, family, etc.). However, these findings are preliminary at best. It would be interesting to see if future studies are able to replicate this finding in other adolescent as well as adult networks.

5.5.4 Limitations and future direction

First, the Dictator Game used in this study might have represented a unique decision-making challenge that adolescents may not be familiar with. It is rare that young people would be given a sum of money to distribute amongst friends, and thus this may not be the best representation of everyday cooperative behaviour in adolescence. Further, this study was confined by logistical (both monetary and ethical) reasons that did not allow the use of real money. It is conceivable that the use of real money might have elicited

differences in decision-making behaviour in participants. However, it should be noted that Burnett Heyes et al. (2015) conducted two similar studies across British adolescents, one that involved real money (although all participants received the same amount of money in the end) and the other imaginary, and found similar results across both. Nevertheless, adolescents may make their cooperative investment decisions more carefully and with more consideration (of social ties and reciprocity) should real money or other more authentic cooperative scenarios be involved.

Adolescent networks represent a complex web of peer relationships and their underlying qualities that likely differs from group to group. While the SNQ assesses multiple aspects of friendship, it is unable to capture all layers of peer interactions, some of which are dynamic and transient (e.g. fights, quarrels). Furthermore, while peer networks studied were authentic, they were all class-based networks, which represents a somewhat forced and arbitrary grouping of individuals. There may exist variability in how close relationships between the individual members of the classes were, i.e. some classes may be very tight knit while others could maintain closer friendships to those from other classes or outside of school. All of these factors might have contributed noise to the data obtained in this study, leading to some of the inconsistencies found. Future studies that utilise this method would benefit from a larger sample size that covers a wider age range (both younger and older age groups). With more data, researchers may be able to pinpoint the exact age at which the impact of social reciprocity on cooperative investment emerges and eventually stabilises.

5.6 Conclusion

More than simply investing in peers that they like, adolescents (13 to 17 years) additionally invested more in those who positively reciprocated their friendship. The impact of social reciprocity on cooperative investment was found in early-mid adolescents (13 years) but was not yet stable even in late (17 years) adolescents. In 14 to 17 year olds, both cultures reported similar levels of social reciprocity impact, but social ties (how much one likes another) affected cooperative investment decisions in British adolescents more so than Malaysians. Finally, the more prosocial and independent, and the less interdependent, the more the adolescent invested in peers. The myriad of findings from this study (some expected, others not) suggests that the factors driving cooperative investment decisions in adolescents are complex and context dependent.

6. General discussion

The collection of cross-sectional studies outlined in this thesis aimed to map out the development of social cognition across the adolescent years, and to further compare developmental trends between cultures where the social pressures of adolescence may be different. Using a multi-methods approach, which included self-report measures, story-based social cognitive tasks, and a combined social network and behavioural economics paradigm, multiple aspects of social cognition were assessed in young people from three countries – Malaysia, China, and the United Kingdom.

In this Chapter, I will present a summary of key findings from these studies, discussing them in terms of their strengths and limitations. I will then highlight the potential implications of this research for forming a holistic understanding of adolescent social development, and suggest directions for future research.

6.1 Summary of key findings

Empirical investigation of social cognition in the adolescent years is a field on the cusp of burgeoning, although still relatively scarce when compared to research on early childhood development. Further, existing studies on adolescent social cognition have focused largely on young people from Western contemporary societies, providing a potentially skewed understanding of development (see Henrich, Heine, & Norenzayan, 2010 for an opinion of the bias in psychology research towards Western, educated, industrialised, rich, and democratic – W.E.I.R.D. – populations). The findings from this thesis begin to shed light on the potential effects of wider sociocultural influences on social

cognitive development across adolescence. It highlights interesting differences (but also similarities) across and within the boundaries of culture on adolescent social cognition. These are as follows.

First, there exist significant variations across cultures in the way young people (nine to 21 years) define themselves as social agents, in particular in terms of their relationship to others and their social roles within a group, i.e. their interdependent selves (Chapter 2). Specifically, Chinese adolescents were more interdependent, while Malaysian and British adolescents were more independent. Next, cognitive and affective aspects of theory of mind (ToM) were shown to improve cross-sectionally with age in both British (10 to 21 years) and Chinese adolescents (nine to 17 years), at times even when accounting for gender and the development in domain-general cognitive abilities, although not always (Chapters 3 and 4). Interestingly, within authentic peer networks, younger and older adolescents (13 to 17 years) used information on social reciprocity, which is presumably underscored by social cognitive skills, equally to make cooperative investment decisions (Chapter 4). The impact of social reciprocity on adolescent cooperative investment did not differ between cultures, and the slopes of developmental trajectories for ToM abilities were also similar between cultures, although Chinese adolescents reported lower ToM performance overall compared to the British.

The first hypothesis outlined in this thesis was that young people from the countries sampled would be characterised by culture-bound construals of the self, similar to that found in adults (Bochner, 1994; Watkins et al., 1998; Markus & Kitayama, 1991; Hofstede, 1980). To this end, significant variations emerged in the interdependent self, but not the independent self (Chapter 2).

Specifically, Chinese adolescents were more interdependent than adolescents from both the UK and Malaysia. The distinction in the interdependent self between Chinese and British adolescents is in line with existing literature in adults (Bochner, 1994; Eaton & Louw, 2000; Rhee et al., 1995), and suggests that cultural variations exist from a young age in how individuals identify themselves socially. The lack of difference in independence across cultures may be unique to the adolescent period, as it is a time of increasing autonomy for individuals, perhaps across all cultures (Schlegel & Barry, 1991; Blos, 1979; Steinberg, 2002; 2008). In this sample, there was indeed an increase in independence with age across adolescence, but this may be driven by mean age differences across the cultural groups (British adolescents were older than Chinese adolescents), which did not allow for conclusive interpretation of age effects. Interestingly, Malaysian adolescents reported lower self-construal scores overall, and were unexpectedly more independent than interdependent. This finding highlights the multifaceted nature of culture and the differences between cultures that exist within broad regional definitions, such as East and West. It is thus important to collect up-to-date empirical data and to include more cultures within studies to obtain a more comprehensive cultural picture.

The second hypothesis of continued maturation of social cognitive abilities across adolescence was partially supported. While experimentally tested social cognitive abilities, i.e. cognitive and affective ToM, showed clear improvements across adolescence in both China and the UK, the behavioural impact of social reciprocity on cooperative investment decisions did not increase with age in either Malaysia or the UK, contrary to Burnett Heyes et al. (2015). These results suggest that while social cognitive abilities continue to be refined

and improved upon across adolescence, the basic ability to see yourself through other people's eyes, i.e. social reciprocity within authentic peer networks, and the propensity to use this information in cooperative behaviour might be present from a younger age than initially thought. As the social networks paradigm is a naturalistic task that reflects authentic relationships, it is also possible that younger adolescents' social interactions and behaviours are simpler and easier to read, thus requiring less sophisticated social cognitive abilities to understand. As adolescents grow older, relationships become more complex (Bagwell & Schmidt, 2011), possibly requiring more matured social cognitive abilities to accurately predict social reciprocity. Thus, disparity in relationship complexity across age may have led to the similar levels of social reciprocity impact on cooperative investments found in younger and older adolescents. Should a younger adolescent have to navigate a peer network of older adolescents, they may then encounter more problems predicting social reciprocity. These findings highlight the effects of task demands and difficulty levels on eliciting developmental effects in social cognition.

With regards to the final question of cultural effects on social cognition, cross-cultural analyses revealed interesting differences, but also similarities, between the cultures. While there was a cultural difference in ToM abilities overall, i.e. Chinese adolescents performed worse than British adolescents, the developmental trajectories were similar across cultures (Chapter 4). Furthermore, there was little difference between British and Malaysian adolescents in using social reciprocity in cooperative investment decisions (Chapter 5). Across studies, similarities between British adolescents with Malaysians and differences with their Chinese counterparts point to the

complexity and changing nature of culture. Overall lower performance in Chinese adolescents in ToM may have been driven by certain sociocultural practices and values or by task artefacts. It is also likely that differences or similarities between cultures stem from the degree to which adolescents live in a society where they are exposed to or restricted from ideologies from other cultures. This may be facilitated by their socioeconomic background, which would afford them access to computers and up-to-date media from the rest of the world. It is worth noting that adolescents from Malaysia and the UK were from similar SES backgrounds (FAS scores: UK = 7.00; Malaysia = 7.49), while Chinese adolescents were from lower SES families (FAS scores = 5.44). In a number of settings (e.g. self-construal ratings, affective ToM performance in Chinese adolescents), socioeconomic status significantly affected results. Furthermore, the structural confines of a society may also have an important role to play, e.g. the Chinese but not Malaysian government restricts access to Western social media on the Internet. Despite past literature that suggests a positive impact of having siblings on early ToM development (McAlister & Peterson, 2007; Perner et al., 1994), no sibling effects were found for ToM development in adolescence, nor did it fully mediate the effect of culture (Chapter 4).

Interesting gender effects on social cognition also emerged across the studies within this thesis. First, males were more independent than interdependent, and also more independent than females, while females embraced neither self-construal more than the other (Chapter 2; largely in line with Cross et al., 2010; Cross & Madson, 1997; Kashima & Hardie, 2000; Gabriel & Gardner, 1999). In terms of social cognitive development, while younger

British males performed worse on the cognitive ToM task SF than females, older adolescent males and females performed comparably (Chapter 3). In contrast, there was no difference between Chinese males and females on SF performance (Chapter 4). For affective ToM, both cultures reported female advantage on EI, but this effect was stronger for the Chinese sample. Taken together, results suggest that gender differences in ToM performance may rely in part on task difficulty. This may help explain results from studies that have not found gender differences in ToM (Jahromi & Sifter, 2008; Ronald et al., 2006). When an effect of gender was found, it was adolescent females who consistently performed better than males across both cultures, in line with past studies that have shown similar female superiority in ToM abilities in both children and adults (Devine & Hughes, 2013; Baron-Cohen et al., 1997; Hall, 1978; Calero et al., 2013). Gender differences were particularly evident for affective ToM, which might lend support to theories that suggest protracted maturation of affective compared to cognitive ToM (Shamay-Tsoory, 2011), as males may only 'catch up' to females at a later age. However, it is important to note that the studies in this thesis cannot tease apart effects of task difficulty levels from true developmental differences between cognitive and affective ToM.

Development of cognitive predictors (all of which showed expected age associated improvements across both cultures) showed task dependent associations to ToM performance (Chapters 3 & 4). Working memory showed the strongest link to SF while verbal ability was most associated with EI. This was possibly due to task demands, i.e. SF required participants to follow characters' actions in a movie while EI and SS required participants to read about characters in stories. Nevertheless, the associations found between working memory and

verbal ability with ToM is largely in line with previous studies on earlier development (Devine & Hughes, 2013; Hughes, 1998; Astington & Jenkins, 1999; Happé, 1994; Ronald et al., 2006; Watson et al., 2001; Ruffman et al., 2003; Davis & Pratt, 1995; Keenan, Olson, & Marini, 1998). Interestingly, matrix reasoning, which measures fluid intelligence, perceptual reasoning, and general intellectual/cognitive abilities, reported the weakest link to ToM across both cultures (in contrast to existing literature; Ibanez et al., 2013; Huepe et al., 2011). While at times initially correlated with ToM, its association was mediated by other factors in the regression models (e.g. age and other cognitive predictors).

6.2 Limitations

Multicultural research poses a unique set of challenges, not least of which are logistical and methodological in nature. First, the studies were carried out with the help of a number of research assistants across various settings (e.g. school classrooms, University computer labs and experimental testing rooms). While every effort was made to standardise testing and to ensure conditions were similar across all participants, it is possible that there exists some variations that may have affected performance. For example, the fact that some of the participants were group tested instead of tested individually was not ideal. However, in all such instances, statistical steps were taken to check for any potential effects and participants were excluded if necessary. It was also difficult to gain access to perfectly matched samples across the cultures. As such, there were differences in age and SES between the cultural samples, although again, these were accounted for statistically. However, this reduced the sample size and limited conclusions that could be drawn (e.g. age effects on the independent self-construal). Furthermore, the cultural appropriateness of certain measures used

remains a concern, and have been discussed at length in Chapter 4.

Second, the age ranges included in this thesis might not have been wide enough to tease apart certain effects and interactions of interest. For example, changes in self-construal occur throughout the lifespan (Takata, 1999). In all instances, cultural differences in trajectories of social development might possibly emerge earlier or later in life, which would not have been captured by these studies. Slopes depicting cross-sectional improvements across age on the SF task (Figure 4.2) would suggest that Chinese adolescents may start to perform comparably to their British counterparts in later adolescence (over 17 years), but this could not be ascertained by the current study. Similarly, it would be interesting to examine the developmental trajectories of females and males across a wider age span to map out the age at which they might interact.

Finally, all studies carried out for this thesis were cross-sectional in nature. As such, only limited conclusions can be drawn regarding the developmental trajectories of social cognitive abilities. Individual differences in performance across the age groups might have masked some of the age effects on social development, in particular in the social networks study. Longitudinal designs would allow researchers to track changes in the variables that influence cooperative behaviour within a social network over multiple time points, providing a richer resource of social information, and which may be robust against transient factors that may influence decision-making. Furthermore, longitudinal studies would be able to examine whether early childhood performance on social tasks, such as the false belief task, might predict performance on more advanced social cognitive tasks, such as the Silent Films or

Emotional Inference task, during adolescence. This would also allow researchers to map out causal relationships between culture, individual differences in gender, and domain general cognitive development with social cognitive development in adolescence.

6.3 Implications and future directions

This body of work adds to a small but growing area of literature that aims to map out adolescent social cognitive development in a culturally inclusive manner. This is important for a number of reasons. Firstly, cultural comparisons of social development such as those outlined in this thesis provide important insight into the age-old nature vs. nurture debate; these studies begin to tease apart development that maybe universal from that which maybe culturally shaped. The lack of cultural inclusion in the investigation of development generates a potentially skewed, possibly inaccurate, and undoubtedly incomplete picture of adolescent social cognition. Using a multiculturalist approach in developmental research also serves to mitigate increasing concerns over the lack of stability and reproducibility of psychological findings in general (Open Science Collaboration, 2015), as well as developmental psychology specifically (Duncan, Engel, Claessens, & Dowsett, 2014; Nielsen & Haun, 2016).

Neuroscience research on the developing brain can also benefit from an understanding of the behavioural differences and similarities in social cognition between adolescents from different cultures (Choudhury, 2010). Pertinently, there is a striking paucity in today's literature regarding the developmental trajectory of the brain circuits underlying social development across adolescence that is culturally sensitive (Frank & Temple, 2009). Exceedingly few studies on

the maturation of relevant brain circuits across adolescence has been undertaken outside of the Western world. Might behavioural differences found in adolescent social cognition (Chapter 4) be reflected on a neural level? And where behavioural differences are not found (Chapter 5), might adolescents from different cultures recruit the same brain circuits to achieve the same results, or are there ‘many ways to be right’? If, as Crone and Dahl (2012) suggest, adolescent brain maturation is an adaptive function that is driven by goal flexibility and social engagement, it might be reasonable to assume that trajectories would follow slightly different paths or timelines, depending on the various cultural and social pressures experienced. The few existing neuroimaging studies on adults and children seem to suggest that this is indeed the case (Kobayashi et al., 2006; 2007).

FMRI studies are also well poised to contribute to establishing the validity of the behavioural social cognitive tasks used, by investigating whether or not relevant brain areas are recruited when performing these tasks, although researchers would need to be cautious about making reverse inferences. Furthermore, it might explain the differences in ToM performance levels found between British and Chinese adolescents. Should the hypothesis that Chinese adolescents confound perspective taking abilities with a weakened self-other distinction, we might expect heightened mPFC (person-centred thoughts) activity in Chinese adolescents compared to British adolescents during ToM tasks, similar to Japanese individuals (Kobayashi et al., 2006; 2007). Moreover, given that these abilities arise from the response of a network of key regions, i.e. the social brain network, it might also be reasonable to expect cultural

differences in the functional connectivity between these areas.

Developmental trajectories for the areas implicated in key aspects of social cognition such as perspective taking and self-other distinction, (Blakemore, 2008; Mills et al., 2014), and the strength of connections between these regions (Burnett & Blakemore, 2009; Kelly et al., 2009), may also show slightly different peaks and changes across age in adolescents from different cultures.

Constructing a culturally holistic view of adolescent social development may also have important clinical implications. Adolescence is a period when many behavioural and mood disorders – anxiety, depression, and substance abuse – have their onset (Kessler et al., 2005; Hankin & Abramson, 2001; Costello, Mustillo, Erkanli, Keeler, & Angold, 2003; Gregory et al., 2007), but we also see stark differences in epidemiology of these disorders across different cultures (Demyttenaere et al., 2004; Kessler et al., 2007; Patel, Flisher, Hetrick, & McGorry, 2007). For example, while East Asians typically report higher levels of social anxiety (Dinnel, Kleinknecht, Tanaka-Matsumi, 2002; Hong & Woody, 2007), they also record lower rates of SAD diagnoses than the West (Hoffman, Asnaani, & Hinton, 2010). Differences in diagnostic criteria, the expression of disorders and cultural acceptance of socially anxious behaviour across cultures may underlie this discrepancy.

Where cultural values differ, the expression of social emotional disorders may also take on distinct forms, as so-called culture-bound syndromes. One such example is the prevalence of Taijin kyofusho (TKS) in cultures such as Japan and Korea (Hofmann, Asnaani, & Hinton, 2010). TKS is thought to be a culture-specific expression of Social Anxiety Disorder (SAD) as defined in the DSM,

although it has been shown to exist in individuals outside of East Asia (Choy et al., 2008). The major difference from typical SAD in Western cultures is that a person with TKS is concerned about doing something, or presenting an appearance, that will offend or embarrass the other person, i.e. relational, allocentric social fears while in contrast, SAD is defined as the fear of embarrassing oneself, i.e. egocentric social fears. The specific overlap and distinction between SAD and TKS, and the cultural-specificity of TKS, is not currently clearly defined (Sakurai et al., 2005; Nakamura, 2006), although both report different correlates across cultures (Choy et al., 2008; Kleinknecht et al., 1997).

As previously discussed, not only do prevalence rates and symptomatic expressions of social and emotional disorders vary across cultures, the very correlates that underlie them are mutable as well (Essau et al., 2008; Chen et al., 1992; 1995a; 1998; Greenberger et al., 2000; Boivin et al., 1995; Rubin et al., 1995; and see Chapter 1, p.21 for more details). Thus, understanding cultural differences in typical social development during these crucial years may be the first step into uncovering the potentially different risk and protective markers for these debilitating disorders. By mapping out typical patterns of development in a culturally specific manner, it would help us to identify when trajectories deviate from the norm, potentially leading to disorders.

It is my hope that this research, and the research that builds upon this, will feed into debate on steps that can be taken to optimise adolescent social development and wellbeing worldwide. Across borders and cultures, the provision of appropriate social support and mental health services is crucial for

society's young people. As the foundation of our future, adolescents need to be provided with adequate frameworks of support, within which they can explore, grow, and flourish. In many cases, it is clear that one size does not fit all.

6.4 Concluding remarks

Adolescence is a period when many changes occur in social behaviour, driven by the protracted maturation of underlying social cognitive abilities. These abilities are in turn underscored by individual differences in gender and general cognitive abilities. Furthermore, wider sociocultural influences, both across and within country borders, act to shape the way adolescents construe themselves, as well as their understanding of and interaction with others. This relationship is multifaceted and complex, with many differences as well as similarities across cultures. Future research should aim to establish culturally appropriate tasks to further disentangle these effects, and to build a holistic picture of adolescent social cognitive development.

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Appendix A

Factorability of SCS items for Principal Component Analysis

Whole sample

Across all participants, the factorability of the 30 SCS items was examined using several recognised criteria. First, the Kaiser-Meyer-Olkin measure of sampling adequacy was .887, well above the recommended value of .6 (Kaiser, 1974; Hutcheson & Sofroniou, 1999). Further, Bartlett's test of sphericity was significant ($\chi^2(435) = 5035.977, p < .001$), confirming that the items did not form an identity matrix. The diagonals of the anti-image correlation matrix were all over .5 and finally, item communalities were all above .35, confirming that each item shared some common variance with other items. Given these overall indicators, principal component analysis was conducted with all 30 items.

United Kingdom

First, the item "I act the same way no matter who I am with" was removed due to its anti-image correlation of below .5, and the analysis was run again with 29 items.

The resulting diagonals of the anti-image correlation matrix were all over .5. The Kaiser-Meyer-Olkin measure of sampling adequacy for this dataset was good (KMO = .815). Bartlett's test of sphericity was significant ($\chi^2(406) = 1822.19, p < .001$), confirming the absence of singularity.

Malaysia

The Kaiser-Meyer-Olkin measure of sampling adequacy for this dataset was good (KMO = .866). Bartlett's test of sphericity was significant ($\chi^2(435) = 2446.12, p < .001$), confirming the absence of singularity. The diagonals of the

anti-image correlation matrix were all over .5, supporting the inclusion of every item in this analysis.

China

The Kaiser-Meyer-Olkin measure of sampling adequacy for this dataset was good (KMO = .792). Bartlett's test of sphericity was significant ($\chi^2 (435) = 1765.06, p = .0000$), confirming the absence of singularity. The diagonals of the anti-image correlation matrix were all over .5. As such, PCA with two factors specified was run on all items in this analysis.

Appendix B

A newly developed Emotional Inference task

Social situations

Experiment guide

This task should be displayed on the computer screen. Participants should press a key to move from one scene to another. The lines below indicate text that should appear in a new scene.

There is no time limit for this task. However, the story should **NOT** remain on screen when the question appears. Questions and their four answer choices should appear together.

Participants should only be allowed to choose one answer before moving on.

This is the male version of the task. The versions differ only in that certain items refer to the character's boy/girlfriend accordingly.

Correct answers are in **bold** below.

Instructions

Pretend that you are a character in the following story.

At the end of some scenes you will be asked a question, and given four answer choices.

More than one answer may seem suitable, but based **ONLY** on the information given, choose the answer you think is most likely/most accurate.

Practice trial

You are taking part in a Psychology experiment at [the University of Oxford].

What are you feeling?

- a. Tired
- b. Excited
- c. Miserable
- d. Lazy

Great, you're now ready to begin!

It's the weekend, and you decide to head to the shops to meet some friends.

You see Mary-Anne walking down the street.

You had seen her fighting with her boyfriend in school yesterday, and know that they had broken up. Later, you heard her crying in the classroom.

You don't think she noticed that you were there, however. As she approaches she gives you a small smile but doesn't say anything.

What do you think Mary-Anne is feeling?

- a. Happy
 - b. Sad**
 - c. Confused
 - d. Relieved
-

You know that she is a very private person and you are not very close to her. However, you are worried about her, and want to know how she feels about the break up.

She glances back at you. You ask, "How are you?"

Mary-Anne blushes and gives a little shrug, before walking away quickly.

What do you think Mary-Anne is feeling?

- a. Guilty
 - b. Afraid
 - c. Annoyed
 - d. Embarrassed**
-

As you continue on your way, you meet Toby, Mary-Anne's ex-boyfriend. He is looking for her and wants to get back together.

He is fidgety and seems to be sweating.

What do you think Toby is feeling?

- a. Bored
 - b. Angry
 - c. Nervous**
 - d. Sad
-

He had seen you with her earlier and asks you which direction she left to. You point him in the right direction and continue on your way to your friends.

When you reach your friends Steven comes up to greet you.

“Look! It finally came, your birthday present!” He says, holding out a brightly wrapped package to you.

He has been talking about it for weeks, saying that it is sure to be the best birthday present you have ever gotten.

He looks at you with a grin.

What do you think Steven is feeling?

- a. **Excited**
 - b. Brave
 - c. Amused
 - d. Relieved
-

You've been really looking forward to it, and unwrap it eagerly.

Unfortunately, you discover what you think is the ugliest pair of sneakers you've ever seen.

You are very disappointed but you know that Steven put a lot of effort into picking it.

He is looking at you expectantly. You say brightly, "They're lovely, Steven! Thank you!" You look up and catch his eye.

What do you think Steven is feeling?

- a. Polite
 - b. Nervous
 - c. Disappointed
 - d. Proud**
-

How do you think he would feel if you had told him the truth?

- a. Disappointed**
 - b. Relaxed
 - c. Proud
 - d. Nervous
-

You pack away the sneakers for now.

"So I heard your parents got you a pet for your birthday! How do you like it?"
Asks Steven.

"Oh it's great," you say, "It loves to scurry around its cage. I don't let it out much though, because it sheds, and I'm worried it might get lost, or worse, I might step on it!"

What pet did your parents get you?

- a. Rabbit
 - b. Dog
 - c. Hamster**
 - d. Iguana
-

As you move to join the rest of the group, you notice Chris and Alex, who are brothers, arguing as usual.

"Why did you tell Mom I snuck out last night? You should've just said I was asleep! I'm going to be in so much trouble!" Chris says.

"Because you did sneak out!" Alex answers, "And you told Dad that I failed Maths last week, so it would serve you right!"

Alex told his parents that Chris snuck out because he feels:

- a. Jealous
 - b. Brave
 - c. Stressed
 - d. Vengeful**
-

"Well, you did fail Maths Alex!" says Chris, looking intensely at his brother.

You come up and say hi but Chris doesn't answer.

What do you think Chris is feeling?

- a. Jealous
 - b. Annoyed**
 - c. Rude
 - d. Disgusted
-

"Fine, I'll tell Mom that you were watching TV instead if you tell her I was studying!" says Alex.

"Fine!" Chris rolls his eyes and sighs, finally acknowledging you with a small nod.

What do you think Chris is feeling?

- a. Tired
 - b. Pleased
 - c. Relieved**
 - d. Friendly
-

What do you think their mom would feel if she knew the truth?

- a. Pleased
 - b. Anxious
 - c. Relieved
 - d. Angry**
-

Alex turns to the group and apologises, 'Sorry about the fighting guys, brothers, you know?' Although it has been getting on your nerves slightly you assure him that it's okay.

You and your friends decide to have lunch, and head to a restaurant nearby.

Along the way, your best friend Amy stops at a shop to get some stuff for her upcoming holiday. She buys a map, a compass, matches, mosquito repellent and a book.

Where do you think Amy is going on holiday?

- a. Beach
 - b. Cruise
 - c. Camping**
 - d. Fishing
-

At the counter, the cashier informs Amy that three 500ml bottles of water cost £1.20, and a large 1l bottle of water costs £1. Amy exchanges her large bottle for three small ones.

This makes sense because

- a. Small bottles are better
 - b. It is better for the environment
 - c. There is more value for money**
 - d. The cashier said so
-

You all continue to the restaurant.

As you are walking, there is a loud, sudden bang. Amy jumps up and grabs Alex's hand, letting out a tiny squeal.

Amy does this because she is

- a. **Surprised**
 - b. Excited
 - c. Friendly
 - d. Happy
-

You all turn to look at her, alarmed at her reaction. Alex laughs loudly to himself.

What do you think Alex is feeling?

- a. Awkward
 - b. **Amused**
 - c. Happy
 - d. Confused
-

Amy quickly lets go of Alex's hand and walks ahead without looking at anyone.

What do you think Amy is feeling?

- a. Relieved
 - b. Frightened
 - c. Unfriendly
 - d. **Embarrassed**
-

Alex stops laughing immediately and tries to call after her.

What do you think Alex is feeling?

- a. Hurt
 - b. **Guilty**
 - c. Irritated
 - d. Pleased
-

You know that Amy has had a crush on Alex for weeks now. You are the only one she's told and you know she's quite embarrassed about it. However, her reaction amuses you a lot. You catch up to her to tease her.

Behind you, Steven exclaims loudly. "Ow! That hurt! Why did you throw that at me?" He glares at Chris.

"Oh don't be a baby, " says Chris, "That was tiny!"

"Yeah, but it was heavy and had sharp edges!" Says Steven.

"Alright, alright, sorry," Chris grins sheepishly.

What do you think Chris threw at Steven?

- a. **Stone**
- b. Leaf
- c. Book
- d. Twig

As you walk, people around you start putting their hoods up and looking down as they walk.

"Ooh, it's so cold!" Amy scrunches up her face as she speaks, but you can barely hear her over the howling around you.

You all speed up to escape indoors.

What do you think the weather is like?

- a. Sunny
- b. Rainy
- c. Snowing
- d. **Windy**

You have lunch at a rather posh and quiet restaurant.

When your stew comes, the waiter accidentally spills a lot of it on your favourite pair of jeans. The waiter apologises and offers to let you have your meal free of charge in return. You accept the offer and head to the toilet to clean up.

When you come out of the toilet you notice your girlfriend, Sam sitting on a bench outside with another boy.

They are laughing and sitting pretty close together. You see her nudge his side at one point.

What do you think Sam is feeling?

- a. Guilty
 - b. Boastful
 - c. Friendly**
 - d. Nervous
-

She had told you that she could not see you today due to family reasons, so you are sure she has lied to you, to be with another boy! You go out immediately to find out what's going on.

As it turns out she is there with her cousin, Julian, who is visiting for the day.

You invite them to join and your friends, and they happily agree. You return to your table together.

During lunch you get an email on your phone saying that your application to an exciting summer camp has been successful.

You've been really nervous about it as you really want this opportunity, and you spent weeks on the application.

You are extremely happy and want to share the good news with everyone! However, you know that Chris' application had been rejected last week.

Although you are hesitant at first, eventually you tell them the good news. Your friends are all very happy for you. Everyone, Chris included, congratulates you warmly, saying you deserve it!

However, you overhear Chris telling Alex that he doesn't think it's that great an opportunity.

What do you think Chris might be feeling?

- a. Jealous**
 - b. Concerned
 - c. Serious
 - d. Doubtful
-

During lunch, Alex and Sam are discussing their favourite subjects.

"I just love learning about how different life was back then," says Sam.

"Ah, but I hate having to remember all those different dates and names!" Alex responds.

What is Sam's favourite subject?

- a. Psychology
 - b. Economics
 - c. Geography
 - d. History**
-

"I much prefer learning about different countries and their minerals!" Alex continues.

What is Alex's favourite subject?

- a. Chemistry
 - b. Sociology
 - c. Geography**
 - d. History
-

After eating a whole roast chicken during lunch, Steven rubs his belly and lets out a big burp.

He sighs very heavily, stretching his arms and legs out.

What do you think Steven is feeling?

- a. Powerful
 - b. Satisfied**
 - c. Tired
 - d. Sad
-

Amy, who was in the middle of talking to Steven, stops abruptly, frowns, and wrinkles her nose. She turns her head away for a while.

What do you think Amy is feeling?

- a. Sad
 - b. Unfriendly
 - c. Disgusted**
 - d. Upset
-

Not quite sure what to do, Steven goes on to burp out the alphabet.

While the rest of you turn away and beg him to stop, Chris looks at him wide-eyed, not saying a single word.

"How do you do that?" He finally asks when Steven is done.

What do you think Chris is feeling?

- a. Disgusted
 - b. Impressed**
 - c. Lonely
 - d. Hopeful
-

Steven grins widely. "Do you want me to teach you?"

Chris nods his head very quickly, leaning forwards towards Steven.

You try to make conversation with Chris but he waves you away.

What do you think Chris is feeling?

- a. Interested**
 - b. Unfriendly
 - c. Jealous
 - d. Proud
-

"Gosh, I bet you can't do it again anyway!" Says Alex.

Steven puffs his chest up and says, "Of course I can!"

"Go on then, show us!" demands Alex.

What do you think Steven is feeling?

- a. Nervous
 - b. Proud**
 - c. Angry
 - d. Happy
-

Steven sits upright and looks like he is concentrating very hard.

Just as you think he is about to start, he lets out a huge, loud fart instead! The whole restaurant goes quiet.

It is hilarious but you know how embarrassing it must be! You try to stifle it but you can't help laughing your butt off.

After this, Steven turns very red and quiet.

In fact, he insists that you all leave immediately, so you quickly pay the bill and leave.

Outside, you say a warm goodbye to your friends and head for home.

As you are leaving you notice Toby and Mary-Anne walking along the street hand-in-hand.

They are both smiling widely and talking.

They look in your direction but they don't acknowledge you.

What do you think they are feeling?

- a. Happy**
 - b. Rude
 - c. Indifferent
 - d. Friendly
-

It seems there is hope for everyone after all.

You spend the rest of your journey home wondering at the oddity of human behaviour.

The End

Appendix C

Instruction booklet and task checklist for British experimenters

Task Battery Checklist 2014/5

Social Cognition Tasks	Comments					✓
Strange Stories						
Silent Films						
Social Situations						
Overlap task						
Cognitive tasks	Comments					✓
Forwards digit span						
Backwards digit span						
Letter-Digit substitution						
Colour Stroop						
Verbal ability						
Matrix Reasoning						
Questionnaires	Comments					✓
Peterson Development Scale						
Interpersonal Reactivity Index						
Revised UCLA Loneliness Scale						
Family Affluence Scale II						
Self-construal Scale						
Autism Quotient						
Social Anxiety Scale						
Interview	None		Short		Long	
General Comments:						

Task Battery Instructions Booklet (2014/5)

*Make sure to ask if participant wants/needs a break after every task.

Social Cognition tasks

Strange stories (Happe, 1994)

Data Collection:

- Matlab: RUN_STORIES('ID', group)
- Record each answer as verbal audio file as well just in case
- Assign group 1 (non ToM first) & 2 (ToM first) randomly (half & half)
- Write down answers on response sheet

Instructions:

For your first task, I'm going to show you a few short stories on the computer. You will need to read each story very carefully. After each story, there will be a question. The story will not remain on the screen while you answer the question. Your answer doesn't have to be long. Just give me the best answer you can think of. If you don't know, try guessing as sometimes guesses are right.

Do you have any questions? Ok. Let's start.

Question set

Practice

On Christmas Eve Alice's mother takes her to the big department store in town. They go to look in the toy department. In the toy department Mr. Brown, Alice's next-door neighbour, is dressed up as Santa Claus, giving out sweets to all the children. Alice thinks she recognises Mr. Brown, so she runs up to him and asks, 'Who are you?' Mr. Brown answers, 'I'm Santa Claus!'

Why does he say this?

Question 1

Two enemy powers have been at war for a very long time. Each army has won several battles, but now the outcome could go either way. The forces are equally matched. However, the Blue army is stronger than the Yellow army in foot soldiers and artillery. But the Yellow army is stronger than the Blue Army in air power. On the day of the final battle, which will decide the outcome of the war, there is heavy fog over the mountains where the fighting is about to occur. Low-lying clouds hang above the soldiers. By the end of the day the Blue army has won.

Why did the Blue army win?

Question 2

A burglar is about to break into a jewelers' shop. He skillfully picks the lock on the shop door. Carefully he crawls under the electronic detector beam. If he breaks this beam it will set off the alarm. Quietly he opens the door of the store-room and sees the gems glittering. As he reaches out, however, he steps on something soft. He hears a screech and something small and furry runs out past him, towards the shop door. Immediately the alarm sounds.

Why did the alarm go off?

Question 3

Henry is preparing for a big dinner party. He is famous for his excellent mayonnaise. He has bought lots of fresh eggs. The recipe says, 'Carefully separate the yolks of six eggs and add oil very gradually'. He has already bought easily enough dessert to feed everyone. However, he now looks up the recipe for meringues. Henry will not waste anything.

Why does Henry make meringues?

Question 4

Paul is very rich, and today he is going to buy an expensive new car. He is considering whether to make a single payment, or whether to spread the cost over the year. If he pays in monthly installments, the dealer will charge five percent interest on the loan. His bank currently gives him eight percent interest on the money in his account. Even though he has easily enough money to pay the full amount, he decides to pay by monthly installments.

Why does he do that?

Question 5

Old Mrs. Robinson is very frail. One day she slips on her icy door step and falls on her side. She gets up right away, although she feels quite bruised and shaken. The next day her leg feels very stiff and she can scarcely walk. She makes her way to the doctors. As soon as the doctor hears about the fall, and sees her swollen side, he says, 'Go immediately to casualty'. At the casualty department they take an X-ray.

Why did they take an X-ray?

Question 6

During the war, the Red army captures a member of the Blue army. They want him to tell them where his army's tanks are; they know they are either by the sea or in the mountains. They know that the prisoner will not want to tell them, he will want to save his army, and so he will certainly lie to them. The prisoner is very brave and very clever; he will not let them find his tanks. The tanks are really in the mountains. Now when the other side asks him where his tanks are, he says, 'They are in the mountains.'

Why did the prisoner say that?

Question 7

Brian is always hungry. Today at school it is his favourite meal: sausages and beans. He is a very greedy boy, and he would like to have more sausages than anybody else, even though his mother will have made him a lovely meal when he gets home! But everyone is allowed two sausages and no more. When it is Brian's turn to be served, he says, 'Oh, please can I have four sausages, because I won't be having any dinner when I get home!'

Why does Brian say this?

Question 8

A burglar who has just robbed a shop is making his getaway. As he is running home, a policeman on his beat sees him drop his glove. He doesn't know the man is a burglar; he just wants to tell him he dropped his glove. But when the policeman shouts out to the burglar 'Hey, you! Stop!', the burglar turns around, sees the policeman and gives himself up. He puts his hands up and admits that he did the break-in at the local shop."

Why did the burglar do that?

Question 9

Simon is a big liar. Simon's brother Jim knows this, he knows that Simon never tells the truth! Now yesterday Simon stole Jim's ping-pong paddle, and Jim knows Simon has hidden it somewhere, though he can't find it. He's very cross. So he finds Simon and he says, 'Where is my ping-pong paddle? You must have hidden it either in the cupboard or under your bed, because I've looked everywhere else. Where is it, in the cupboard or under your bed?' Simon tells him the paddle is under his bed."

Why will Jim look in the cupboard for the paddle?

Question 10

Late one night Mrs. Peabody is walking home. She doesn't like walking home alone in the dark because she is always afraid that someone will attack her and rob her. She really is a very nervous person! Suddenly, out of the shadows comes a man. He wants to ask Mrs. Peabody what time it is, so he walks toward her. When Mrs Peabody sees the man coming toward her, she starts to tremble and says, 'Take my purse, just don't hurt me please!'

Why did she say that?

Silent Films Task (Devine & Hughes, 2012)

Data Collection:

- Superlab
- Record verbal responses as audio file.

Instructions

Now for a fun task! In this activity we're going to watch some short film clips on my computer. These clips are from an old silent film. Have you ever seen a silent film before? How is it different to the kinds of films you watch now?

Prompt: *There's no sound; it's black and white; it's like miming.*

Show: Picture of Mildred and Harold (on next page).

I'm now going to show you 5 short clips from an old silent film. In this film there are two characters: Harold and Mildred (point to characters). I'm going to show you each clip once and after it there'll be a short question about the clip. All you have to do is watch each clip carefully. When the clip is over, I'll ask you the question and you can tell me your answer.

Check Comprehension:

- *How many times will the clip be played?*
- *What do you have to do after the clip?*

Do you have any questions before we start off?

OK, let's start.

Social Situations

Data collection:

- Matlab: RUN_SOCIALSITUATIONS_Updated('ID', group)
- Assign group 1 (female) and 2 (male) accordingly

Like the first task, you will read a short story on the computer. Along the way you will be asked questions about the characters in the story. At times, you will also be asked to rate how likely it is for you to act in a certain way in a certain situation.

Okay, do you have any questions?

If you don't understand a word, let me know.

Director Task

Data collection:

- Matlab: RUN_DIRECTOR_ONLY('ID', group)
- Assign testlist 1-6 randomly

Instructions:

This game looks at people's ability to follow instructions on the computer.

Here is an example of what you will see on the computer [showing picture example]. You will be presented with a grid with several objects located in the slots. The director, who is on the other side of the grid, will give you instructions on which objects to move and where to move them. As you can see, there are several covered slots. You are able to see the objects in these slots, but the director cannot.

This is how things look for the director [show slide of the array from director's point of view]. The director does not know what is behind the covered slots, so it will be important to take his point of view into account when you follow his instructions.

[Go back to the first picture] For example you can see the car, and because this slot is not covered, [Go to the director's point of view picture], the director can see the car too.

[Go back to the first picture] Let's do another one. You can see the red apple, but because this slot is covered, [Go to the director's point of view picture], the director cannot see the apple.

[Go back to the first picture] Can you show me another object which the director cannot see? [Wait for a response] ... Yes that's right [Go to the director's point of view picture], the director cannot see the telephone/watch/nail varnish.

[Go back to the first picture] Now can you show me an object that the director can see? [Wait for a response]... [Go to the director's point of view picture], yes that's right the director can see the scissors/person/car/goose.

[Repeat until it seems the participant understands].

So remember, when you follow the director's instructions, it's important to take his point of view into account. But when moving the object "right" or "left" move it according to your own point of view. So, your left and your right. Okay?

In this game, all you have to do is listen to the director's instructions, WAIT UNTIL HE FINISHES TALKING and then use the mouse to move the object you think he is talking about.

You should do this as quickly and as accurately as possible. When you click on them, the objects won't actually move, but you should act and move the mouse as if they did.

Make sure participant knows how to click and drag using mouse pointer during practice trials.

IT'S VERY IMPORTANT THAT YOU DON'T CLICK THE OBJECT UNTIL THE MAN HAS FINISHED TALKING. IF YOU CLICK BEFORE HE FINISHES TALKING, THE COMPUTER WON'T KNOW YOU'VE ANSWERED.

If for some reason you don't respond quickly enough the experiment will move on automatically. If that happens, don't worry – you should just respond to the next instruction and not try to catch up.

Overlap Task

Data collection:

- Superlab

Instructions:

For your final task before the break, you will have to make simple decisions about lines! You will be presented with a line on each side of a face, and your job is to decide which line is horizontal. Press "A" if the left line is horizontal and "L" if the right line is horizontal. However, you only need to respond when the cross in the middle is green! If the cross in the middle is red, you do NOT need to respond. [Show pictures overleaf]

Great, let's begin!

Cognitive Tasks

Forwards Digit Span

Data collection:

- Pen and paper

Instructions:

Okay! To start this part of your session off, I will be reading out a sequence of numbers. You have to listen very carefully and try your best to remember it, because I will ask you to repeat it after I say it.

Okay? Great.

Backwards Digit Span

Data collection:

- Pen and paper

Instructions:

Well done! Now, I want you to repeat the numbers I say again, but this time, backwards. So if I say, 1, 2, 3, I want you to say 3, 2, 1.

Okay? Great, let's begin!

Letter-Digit Substitution

Data collection:

- PEBL

Instructions:

In this game, you are supposed to learn a code of numbers and letters. It is very simple! There will be a line of alphabets with a line of numbers below it. There will be a series of "test" letters, and your job is to press the number that corresponds to this letter.

For example, if the letter "J" was right above the number "7", when the letter "J" appears, you should press "7" on the keyboard. You should keep both your hands above the numbers on the keyboard [make sure they do this].

You should try to respond as quickly and accurately as possible.

Color Stroop Task

Data collection:

- PEBL

Instructions:

In this game you will have to make judgments about colour. Take a few moments to remember the mapping between colours and numbers in this game. [Keep index and middle fingers above the 4 keys]

So 1 is red, 2 is blue, 3 is green, and 4 is yellow.

Okay, you remember that?

Great, so your job is to determine the COLOUR that the written words appear in.

Sometimes, the words will be actual colour names. When this happens, do NOT respond to the written colour name, but only to the colour of the word.

Great, let's start.

Appendix D

Instruction booklet for Chinese experimenters. The English version of task checklist was used as all experimenters spoke and read English.

社会认知研究指导书 2014

实验开始前

- 请受试者&家长签同意书(如果受试者 18 岁以上，不必家长签名，并请受试者自己签“知情同意书_18”)
- 简单解释实验
- 请受试者填 “Participant Details”
- 问卷可以在实验前或后在家完毕

实验当中

- 告知受试者如果他们累的话可以随时休息

实验完毕

- “Checklist” 完整了吗?
- 给受试者“gift/payment“
- 请受试者签 receipt

社会游戏

怪故事 Strange stories (Happe, 1994)

- 1) 打开 Microsoft Powerpoint
- 2) 一半受试者完成怪故事_1，一半完成怪故事_2
- 3) 提前告知被试他的回答会被录音
- 4) 受试者直接口述他们的答案，请把他们的答案写下来并录音 (written & audio recording)
- 5) 确定把受试者正确的 ID 记录下来,录音名改为被试编号加怪故事。 如：
1001_怪

指导:

你会在电脑上看到一些小故事。请非常仔细地读每个故事。每个故事后，你需要回答一个问题。在回答问题的时候，故事不会留在屏幕上。你的答案不用很长，只要给出你能想到的最好的答案就好。如果你不知道答案是什么就猜一下，因为猜的有时候就是对的。

有问题吗？ 好，让我们开始。

怪故事问题:

- 试一试: 平安夜，小佳的妈妈带她去城里的大百货公司。她们去玩具部看玩具。玩具部里，小佳的邻居张先生打扮成圣诞老人，给孩子们发糖果。小佳觉得她认出了张先生，于是她跑到他跟前问道，“你是谁？”张先生回答，“我是圣诞老人！”
→ 他为什么这样说？

- 故事一: 有两支军队打仗很久了。每支军队都赢了几场战役，但现在两军势力不相上下，说不清谁会赢得最终的胜利。蓝军队的步兵和炮兵比黄军队强，但黄军队的空军比蓝军队强。在决定胜负的最后一战那天，在战场所在的山上起了大雾，低垂的云笼罩着士兵。最后蓝军队胜利了。
→ 蓝军队为什么取得了最终胜利？

- 故事二：有个窃贼要打劫珠宝店。他熟练地撬开店门的锁，小心翼翼地从小探测器光束下爬过。如果碰到这束光束，警铃就会响起。他轻轻打开储藏室的门，看到的宝石闪闪发光。正当他向宝石伸出手时，他踩到了一个柔软的东西。他听到一声尖叫，一个毛茸茸的小东西从他身边跑过，冲向店门口。警铃立刻响了。
→ 警铃为什么响了？

- 故事三：小方在准备一个盛大的晚宴。他最拿手的菜是他出色的蛋黄酱。小方已经买好很多新鲜鸡蛋。蛋黄酱的配方是：“小心地将六个鸡蛋的蛋黄分离，然后慢慢往里面添加油。”小方已经买好足够的甜点招待每一个客人，但现在他却在查做蛋白酥的方子。小方不会浪费任何东西。
→ 小方为什么要做蛋白酥？

- 故事四：小华很富有。今天，小华要买一部昂贵的新汽车。他在考虑是一次性付清呢，还是在一年里分期付款。如果他按月分期支付，汽车经销商会收取 5% 的贷款利息。目前他在银行存款的利息是 8%。尽管小华有足够的现金一次性付清，他决定按月分期支付。
→ 他为什么这样做？

- 故事五：李太太弱不经风。一天，她在结了冰的台阶上滑倒了，侧身着地。滑倒后李太太立刻站了起来，虽然她跌得不轻，还起了淤青。第二天，她觉得腿非常僵硬，几乎走不了路。于是她去看医生。医生一听到她滑倒了，看到她侧身肿起，就说：“马上去急诊。”急诊部给李太太做了 X 光。
→ 急诊部为什么给李太太做 X 光？

- 故事六：战争期间，红军队的人俘虏了一个蓝军队的人。红军队的人想让这个俘虏说出蓝军队的坦克在哪里；红军队的人知道坦克不是在海边就是在山上。红军队的人知道这个俘虏不想讲真话，因为这个俘虏想救自己的军队，所以一定会讲假话。这个俘虏是个很聪明很勇敢的人，所以他不会

让红军队的人找到坦克。其实坦克真的就在山上。当红军队的人问他坦克在哪里的时候，这个俘虏就说，“我们的坦克在山上。”

→ 这个俘虏为什么这么说？

- 故事七：小明经常肚子饿。今天学校的午餐有他最喜欢的食物：香肠和豆子。他是一个很贪心的小朋友，即使他知道回家后，妈妈会为他准备丰盛的晚餐，他都想比其他人吃更多香肠！不过，每个小朋友在午餐的时候，最多只能吃两条肠。所以到轮到小明的时候，他就说，“我可不可以要四条香肠啊，因为我今晚回家没有晚餐吃！”

→ 小明为什么这么说？

- 故事八：有个贼刚刚打劫完一家店，正在逃回家。在这个时候，有个警察在街上巡逻，看到这个贼的手套掉到了地上。这个警察只想告诉他手套掉了，并不知道这个人是贼。但当个警察大声叫：“喂，你停一下！”，这个贼转过身看到是警察，就举高双手投降，承认自己打劫了家店。

→ 这个贼为什么这么做？

- 故事九：小吉是一个撒谎精。小吉的哥哥大严知道这一点，他知道小吉永远不会讲真话！昨天，小吉偷了大严的乒乓球拍。虽然大严知道是小杰把他的乒乓球拍藏起来了，但是他不知道小杰把它藏在哪里了。大严非常生气。他问小吉，“你把我的乒乓球拍藏到了哪里？你一定要么藏在碗柜里，要么藏在你的床下，因为其他地方我都找过啦。到底是哪里，碗柜里还是床下？”小吉说他藏在了床下。

→ 大严为什么会去碗柜里找乒乓球拍？

- 故事十：一天深夜，杨太太正往家走。她不喜欢一个人在黑暗中走路回家，因为她总是害怕有人会袭击并打劫她。她是一个动不动就神经紧张的人！突然，从黑暗中走出一个男人。他想问杨太太现在几点了，所以他向她走去。当杨太太看到这个男人向她走来的时候，她开始发抖并说，“钱包你拿去吧，但千万伤害我呀！”

→ 她为什么这么说？

无声电影 Silent Films Task (Devine & Hughes, 2012)

- 1) 打开 Microsoft Powerpoint – SilentFilms(CHN)
- 2) 受试者口述他们的答案，请把他们的答案写下来并录音 (written & audio recording)
- 3) 确定把受试者正确的 ID 记录下来. 记录下来,录音名改为被试编号加怪故事。 如：1001_默

指导：

“接下来是个有趣的任务！你将在电脑上看到一些短片。这些短片是从一部老式无声电影中剪辑而成的。你看过无声电影吗？它跟现在的电影有什么区别？”
(提示：没有声音，黑白，夸张的形体模仿)

给受试者看：米勒与哈罗德的照片

“我现在放这部老式默片的 5 个片段。这部影片有两个人物：哈罗德 (Harold) 和米勒 (Mildred) (point to characters)。每个短片只会放一次，然后会有一个关于该短片的问题。你需要做的就是仔细观看每个短片。片段结束后我会问你问题，你告诉我你的答案就好。”

“你明白了吗？那你告诉我：”

- 短片会放多少次？
- 看完短片后你需要做什么？

“在开始前你还有其他什么问题吗？”

“好，让我们开始吧“

Social Situations

- 1) 打开 Superlab: 社会情景
- 2) Participant Group: 女士 Female 组, 男士 Male 组
- 3) Session ID: 1. 确定保存受试者正确的 ID. 数据文件名保存为“编号_社会”
如: “1001_社会”

指导:

“接下来, 跟第一个任务一样, 你会看到一个小故事。随着故事的发展, 你需要回答跟故事中的人物有关的问题。

你有什么问题吗?

回答问题过程中, 如果有不理解的地方就问我。”

Director Task

- 1) 打开 E- Prime
- 2) 随机分配受试者 1 / 2/3/4/5/6 组

指导:

“这个游戏考察的是我们在电脑上执行命令的能力。

这是游戏里面的一个场景例子。[给受试者看图画] 在一会儿的游戏中你会看到一个架子, 架子上有一些不同的物品分布在不同的格子里。这里有一个指示者站在架子的另一边, 他会指示你如何移动某些物品。正架子上有几个格子后面有挡板。所以有些物品是你能看到, 但是指示者看不到的。

瞧, 从指示者的角度看架子是这样的。[给受试者看指示者视角的图画] 指示者不知道有挡板的格子后面放着什么。这一点很重要, 你执行他的指示时一定要记得把他的视角纳入考虑之中。

[回到第一个图画] 例如, 你可以看到车, 因为这个格子没有挡板, [指示者视角的图画], 指示者也可以看到这辆车。

[回到第一个图画] 再比如, 你可以看到红苹果, 但因为这个格子有挡板, [指示者视角的图画], 同样的苹果指示者却看不到。

[回到第一个图画] 你能不能告诉我一个指示者看不到的物件?

[等受试者给答案]…没错

[指示者视角的图画] 同样的道理，指示者也看不到电话/手表/指甲油。

[回到第一个图画] 现在你能不能告诉我一个你和指示者都能看到的物品？

[等受试者给答案]…没错

[指示者视角的图画] 同样的道理，指示者也可以看到剪刀/人/车/鹅。

[重复到明白为此].

所以请记住，当你听从指示者的指示时，考虑到他的角度非常重要。不过，你会听到向“右”或“左”移动物品的指示，这个时候你只用遵循你自己的左和右就可以了。也就是说，“左”指的是你的左边，“右”是你的右边。

有问题吗？

整个游戏你唯一需要做的就是听从指示者的指示，等到他把指示说完之后，使用鼠标移动你所认为吻合的物品。在指示者讲完话之前，请不要点击移动，这一点非常重要。因为如果你在他讲完前点击了鼠标，电脑会以为你没有做出回应。

完成每一个指示的时候你要尽可能的快，并且尽可能的准确。你点击移动物品的时候，在图像上虽然位置不会变，你就像可以动一样点击移动鼠标操作就可以了。[确定受试者会正确地 click and drag using mouse pointer during practice trials] 如果出于种种原因你回应的速度不够快，游戏将自动进入下一局。这种时候不用担心，你只需要继续执行下一条指示就可以了，不需要试图赶上或者弥补。

Overlap Task

- 1) 打开 Superlab
- 2) Overlap(CHN)

指导:

“我们中场休息之前最后来做一个跟“线”有关的游戏。

[给受试者看图片] 在游戏里你会看到一张脸，脸颊两边会各自出现一条线，要么是水平的，要么是垂直的。你需要判断哪边的线是水平的，然后在键盘上选择。如果左边的线是水平的，按“A”；如果右边的线是水平的，按“L”。但是，每次脸颊中间都会有一个叉，有的时候是红色的，有的时候是绿色的。你只需要在中间的叉是绿色的时候作答！如果中间的叉是红色的，请不要作答。请尽量又快又准确的回答问题，并且始终保持手指在“A”和“L”键上。

好，让我们开始吧!”

Cognitive Tasks

Forwards Digit Span

- 1) 用笔与纸记录答案
- 2) 确定记录受试者正确的 ID
- 3) 如果被试在同一组的两个数字都出现错误则终止实验。如果错一题的话，继续。分数正确记 1，错误记 0.

指导:

“怎么样，休息的好不好？咱们继续吧。

接下来我会报出一串数字。你需要仔细听好，尽你所能按我所说的样子记住，然后在我报完之后完整的重复这串数字。

没问题吧？好。”

Backwards Digit Span

- 1) 用笔与纸记录答案
- 2) 确定记录受试者正确的 ID
- 3) 如果被试在同一组的两个数字都出现错误则终止实验。如果错一题的话，继续。分数正确记 1，错误记 0.

指导:

“接下来，我会和刚才一样报出一串数字让你重复。不过这次你要以逆序来重复。不如，如果我说：1，2，3；你要说：3，2，1。

有问题吗？好，那我们开始吧!”

Letter-Digit Substitution

- 1) 打开 PEBL
- 2) 确定语言：cn，选 Fullscreen
- 3) 确定输入受试者正确的 ID

指导：

“在这个游戏中，你需要学习一串数字和字母。这很简单！你会看到一串字母，字母下面会有一串数字。你会看到一系列“测试”字母，你的任务就是按字母所对应的数字。

例如，如果字母“J”在数字“7”上面，当字母“J”出现时，你应该在键盘上按“7”这个数字键。请将你的两只手保持放在数字键盘上。（确保他们正是这样做的）这样可以帮助你快且准确的作出反应。

请尽量快并尽可能准确地作出反应。“

Verbal ability

- 1) 录音&用笔与纸记录答案
- 2) 把词汇给被试看
- 3) 确定把受试者正确的 ID 记录下来. 记录下来,录音名改为被试编号加怪故事。 如：1001_词

指导语

“在本字词测验中，我会大声地逐一读出每一个词，要求你解释这个词的意思。词汇难度是按照年龄逐渐加深的，所以如果你回答不出没有关系，不用紧张。”

Matrix reasoning

- 1) 用笔与纸记录答案
- 2) 在答案卷上圈答案

指导语

“接下来你将看到一组图片，请依据其规律在下面的图片中选择你认为合适的图片，题目难度是按照年龄逐渐加深的，所以如果你回答不出没有关系，不用紧张。”

实验完毕

- 检查 Task Checklist
- 受试者签 receipt

Glossary of Abbreviations

A

ACC	Anterior Cingulate Cortex
ANCOVA	Analysis of Covariance
ANOVA	Analysis of Variance
ATC	Anterior Temporal Cortex
ASD	Autism Spectrum Disorder

C

CollSC	Collectivistic-Interdependent Self-Construal
CWM	Cognitive Working Memory

D

dIPFC	Dorsolateral Prefrontal Cortex
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E

EC	Empathic Concern
EI	Emotional Inference

F

FFA	Fusiform Face Area
FI	Factual Inference
FS	Fantasy Scale
FAS	Family Affluence Scale

H

HBSC	Health Behaviour in School-Aged Children
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I

I-C	Individualism-Collectivism
Ind	Independent Scale
Int	Interdependent Scale
IRI	Interpersonal Reactivity Index

M

mDG	Modified Dictator Game
mPFC	Medial Prefrontal Cortex
MG-MRQAP	Multi-Group Multiple Regression with Quadratic Assignment Procedure
MRQAP	Multiple Regression with Quadratic Assignment Procedure
MR	Matrix Reasoning

O

OFA	Occipital Face Area
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P

PCA	Principal Component Analysis
PD	Personal Distress
PDS	Pubertal Development Scale
pSTS	Posterior Superior Temporal Sulcus
PT	Perspective Taking

R

RelSC	Relational-Interdependent Self-Construal
rm-ANCOVA	Repeated Measures Analysis of Covariance
RT	Reaction Time

S

SAD	Social Anxiety Disorder
SCS	Self-Construal Scale
SES	Socioeconomic Status
SF	Silent Films
SNQ	Social Network Questionnaire
SS	Strange Stories
SSM	Strange Stories Mentalising
SSP	Strange Stories Physical
STS	Superior Temporal Sulcus
SVO	Social Values Orientation
SWM	Social Working Memory

T

TKS	Taijin Kyofusho Syndrome
ToM	Theory of Mind
TPJ	Temporoparietal Junction

V

VA	Verbal Ability
vmPFC	Ventromedial Prefrontal Cortex
VPT	Visual Perspective-Taking

W

WASI	Wechsler Abbreviated Scale of Intelligence
WISC	Wechsler Intelligence Scale for Children
WHO	World Health Organisation
WM	Working Memory