The Planning Fallacy put into Context: Investigating the Role of Control in Human Time Perception.

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People are prone to underestimate how long tasks will take them. This is a common phenomenon that has been named *the planning fallacy* (Kahneman & Tversky, 1977). This phenomenon can be observed in everyday life on relatively short time scales and also holds true for large-scale projects that involve forecasting for long time horizons. Kahneman and Lovallo (1993) suggested that one mechanism that could underlie the planning fallacy is the so-called optimism bias, a bias which has also been linked to heightened perceptions of control (Shepperd, Waters, Weinstein & Klein, 2015). This thesis was the first experimental investigation into the relationship between objective controllability of a task and future task completion time underestimations, as is characteristic of the planning fallacy. The experiments in this thesis investigated whether predictions of future task completion times would be shorter following controllable experimental tasks as compared to following uncontrollable experimental tasks. It was found that participants indeed made shorter future task completion time estimates following a controllable task. Furthermore, when compared to their actual completion times it was found that these estimates represented an underestimation. That such underestimations were not found for past completion time estimates, is in line with the inside-outside model of the planning fallacy (Kahneman & Tversky, 1977) and the Extended Inside-Outside Model of the planning fallacy proposed by Buehler, Griffin and Peetz (2010) and Buehler and Griffin (2015). The second variable that was investigated in its effect on future task completion time estimates was the *subjective* perception of control over a task. It was found that subjective control perceptions were not related to future task completion time estimates. This finding was also replicated by experiments involving real-life tasks. It had been predicted that people who perceive themselves as being more in control over completing the task in a timely manner would predict shorter task completion times. However, this prediction was not supported. Furthermore, individual-difference variables, such as depression, the desire for control and the intolerance of uncertainty, had been predicted to be associated with future task completion time estimations. However, no relationship was found. Taking the findings of all the experiments in this thesis together, it is proposed that it is the objective controllability of the task preceding the prediction that influences future task completion time predictions and not the subjective perception of controllability over the preceding or the future task. A new explanatory model of the planning fallacy is proposed, *The Control Model of Future Time Prediction,* in which the controllability of both the past task and the future task are taken into account to explain future task completion time predictions.

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Chapter 1: Introduction

Defining the Planning Fallacy

People are often prone to underestimate how long tasks will take them. This is a common phenomenon that has been named *the planning fallacy* (Kahneman & Tversky, 1977). This phenomenon can be observed in everyday life on relatively short time-scales (see Buehler, Griffin & Ross, 1994; Buehler, Griffin & MacDonald, 1997; Buehler & Griffin, 2003; Buehler, Griffin, Lam & Deslauriers, 2012; Newby-Clark, Ross, Buehler, Koehler & Griffin, 2000; Sanna & Schwarz, 2004; Sanna, Parks, Chang & Carter, 2005; Peetz, Buehler & Wilson, 2010; Min & Arkes, 2012; Kruger & Evans, 2004; Wiese, Buehler & Griffin, 2016) and also holds true for large-scale projects that involve forecasting for long time horizons (see Flyvbjerg, Stewart & Budzier, 2016; Flyvbjerg, Holm & Buhl, 2002; Flyvbjerg, Budzier & Lunn, 2014; Ansar, Budzier & Flyvbjerg, 2011). Most people are familiar with the problem of running late for meetings, even though they had planned to be on time, or have experienced tasks taking longer than expected. The importance of the problem of the planning fallacy for the wider society and economy has been stressed by research into project management, which found that many large-scale projects, across all sectors, considerably overrun their initial time horizon. Flyvbjerg et al. (2016) report that large-scale projects are on average 37.5% over-schedule. One of the most well-known examples of the planning fallacy in the project management literature is the construction of the Sydney Opera House – a project that was over 10 years behind schedule and 1,400% over budget (Flyvbjerg, 2014, p. 10). This shows how much the

statement “Time is Money,” relates to the planning fallacy, as schedule overruns generally also mean incurring additional and unpredicted costs. There is therefore an economic, as well as a scientific, need for understanding the causes of the planning fallacy.

The Original Inside-Outside Model of the Planning Fallacy

In their initial article on the planning fallacy phenomenon Kahneman and Tversky (1977) discussed possible causes and mechanisms underlying the planning fallacy. They attributed the planning fallacy to the fact that people ignore their own past experience of similar tasks and only focus on the specific task at hand. Kahneman and Tversky called this the “internal approach” (p. 12) or taking the “inside view” (Kahneman & Lovallo, 1993, p. 25). This approach to planning and forecasting, they suggested, leads people to only look at the characteristics of the current task and base their predictions on specific task completion plans and future scenarios, disregarding their memories of past task completions.

Following on from their theory of the main underlying cause of the planning fallacy, i.e. people taking the inside view, Kahneman and Tversky (1977) also proposed a solution for the planning fallacy. They suggested that in order to make less biased time predictions forecasters should consider distributional data of similar projects and tasks that have previously been completed. They called this taking an “external approach” (Kahneman & Tversky, 1977, p.13) or the “outside view” (Kahneman & Lovallo, 1993, p. 24). They further suggested

that in order to have the right distributional data people should build a so-called "reference class" (p. 18) of similar tasks or projects. Importantly, they stress that this reference class has to be chosen with great care in order to ensure that it consists of tasks and projects that are similar enough to the current task, but also broad enough to capture a wide range of possible outcomes (e.g. tasks/projects being completed early or late). In order to select this kind of reference class they also highlight the importance of choosing the right kind of decision variables or inclusion criteria that connect the reference class in a meaningful way to the current task or project (Kahneman & Tversky, 1977; Lovallo & Kahneman, 1993; Kahneman & Lovallo, 2003). Once the reference class is established its distribution and descriptive statistics have to be calculated and the initial time prediction for the current task or project has to be adjusted according to the reference class average and the reliability calculation of the initial estimate (Kahneman & Tversky, 1977; Kahneman & Lovallo, 2003).

The Planning Fallacy, Optimism Bias and Control

Kahneman and Lovallo (1993) also suggested that the planning fallacy is related to so-called "optimism bias". Optimism bias has been widely studied and has been called "one of the most consistent, prevalent, and robust biases documented in psychology and behavioral economics" (Sharot, 2011; see also Sharot, 2012). For optimism to be a biased view of the world or the future, the optimistic view has to be in contradiction to the actual world or the actual future outcomes, i.e. in contradiction to reality (see Armor & Taylor, 1998, p. 315-317).

This means that if the optimistically predicted future actually occurs, this prediction could not be considered as biased. It is furthermore important to distinguish between two types of optimism: *dispositional optimism* and *specific optimism* (see Armor & Taylor, 1998). People can have a general positive outlook on life and the world as a whole, which is called *dispositional optimism*, but they can also be optimistic about specific future situations and outcomes, which is called *specific optimism.* Previous research suggests that the personality trait of dispositional optimism is not necessarily related to optimism about specific situations and optimistic predictions of future outcomes (Armor & Taylor, 1998; Buehler & Griffin, 2003). For example, Buehler and Griffin (2003) conducted a series of studies in which participants had to estimate their future task completion times for everyday-life and academic tasks and these were compared to their actual completion times. Furthermore, participants' *dispositional optimism* was measured using the Life Orientation Test (LOT) (Scheier & Carver, 1985). Buehler and Griffin found that participants exhibited a significant *specific optimism bias*, as they significantly underestimated their task completion times, as characteristic of the planning fallacy. However, they also found that this *specific optimism bias* was not related to the personality trait of *dispositional optimism.* Therefore, it is this *specific optimism bias* that is of interest in this thesis – in line with other previous literature, which proposed that the planning fallacy is one example of this specific optimism bias (e.g. Armor & Taylor, 1998; Shepperd, Klein, Waters & Weinstein, 2013).

The link between optimism bias and the planning fallacy has often been stated (e.g. Armor & Taylor, 1998; Shepperd et al. 2013; Flyvbjerg, 2006). Shepperd et

al. stress in their literature review on optimism bias that "perhaps nowhere is unrealistic […] optimism more evident than in people's estimates of the time to complete a task, better known as the planning fallacy" (Shepperd et al. 2013, p. 397). However the underlying causes for this optimism bias in future time predictions have not yet been clearly established. This thesis aims to investigate what causes people to be optimistically biased in their future time predictions. Of special interest is whether this bias is a stable processing bias, i.e. consistent across many types of tasks, as previously suggested by Kahneman & Tversky (1977) and Kahneman & Lovallo (1993) in their inside-outside model (described above), or whether it is influenced by variables within the task itself, i.e. context dependent. The hypothesis is tested in this thesis (Hypothesis 1, p. 16), that one of the most important task-variables is the controllability of the task, something that none of the previous models of the planning fallacy – both the inside-outside model described above and the other four models described later in this chapter – have taken into consideration. In the paragraphs below the choice of this focal variable will be explained.

Optimism bias and control perception

Previous research suggests that predictions about tasks and outcomes that are seen as controllable are more prone to optimism bias than those that are seen as uncontrollable (see Armor & Taylor, 1998). The link between optimism bias and control has been reported since optimism bias was first investigated by Weinstein (1980). In a study of university students, Weinstein (1980) presented participants with lists of positive and negative life events. Participants then had

to rate the likelihood of these events happening to themselves as compared to other students. He found that, when predicting their own futures, participants generally displayed comparative optimism bias, as they predicted that positive events were more likely and negative events were less likely to happen to themselves than to the average student. Importantly, Weinstein also found that perceived controllability was associated with greater optimism bias for negative events: the greater participants' perceived control over negative events, the more prone to the optimism bias they were.

Since then many studies have investigated the link between optimism bias and controllability perceptions. A literature review by Harris (1996) concludes that "there is clear evidence of an association between perceived controllability and both optimism bias and comparative optimism, especially for negative events" (Harris, 1996, p. 24). This view also received support from a more recent meta-analysis (Klein & Helweg-Larsen, 2002), in which effect sizes of 27 studies investigating the relationship between optimism bias and control perceptions were analysed. The meta-analysis found an average *d* of 0.64 for the correlations between control perceptions and optimism bias. In light of this evidence for the correlation between control perceptions and optimism bias, it is possible that objective control and control perceptions are variables influencing the planning fallacy.

Objective task control and the planning fallacy

It is interesting to note, however, that no published studies have investigated objective task control as a variable influencing the planning fallacy, even though perceived controllability has been mentioned in the planning fallacy literature as a factor that might contribute to task completion time underestimation (e.g. Buehler & Griffin, 2003; Buehler, Messervey & Griffin, 2005; Buehler, Griffin & Peetz, 2010). What is missing from the literature is an investigation into the link between objective control over a task, perceived controllability and the planning fallacy phenomenon. It is this gap in the literature that is the starting point for this thesis.

The Control Model of Future Time Predictions

As stated above, it is suggested in this thesis that one important variable that might cause optimism bias in future time predictions for is the controllability of tasks. This assumption is the basis for the new model that is proposed in this thesis, *The Control Model of Future Time Predictions* (see Figure 1).

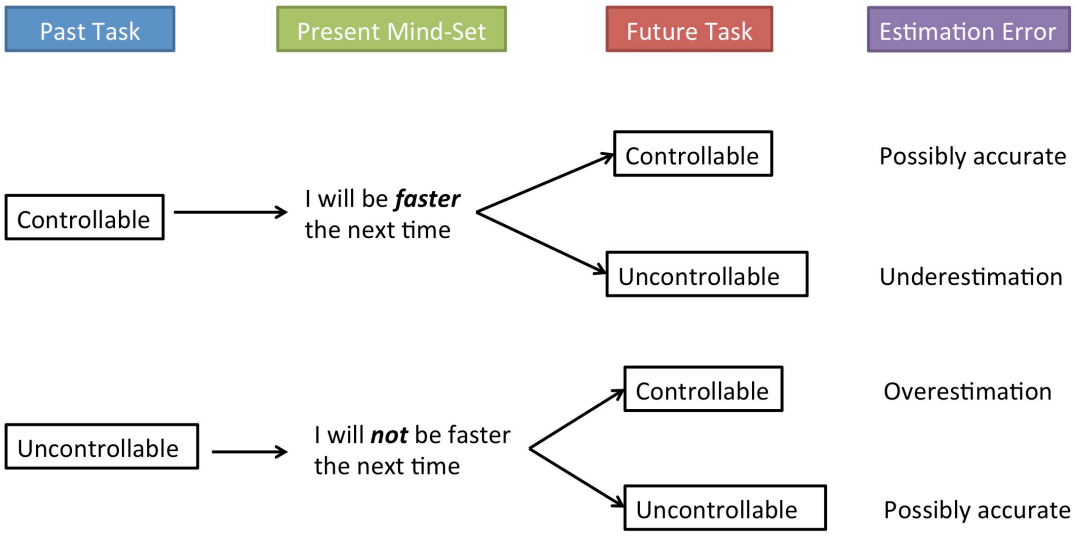

Figure 1: *The Control Model of Future Time Prediction*.

This model suggests that if people experience a controllable task they will predict shorter future task completion times for a similar task. This biasing effect of control on future time estimation would lead to optimism bias, as characteristic of the planning fallacy, if there is a mismatch in the controllability of the past and future tasks. If both tasks are controllable then predicting that one would be faster the next time might actually be accurate. However, if the past task is controllable and the future task is uncontrollable, then the bias to predict that one would be faster the next time would lead to the planning fallacy, as the uncontrollable future task might not take a shorter time to complete than the past task. This thesis constitutes the beginning for testing this newly proposed model, by investigating the first half of Figure 1, i.e. the influence that the task controllability has on future task completion time predictions. The second half of the model presented in Figure 1 above is the theoretical explanation of how optimism becomes optimism bias and is suggested for investigation in future research.

Hypothesis 1

The first hypothesis that will be investigated in this thesis is that enhanced *objective* control over a task leads to shortened predictions of future task completion times. It is proposed that predictions of future task completion times will be shorter following controllable tasks as compared to following uncontrollable tasks. The effect of objective control on task completion estimates will be investigated using experimental laboratory tasks in Chapter 2.

Hypothesis 2

The second hypothesis states that heightened *subjective* perceptions of control over a task will also lead to shorter task completion time estimates. This hypothesis will be investigated for experimental tasks in Chapter 2.

Furthermore, it will be investigated in Chapter 4, if for real-life tasks, people who perceive themselves as being more in control over completing the task in a timely manner will predict shorter task completion times in comparison to people who do not see themselves as being in control over a timely task completion.

The Planning Fallacy and the Illusion of Control

Besides optimism bias, another "positive illusion" (Taylor & Brown, 1988, p. 193) that links the planning fallacy to the perceptions of control is the so-called *illusion of control*. This is the phenomenon that people often overestimate their personal control over situations and tasks, which holds true even if these tasks are objectively uncontrollable. Evidence suggests that increasing the probability (also sometimes referred to as *density*) with which outcomes are presented can lead to this enhanced (illusory) perception of control over uncontrollable tasks (Alloy & Abramson, 1979). It has also been suggested that this illusory perception of control might be beneficial to people in sustaining good mental health and positive mood (Alloy & Abramson, 1979; Alloy, Abramson & Viscusi, 1981; Taylor & Brown, 1988), and that people who are depressed might not be

as susceptible to the illusion of control. Alloy and Abramson (1979) conducted a study in which they tested mildly depressed and non-depressed participants. These participants had to perform two tasks, both of which were objectively uncontrollable – meaning that the probability of the participant's actions producing an outcome was equal to said outcome occurring in the absence of their actions. What differed between the two tasks was the probability with which the outcome was presented to the participants. In one task the outcome probability was 25% (in presence and in absence of an action) and in the other task the outcome probability was 75% (in presence and in absence of an action). It was found that non-depressed participants rated their control perceptions higher for the task with a higher outcome probability (75%) than for the task with lower outcome probability (25%). This effect was not found for the mildly depressed participants, who were on average relatively accurate in their control judgements. In a further experiment they presented depressed and non-depressed participants again with two objectively uncontrollable tasks. This time the outcome probability was held constant at 50% (in presence and in absence of an action). However, in this experiment, the valence of the outcomes was varied between winning money and losing money when the outcomes were presented. It was found that non-depressed participants rated their control higher in the win situation than the lose situation. No such effect was found for the mildly depressed participants, who were again relatively accurate in their control judgements. Alloy and Abramsons took these findings to suggest that the task with higher outcome probability and the task that was associated with positive outcomes had induced an illusion of control for the non-depressed participants, because these tasks had been equally uncontrollable as compared to the other

tasks used in the two experiments.

Previous studies (Msetfi, Murphy, Simpson & Kornbrot, 2005; Msetfi, Wade & Murphy, 2013) have established a link between the seemingly more accurate control ratings of depressed participants and their difference in processing temporal and contextual information when performing uncontrollable as well as controllable tasks. Msetfi et al. (2005) found that depressed participants were not as sensitive to contextual manipulations within the task as compared to non-depressed participants. However, and importantly in connection to the current thesis, Msetfi et al. (2013) found that temporal delay manipulations within the task had a stronger effect on mildly depressed participants' control ratings than on non-depressed participants. Msetfi et al. (2013) suggest that this stronger effect of delay manipulations on depressed participants' control judgments might be due to the fact that their time perception is generally slowed down (see also Msetfi, Murphy & Kornbrodt, 2012; Bschor, Ising, Bauer, Lewitzka & Skerstupeit, 2004), which exacerbates the length of the delays introduced.

Hypothesis 3

The third hypothesis of this thesis, which will be explored in Chapter 2 (Experiment 2 & 3), states that depressed participants would be less prone to shortened predictions of future task completion times following controllable tasks.

This hypothesis is proposed because mildly depressed people have been shown to have different perceptions of control as compared to non-depressed people. For example they are less prone to the illusion of control following uncontrollable tasks with high outcome probability. Furthermore, this hypothesis rests on previous suggestions that depressed people have different ways of processing time information and generally slowed down perception of time.

Evidence for the Original Inside-Outside Model

Since Kahneman and Tversky (1977) theoretically proposed the inside-outside model of the planning fallacy, psychology researchers have experimentally tested whether people indeed display a natural tendency for the planning fallacy and if this could be due to people adopting an inside view. In a series of experimental studies into the psychology of the planning fallacy by Buehler and colleagues over the past 25 years (e.g. Buehler, Griffin & Ross, 1994, Buehler, Griffin & MacDonald, 1997; Newby-Clark, Ross, Buehler, Koehler & Griffin, 2000; Buehler & Griffin, 2003; Buehler, Griffin, Lam & Deslauriers, 2012; Wiese, Buehler & Griffin, 2016) the general tendency of people to underestimate completion times, as is characteristic for the planning fallacy, was confirmed. Furthermore, these experiments suggested that people indeed tended to focus on future plans for the particular project or task and did not often mention their past experiences with similar projects and tasks. Furthermore, the studies found that people did not often list possible future obstacles or problems when

thinking about predictions. The way that the studies mentioned above tested whether people naturally adopt the inside-view when making completion time predictions was by recording the types of information that people spontaneously think about while making the predictions. They used the so-called thought-listing technique (e.g. Buehler et al., 1994), in which participants, who were estimating completion times of a variety of different tasks, were instructed to list (verbally or in written form) all thoughts that came into their mind while making their time predictions.

In their initial study (Buehler et al., 1994) participants were asked to estimate their completion times for a school project (Exp. 3). Relating to the outcomes of the thought-listing measure, the majority of thoughts that participants listed (71%) were about future plans. Only 3% of thoughts related to future problems. Furthermore, only 7% of thoughts listed indicated a focus on the past, with 6% of thoughts relating to past success and only 1% of thoughts relating to past problems. Also, only 15% of thoughts included a mention of the tasks' deadline, which Buehler et al. found to be surprising given that participants' completion time predictions correlated with the deadline. Only 2% of thoughts related to the participants' own character. And lastly, only 1% of thoughts related to other people's past experiences.

A second experiment using the thought-listing procedure and concerning completion time predictions for a class computer assignment (Buehler et al., 1994, Exp. 4) found a very similar pattern of thought categories. When looking at the percentage of participants that listed thoughts of different types, Buehler et

al. found that 93.5% of participants listed thoughts about future plans and only 8.9% of participants listed thoughts about past experiences. Furthermore, only 9.8% of participants mentioned future problems. People also tended not to refer to their own personality/disposition when thinking about future time forecasts as only 4.9% of people mentioned thoughts in that category. Lastly, only 4% of people mentioned their deadline and no participants mentioned other people's past experiences. However, interestingly both experiments listed above did not find a relationship between thought focus and estimation biases. Buehler et al. (1994) suggest that this might be the case because so few thoughts about the past were listed and therefore no statistical relationship could be observed between future vs. past focus and time predictions.

Buehler and Griffin (2003) found the same pattern of thought focus when participants predicted completion times of real-life projects, such as Christmas shopping. In their thought-listing investigation they found that 73% of listed thoughts were about plans for future task completion. Only 8% of thoughts were about past experiences and even fewer (6%) about past problems with similar tasks. Equally, future obstacles were most often ignored, with only 11% of thoughts relating to future problems. Similar to the earlier study only 3% of thoughts related to the participants' own personality.

As shown in the studies above, it was confirmed that people do indeed display a general tendency to focus quite narrowly on how the current project will unfold in the future. These future plans tend to be overly optimistic and, as suggested by Kahneman & Tversky (1977), do indeed tend to disregard similar past

experiences. The future plans also disregard other people's experience with similar tasks. Furthermore, it was found that future plans also tend to ignore the possibilities of future obstacles and problems.

Oversimplification of future obstacles

One possible reason why obstacles are not part of the task completion plans that people make is that people underestimate the complexity of things that could go wrong during task completion. This is in line with philosophy of science investigations into how people think about causes, which suggest that people are prone to causal oversimplification, i.e. the reduction of the causes of an event to a single cause (Mumford & Anjum, 2011; Anjum & Mumford, 2018). In this regard Kahneman and Tversky (1977) suggest that the possibilities of future problems can be endless. Lovallo and Kahneman (2003) also emphasise that people are generally bad at taking the wealth of possible future occurrences into account, i.e. they tend to predict oversimplified future scenarios:

> "No matter how detailed, the business scenarios used in planning are generally inadequate. The reason is simple: Any complex project is subject to myriad problems—from technology failures to shifts in exchange rates to bad weather—and it is beyond the reach of the human imagination to foresee all of them at the outset." (Lovallo & Kahneman, 2003, p. 4).

Kahneman and colleagues, therefore, stress in their three papers (Kahneman & Tversky, 1977; Kahneman & Lovallo, 1993; Lovallo & Kahneman, 2003) that in their proposed reference class forecasting method specific details of the current project and potential future scenarios should be ignored in favour of a focus on distributional data of past projects. In their view this external approach would not attempt to "define the specific manner in which a plan might fail" (Kahneman

& Tversky, 1977, p. 2.3). Furthermore, they suggest that future scenarios that include extreme outcomes and obstacles should also be ignored when constructing a reference class (Kahneman & Tversky, 1977, p 3.9-3.10; Kahneman & Lovallo, 1993, p. 25-26; Lovallo & Kahneman, 2003, p. 7). This means that their reference class will be relatively normally distributed and only captures completion times that are relatively close to the mean, as suggested by Kahneman and Lovallo (1993):

> "It is a conservative approach, which will fail to predict extreme and exceptional events, but will do well with common ones. Furthermore, giving up the attempt to predict extraordinary events is not a great sacrifice when uncertainty is high, because the only way to score 'hits' on such events is to predict large numbers of other extraordinary events that do not materialize." (Kahneman & Lovallo, 2003, p. 25-26).

Focus on possible future obstacles

However, other psychology researchers have tested whether an induced focus on future problems could have a de-biasing effect on completion time predictions. Byram (1997) used a task where participants had to build a PC stand and predict their own completion times. Participants were instructed (in one of the manipulation conditions) to "list surprises that could prolong construction" (Byram, 1997, p. 221). The findings of this manipulation showed that most reported problems were task related (65%). These included problems with the parts (35%), problems with the tools (16%), problems with the assembly instructions (16%) and problems with the assembly itself (5%). The surprises that were not task-related, related to interruptions (16%) and other surprises (12%). Interestingly, only 5 out of 62 participants mentioned making a mistake. However, there was no correlation between the number of surprises (i.e. future

obstacles) listed and participants' 'best guess' prediction of completion times. Furthermore this study also did not find an effect of being in the surprise-listing condition on completion time estimates, as compared to a control group. However, one limitation of this study was that Byram only collected actual completion times from 20 of the 126 participants and therefore estimation errors and the effect of the surprise-listing technique on underestimation bias cannot reliably be investigated.

It was later suggested by Sanna and colleagues (Sanna & Schwarz, 2004; Sanna, Parks, Chang & Carter, 2005) that it might not just be the focus on problems per se that could make future task completion time predictions more accurate, but instead that the ease with which these problems come to mind might be of importance. In their initial study Sanna and Schwarz (2004) made participants estimate when they would finish revising for an upcoming university exam. Participants furthermore had to list either 3 or 12 ways in which they could succeed or fail in their exam before making a time estimate for completing their revision for the exam. Sanna and Schwarz found that participants in the 3 failure and the 12 success groups predicted later completion times than participants in the 12 failure and 3 success groups. They argued, as confirmed by participants' difficulty ratings, that it is harder to bring to mind 12 ways of succeeding or failing than to think about only 3 ways of succeeding or failing. Therefore Sanna and Schwarz suggested that when participants had to list 12 thoughts about failing, they thought that *failure was less likely* and therefore predicted shorter completion times. When participants were made to list 12 ways of succeeding they thought that *success was less likely* and therefore predicted longer

completion times. However, this study had a similar limitation to that of Byram (1997) in that only 1/3 of participants reported their actual completion times and therefore estimation errors or bias is not accurately computable for the whole sample.

Sanna et al. (2005) backed up their earlier findings in a study that used the PC stand assembly laboratory task in a group setting and did record actual completion times of the whole sample. In this study groups had to list 5 or 15 thoughts of success or failure. It was found that groups that had to list 15 thoughts of success or 5 thoughts of failure were less prone to underestimation of task completion times. A similar pattern of findings was later also reported by Min and Arkes (2012) using an academic assignment where participants had to estimate completion times as well as create scenarios with 2 or 8 steps to successful or unsuccessful task completion. They found that participants who had to create scenarios with 8 steps to success were least biased and participants who had to report 2 steps to success underestimated task completion times the most. Participants in the two conditions that had to report 2 or 8 steps to unsuccessful task completion underestimated task completion times, but to a lesser extent than participants in the 2 success-step condition. Furthermore, participants rated the optimistic scenarios as more plausible than the pessimistic scenarios. It should be noted that the difference between the studies by Sanna and Schwarz and Sanna et al. (2005) in comparison to the study by Min and Arkes (2012) is that the former made people list separate reasons for success vs. failure, whereas the latter made people only construct one scenario but with varying numbers of steps.

Based on the above investigations it could be suggested that focusing on obstacles while estimating future task completion times might not lead to less task completion time underestimation (see Byram, 1997). However, as described above, it has been suggested that making people increase the number of obstacles that they think about before making a completion time prediction might not de-bias people's predictions because it is difficult to generate thoughts about many obstacles and therefore the likelihood of the obstacles occurring is judged as low (see Sanna & Schwarz, 2004; Sanna et al., 2005). The findings above therefore suggest that considering a *few* obstacles might work as a de-biasing technique for future task completion estimates.

Plausibility of future obstacles

Kahneman and Tversky (1977) and Lovallo and Kahneman (2003) suggest that another possible reason why people might not take into account possible obstacles when planning is that they believe their occurrence to be less likely (i.e. less probable). It has been suggested that bleak future scenarios are not only seen as less likely but also as less plausible (i.e. less credible) (Newby-Clark et al., 2000; Min & Arkes, 2012). To specifically test this hypothesis Newby-Clark et al. (2000) instructed participants to construct a best-case, a worst-case and a most-likely scenario before making completion time predictions for school assignments. They found that constructing a worst-case scenario before predicting made participants underestimate their completion times less (though they were not more accurate in terms of absolute errors). But, when participants

then had to also state a most-likely prediction afterwards, they did not base those on their worst-case scenarios or associated less underestimated time predictions. Newby-Clark et al. explained this through their findings that when participants rated the plausibility of the different scenarios, the plausibility of the worst-case scenario was rated significantly lower than the other two (best-case and most-likely) scenarios – hence it did not influence the most-likely predictions. This finding suggests that future obstacles might indeed be ignored during the prediction process, because people do not think they are likely to occur and/or are not seen as plausible.

Focusing on one's own past reduces underestimation

As noted above, Kahneman & Tversky (1977) suggested that one solution for the planning fallacy would be to encourage people not to take the inside view, and instead take the distribution of past outcomes for similar projects into account by doing reference-class forecasting. However, Wiese, Buehler and Griffin (2016) suggest that doing formal reference class forecasting is not always possible for personal projects: "Note, however, that such strategies are most applicable in those relatively rare prediction contexts where a class of comparable projects can be readily identified." (Wiese et al., 2016, p. 148). Therefore, they proposed that making people focus on their *own* past experiences and past completion times could be a viable solution for counteracting the inside view for personal projects. Therefore, they experimentally investigated whether people could be 'made' to take their own past experiences more into account when making predictions. Buehler et al. (1994, Exp. 4) gave participants a computer

assignment with a 1-2 week completion deadline for which participants had to estimate their completion times. Participants were divided into three groups (thought-focus conditions). The first group (recall condition) had to recall the distribution of their own past completion times for similar assignments before making a completion time prediction. The second group (recall-relevant condition) had to recall their own past completion times similar to the first group, but was then instructed to explicitly link these memories of past completion times to the current task by taking their distribution into account while making their predictions and by describing a plausible scenario that would result in them finishing at a similar time as in the past. The third group acted as a control group and had to report memories of their past completion times only after making the completion time predictions. It was found that participants in the recall and control conditions generally underestimated their completion times. However, making participants connect their own past experience to the current project in the recall-relevant condition eliminated the underestimation bias. Furthermore, in the recall-relevant condition 60% of participants finished at their predicted time as compared to an average of 33.5% in the other two conditions. However, one has to note that the recall-relevant manipulation made participants in general less optimistically biased in their time predictions, but did not make individual participants more accurate, as absolute error did not decrease. In conclusion Buehler et al. (1994) suggest that the mere presence of memories of past task completions is not enough, but that these memories have to be explicitly and intentionally connected to the current task in order to counteract future completion time underestimations.

Another study using a lab task to investigate the effect of past problem focus on task performance estimates was Hinds (1999). In this study participants of different expertise levels (novice, intermediate and expert users) had to perform tasks on a mobile phone, such as recording a voice message. The aim of the study was to investigate how thinking about past problems might de-bias experts' as compared to novices' task completion estimates for novices' task performance. The study found that task completion times were generally underestimated but that making participants think about their own past problems with a similar task or giving them a list of problems that novices usually encounter de-biased novices' and intermediate users' predictions, though it had no effect on experts' predictions. From the studies described above it can be suggested that making people connect their past experiences in a relevant way to the task for which they are estimating task completion times might be a way of reducing completion time underestimations.

Attributions of one's own past underestimations

One possible reason why memories of past completion times and especially memories of past failures to complete tasks by a predicted time might not spontaneously be taken into account when making future completion time predictions are the causal attributions people make for past failures. This might be one of the key reasons why people do not learn from their past mistakes. That attributional processes are linked to the causes of the planning fallacy was suggested by Kahneman and Lovallo (1993). Following Taylor and Brown (1988), they state that "unrealistically positive self-evaluations" could be seen as

underling mechanisms of optimistic biases (Kahneman & Lovallo, 1993, p. 27). These positive self-evaluations have been linked to the self-serving attribution bias, which denotes the tendency of people to attribute success to themselves and failure to external factors (see e.g. Miller & Ross, 1975; Weiner, 1985; Lovallo & Kahneman, 2003). As Lovallo and Kahneman (2003) write: "We take credit for positive outcomes while attributing negative outcomes to external factors and deny the role of chance in our plans' outcomes. Result? We assume we can avoid or overcome all project problems." (Lovallo & Kahneman, 2003, p. 1).

The relationship between the planning fallacy and the above described attribution bias has been experimentally investigated by Buehler et al. (1994). In multiple experiments they investigated people's attributions of past performances based on three attribution dimensions: external vs. internal, transitory vs. stable, and specific vs. global, which is in line with earlier attribution theories (Peterson, Semmel, Von Baeyer, Abramson, Metalsky & Seligman, 1982). When asked to recall instances where they had underestimated their own task completion times and when a friend had underestimated his/her task completion times, they found that people attributed their own past task completion underestimations to relatively more transitory and specific factors as compared to the task completion underestimation of a friend. In another experiment Buehler et al. (1994) found that when participants who had underestimated their completion times for a computer assignment were asked to explain their own lateness, they also attributed their own lateness to relatively more transitory and specific factors as compared to participants who had to

explain why they had been on time. As stated above this study also tested whether people made more external attributions as might be expected based on previous attribution research (e.g. Peterson et al., 1982), but the results were not clearly significant. It can be seen from the research described in this section that attributional processes could be an important factor linked to the planning fallacy. However the exact mechanism underlying the influence of attributions on future time estimates should be further investigated. Suggestions for this will be described in the sections below.

Attributions of past underestimation linked to controllability

In the previous literature on the planning fallacy and attributions of past performance, described above, attributions have been split into three dimensions: external vs. internal, transitory vs. stable, and specific vs. global. However, there are other theories of attributions (Weiner, 1979; Weiner, 1985) that suggest the inclusion of another dimension that adds more precision to the distinction of different attribution factors. This dimension is the controllability of attribution factors. Adding this dimension would counteract one possible limitation of the three dimensions listed above, which is that the internal vs. external dimension does not distinguish between people's own actions and their own mental states. As Forsyth and McMillan (1981) suggest, the inclusion of controllability as a dimension makes it possible to distinguish between internal factors relating to mental processes (e.g. mood), which are suggested to be less controllable, and internal factors relating to actions (e.g. effort), which are suggested to be more controllable. Therefore, the dimension of controllability

seems to bring additional clarity when investigating attributions of past performance.

Attributions of past underestimation, thinking of future obstacles and the influence of controllability

Drawing upon research into attributions of past failures to predict task completion times (Buehler et al., 1994), research into the effect of thinking about future obstacles on task completion estimation (Sanna & Schwarz, 2004; Sanna et al. 2005; Min & Arkes, 2012), the attributional dimension of controllability suggested by Weiner (1979), and research that linked heightened perception of control to optimism bias (Weinstein, 1989; Harris, 1996; Klein & Helweg-Larsen, 2002; Shepperd et al., 2015), this thesis will investigate how perceptions of control over past and future obstacles (and facilitating factors) influence task completion time predictions. It is suggested that people who feel more in control over past and future facilitating factors (helpers) and especially past and future obstacles (hinderers) would be more prone to underestimating their future task completion times.

Hypothesis 4

The fourth hypothesis states that for real-life tasks, people who perceive themselves as having more control over possible facilitating factors (helpers) and impeding factors (hinderers), contributing to or working against their timely task completion, will predict shorter task completion times in comparison to people who do not perceive themselves as being in control over these positive

and negative factors. Furthermore, it is expected that it is especially a heightened perception of control over impeding factors that would lead to shortened time predictions. This will be investigated in Chapter 4.

Hypothesis 5

The fifth hypothesis of this thesis is that people who are made to think about negative causal factors (hinderers) that might affect their task completion in the future will be less likely to predict shortened completion times. Furthermore, people who are made to think about positive causal factors (helpers) will be more likely to predict shortened completion times. This hypothesis will be investigated in Chapter 4. Taking into account suggestions from the previous literature, the ease of generation for both positive and negative causal factors will be kept constant (in this case, easy generation) in order to be able to assess the effect of valence of causal factors on its own.

Desirability of Control, Attributions and the Illusion of Control

The desire for control, as measured by the desire for control (DoC) scale (Burger & Cooper, 1979), has been found to be related to how people attend to and process information about their own control over a situation (Burger, 1993). Burger suggests that this is due to the fact that people with high desire for control "are more likely to attend to and recall this control-relevant information than those scoring low in desire for control" (Burger, 1993, p. 204).

Furthermore, it has been suggested that people high in desire for control are also more prone to attribution biases and the illusion of control.

Burger (1993) related the desire for control to attribution bias theories. In his view people make attributions in order not only to understand the past, but also to feel in control over the outcome of similar future situations. Burger and Hemans (1988) performed three experiments in which they asked participants to make attributions of others' and their own real and hypothetical behaviours. In the first experiment they found that people high on the desire for control scale (as compared to people low on the DoC scale) attended more to information that helped them make attributions of past behaviours of others. In their second experiment they found that participants high on desire for control also sought out more information, by asking relevant questions that helped them make attributions of their own hypothetical good or bad performance. Furthermore, in their third experiment they found that participants high on desire for control made more complex attributions, by listing more reasons for their own past success or failure.

Furthermore, Burger (1993) suggests that people high in desire for control are more prone to self-serving attribution biases, attributing success to themselves and failure to external factors. An earlier study by Burger (1987) asked participants in one experiment to list reasons (and rate presented reasons) for their own good or bad performance on a university exam. They found that participants with high desire for control who had been successful in their exam attributed their exam results to more internal factors than participants with high

desire for control who had been unsuccessful. This effect was not found for participants with low desire for control scores. Furthermore, participants with high desire of control were more likely to attribute their success to their own ability than participants low on desire for control. In a second experiment participants had to perform a timed intelligence task and were given feedback on their performance. This feedback was experimentally manipulated and indicated always that participants were either in the 15th or 85th performance percentile of university students. The same pattern of results was found as in the first experiment, in that participants with high desire for control who were told that they had performed well attributed their performance to more internal factors than participants with high desire for control who were told that they had performed poorly. Again, no difference in attributions of success vs. failure was found for participants with low desire for control scores.

Lastly, Burger (1993) also reports evidence that people high on the desire of control scale are also more susceptible to the illusion of control. They are especially prone to this when they are presented with a frequent positive outcome in the beginning of a sequence of outcomes or when they are familiar with the task before completing it (Burger, 1986). These results were suggested in a study (Burger, 1986) using two experimental gambling tasks. It was found that participants with high desire for control were willing to bet more if they were playing with familiar cards. When participants were presented with a series of 30 coin-tosses, participants with high desire for control who won more frequently in the beginning of a sequence, as compared to winning the same number of times later in the sequence, were more likely to attribute their success

to their own ability. Furthermore, when these subjects had to estimate how often they would guess correctly in another sequence of 100 coin-tosses, they expected significantly more correct guesses. This betting behaviour was taken to indicate illusory control following Langer (1975) and Langer and Roth's (1975) definition of illusory control. Burger (1993) suggests that people with high desire for control display a tendency to higher illusion of control due to the fact that they do not wait for all the evidence before making decisions about the nature of a situation and hence end up being less accurate in their control judgments than people low on desire for control who wait for the more of the evidence before making a control judgment.

The link between the desire for control and the planning fallacy has been suggested in two experiments by Halkjelsvik, Rognaldsen and Teigen (2012), in which participants had to estimate their task completion times for two tasks, an active task and a passive tasks. Participants were presented with two different tasks: one was a document editing/typing task and one was the passive viewing of a video. Furthermore, a monetary incentive for speedy task completion was introduced for half of the participants. It was found that participants who were high on the desire of control were more prone to underestimating their task completion times for both tasks (passive and active) and this was especially the case when there was an incentive for speed. Because of the close link that has been suggested between desire of control and the other phenomena investigated in this thesis, namely the planning fallacy and associated with it attribution biases and the illusion of control, the desire of control was included as a variable for investigations in this thesis.

Hypothesis 6

The sixth hypothesis of this thesis is that people with high desire for control would be more inclined to predict shorter task completion times than people with low desire for control. This line of reasoning will be tested in Chapter 2 (Experiment 3 & 4). It is also predicted that people with higher desire for control will predict shorter task completion times for real-life tasks, as investigated in Chapter 4.

Other Models of the Planning Fallacy

Since the early conceptions of the mechanisms underlying the planning fallacy by Kahneman and his colleagues (e.g. Kahneman & Tversky, 1977) other researchers in experimental psychology have aimed to illustrate the causes of the planning fallacy. However, as stated above, none of these further models investigated the influence of task controllability on the planning fallacy phenomenon. The first of the further models, the so-called *Extended Inside-Outside Model*, builds on the original inside-outside model of Kahneman and Tversky (1977) and Kahneman and Lovallo (1993). There are three further theories that have been most prominent in the psychological literature about the planning fallacy. These three are: the *Memory Bias Account*, the *Anchoring and Adjustment Account* and finally the *Self-Learning Account*. In what follows I will describe each of these models and their contrasting explanations for biases in predicting future task completion times.

The Extended Inside-Outside Model

Buehler, Griffin and Peetz (2010) extended the original inside-outside model of the planning fallacy as proposed by Kahneman and Tversky (1979) and Kahneman and Lovallo (1993) by incorporating new experimental evidence about different factors underlying the planning fallacy. As can be seen in Figure 2 their *Extended Inside-Outside Model* suggests that there are three main categories of variables that lead to people adopting an inside-view, namely: i) a narrow perspective, ii) incentives/motivation to finish the task at hand quickly, and iii) social pressure.

As can also be seen in Figure 2 below, there are three variables that they suggest as contributing to a narrower perspective - these are i) closer temporal distance of the task; ii) first person imagery, and iii) actor status. Relating to the variable of temporal distance, Peetz, Buehler and Wilson (2010) found that a feeling of the task's deadline being near (e.g. Christmas approaching in the case of buying presents) led to a less optimistic time prediction and a greater focus on obstacles. Relating to the imagery perspective variable Buehler et al. (2012) found that a successful de-biasing strategy was adopting a 3rd person imagery perspective (i.e. imagining oneself doing the task from an observer perspective), rather than a 1st person imagery perspective. Their study showed that participants adopting a 3rd person perspective when estimating project completion times were less prone to underestimation. Furthermore, looking at the outcomes of the thought-listing measure, these participants also focused more on obstacles as compared to plans for success. Further research (Buehler

et al., 1994; Newby-Clark et al., 2000) found that observers, as opposed to people who were actively completing a task, were less prone to completion time underestimations.

The *Extended Inside-Outside Model* further suggests that social pressure, which was found to make people prone to the planning fallacy, can come from being a member of a group that forecasts time horizons in the manner of group decision. Buehler et al. (2005) found that making completion time predictions as part of a group also led to reduced focus on obstacles and greater focus on plans, which in turn mediated the effect of group predictions that exacerbated the planning fallacy. Having higher social power within a hierarchy when predicting task completion times (Weick & Guinote, 2010) was also found to exacerbate the planning fallacy. Lastly, the model suggests that (monetary) incentives or motivation to finish a task quickly might lead to exacerbated temporal underestimation (Buehler et al., 1997; Byram, 1997). Buehler et al. (1997) found that an incentive for speedy task completion exacerbated the planning fallacy as well as the tendency to focus on plans for the future and discount past experiences and the possibility of future impediments.

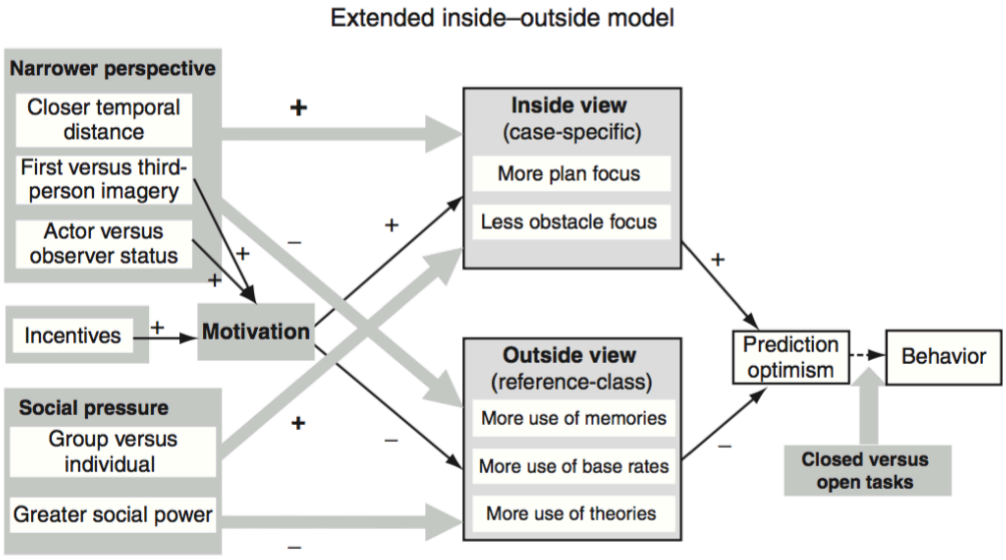

Figure 2. Extended Inside-Outside Model. Reprinted from *Advances in Experimental Social Psychology*, 43, R. Buehler, D. Griffin, and J. Peetz, The Planning Fallacy: Cognitive, Motivational, and Social Origins, p. 25, Copyright (2010), with permission from Elsevier.

There are further variables that Buehler et al. (2010) do not formally include in their new model, but which Buehler et al. (2010) and Buehler and Griffin (2015) also state as important contributing factors to the planning fallacy, namely: i) temporal frames, ii) unpacking, and iii) self-presentation biases. They refer to research by Sanna et al. (2005) that shows that participants made less biased time predictions when estimating task completion times based on a negative temporal frame (telling participants that they had *little* time remaining to complete the task) as compared to a positive temporal frame (telling participants that they had *a lot* of time remaining to complete the task). In another line of research, Boltz and Yum (2010) showed that time motion perspectives (time-motion vs. ego-motion) influence the planning fallacy, with people adopting a time-motion perspective being less biased.

Furthermore, Buehler et al. (2010) suggest that inducing a heightened focus on future plans exacerbates the planning fallacy. A study by Buehler and Griffin (2003) found that participants underestimated their task completion times for Christmas shopping and academic tasks more if made to focus on detailed future plans before making their completion time predictions. However, Buehler et al. (2010) also state that "unpacking" a task into smaller sub-components has been found to attenuate prediction biases (Kruger & Evans, 2004; Forsyth & Burt, 2008). Buehler et al. (2010) stress that unpacking a task is not the same as focusing on plan based scenarios typical for the "inside view", because unpacking facilitates thoughts about obstacles and otherwise ignored components that contribute to longer time horizons for completion. However, they also refer to studies that found no positive effect of unpacking a task on prediction bias (Byram, 1997; Connolly & Dean, 1997).

The Memory-Bias Account

Roy, Christenfeld and McKenzie (2005) propose an alternative explanation of the planning fallacy, which they call the *Memory-Bias Account*. They suggest that the planning fallacy might not be due to people ignoring their memories of past task performances, but rather due to these memories being erroneous in the first instance. They propose that people's memories of past task performance times are already underestimations of their actual performance time, and hence when predictions are based on memories these will also be biased towards underestimation of task durations. In their account they propose that novel tasks should not be underestimated, as there are no biased memories on which

predictions could be based. They contrast this with Buehler et al.'s (1994) model that would predict novel tasks to be most biased, as no distributional data is available to facilitate the outside-view. Furthermore, they suggest that retrospective time judgments are often biased, and the direction of this bias would depend on the duration of the task, in that shorter tasks would be overestimated and longer tasks would be underestimated (Roy et al., 2005).

In a series of experimental studies, supporting their proposed model, Roy and Christenfeld (2007) found that people indeed did *not* underestimate novel tasks (making origami figures), but showed a tendency to overestimate tasks that they had not previously performed. However, in line with their predictions people did underestimate tasks retrospectively. In line with their suggestion for retrospective estimates, Roy and Christenfeld (2008) using a lab task of counting stacks of paper (50-500 sheets) found that short lab tasks of under 1min 32sec duration were overestimated and longer tasks between 1min 32sec - 17min duration were underestimated. This pattern of bias occurred for both past and future task completion time estimates. However, a later study by Schwab, Memmert and Roy (2013) using an origami task of similar short duration to the study above, with average completion times of 94.8 sec and 234.6 sec in the different conditions, found no effect of task duration on past task completion time estimates. A further study (Roy, Christenfeld & Jones, 2013) that asked participants to make past and future task completion time estimates and used two different tasks, counting 250 sheets of paper similar to the task in Roy and Christenfeld (2008), with an average duration of 6.8min (*IQR* = 2.6), and a spellchecking task, with an average duration of 3.8min (*IQR* = 1.5), found that the

spellchecking task was more likely to be overestimated and the paper counting task was more likely to be underestimated. Underestimation for the paper counting and overestimation of the spellchecking task was more pronounced for future task completion time estimates. Roy et al. (2013) suggest that the direction of bias might have been due to the difference in duration of the two tasks (3.8min vs. 6.8min). The figure in their paper suggests a cut-off point between over- and underestimation of 5min 23sec for future task completion time predictions. However they do point to the fact that the tasks also differed in many other aspects, so direction of task completion time estimation bias cannot be clearly attributed to task duration.

Supporting the *Memory-Bias Account*, Roy, Mitten and Christenfeld (2008) found that estimation bias was reduced when participants were given accurate feedback after performing a task and before predicting future task performance duration. This was true for lab tasks, academic tasks and some real-life tasks. Furthermore, contrasting Buehler et al. (2010) and Buehler and Griffin's (2015) suggestion, Roy et al. (2013) found that observers were not less biased in their future time estimates.

The Anchoring and Adjustment Account

The third model of the underlying factors causing the planning fallacy is the *Anchoring and Adjustment Account*. Thomas, Newstead and Handley (2003) suggested that people anchor their future time predictions on the duration of a previously performed task. This means that if a forthcoming longer task has to be

estimated and is preceded by a shorter task, it will be underestimated. Conversely, if a forthcoming shorter task has to be estimated and is preceded by a longer task it will be overestimated. Using a standardised problem solving task (the *Tower of Hanoi* task) of different complexities and durations (20-250sec), Thomas et al. (2003) found that the tasks were generally overestimated. However, in support of their anchoring hypothesis, shorter tasks were overestimated if preceded by a longer task, and longer tasks were underestimated if preceded by a shorter task. They furthermore suggested that the anchoring was due to the difference in durations of the tasks and not complexity, as the same pattern of results was found using a no-rule variant of the same tasks, in which durations could be compared without variations in complexity. They replicated these findings in a series of other studies using different tasks such as anagrams (Thomas, Handley & Newstead, 2004) and building toy castles (Thomas, Newstead & Handley, 2004; Thomas, Handley & Newstead, 2007). They also found that future time predictions were anchored on the duration of the previous task, even if the previous task was of completely different nature, in this case the focal task being building a toy castle and the preceding task being the Tower of Hanoi task (Thomas et al., 2004b).

However, it could be that some aspects of previous tasks might lead people to focus more on the durations of some of the previous tasks than others. That would mean that if participants perform multiple tasks before estimating a completion time duration there could be factors that determine which of the previous task durations is used as an anchor. Based on the literature reviewed earlier in this chapter it could be suggested that the controllability of a

previously experienced task would make that task more likely to act as an anchor when predicting future task completion times.

Hypothesis 7

The seventh hypothesis of this thesis tests an alternative or additional mechanism for how controllability might lead to shorter task completion time estimates. This hypothesis states that people might use the duration of a previously experienced controllable task as an anchor for their future time predictions but do not use the duration of a previously experienced uncontrollable task as an anchor. This would be separate or additional to objective control over a previous task acting as a biasing factor for future task completion time estimates in itself. This hypothesis will be explored in Chapter 3 in which participants will be presented with two tasks of varying length and controllability before making their completion time estimates.

The Self-Learning Account

The *Self-Learning Account* builds on the earlier *Anchoring and Adjustment Account*, but differs in several ways. *The Self-Learning Account* postulates that people use their knowledge about their own past estimation biases as anchors when predicting forthcoming tasks. This means that if the last task was underestimated, people will adjust their next task duration prediction to be longer and if the last task was overestimated, they will adjust their next task duration prediction to be shorter. Support for this model comes from two studies. König, Wirz, Thomas and Weidmann (2015) used two different tasks of

approx. 25min duration, the first being building a toy and the second a paper and pencil colouring-in task. They found that if participants were made aware of their prediction bias, in this case underestimation, on a previous task (building a toy), by having to estimate it before and after completing it, they were less biased for predicting the completion time of another unrelated task of the same length (colouring-in task). Thomas and König (2018) found that when people underestimated an initial task (e.g. writing an essay) and then predicted the duration of doing the same task again, their predictions were relatively accurate. However when the initial task (building a toy castle) was not underestimated and then was followed by an unrelated task (writing an essay) the second task was underestimated. They found this effect when giving people explicit feedback about their first task completion times and in the absence of feedback. They took this to suggest that if people are aware of their previous biases, e.g. underestimation, they will try and adjust their following predictions accordingly. However, people do not adjust their predictions based on the previous task if the duration of that task was not misjudged in the first place.

Comparing the Five Planning Fallacy Models

The five models described above, including the initial *inside-outside model* put forward by Kahneman and Tversky (1977), differ in terms of the type of information they assume is initially considered by people when making future task completion time estimates and which leads to underestimation. Kahneman and colleagues suggest in their initial account that people take the inside-view,

and therefore focus only on the specific task at hand and plans of how to complete it. This is supported by Buehler et al.'s (2010) *Extended Inside-Outside Model*, which also suggests that people focus excessively on the current task and are therefore taking the biased inside-view to prediction. However, the later models suggest that it is not the focus on the current task that leads to completion time underestimation, but that it is previously experienced tasks that are the biasing factor. Roy et al.'s (2005) *Memory-Bias Model* assumes that all tasks of similar durations are misremembered in the same way, or the same direction. They suggest that short tasks are retrospectively overestimated and long tasks retrospectively underestimated. These erroneous memories then lead to future task completion estimation biases. They base their assumption about what kind of previous tasks are biasing future predictions mainly on the duration of the current task and suggest that memories of previous tasks of similar durations will be used when predicting completion times.

The type of information people use when predicting future task completion times becomes even narrower in the *Anchoring and Adjustment Model* (Thomas et al., 2003), which proposes that it is only the task just preceding the to-be estimated one that leads to task completion underestimation, because people anchor and adjust their future task completion estimate in accordance with the duration of the previous task. The relevant information in König et al.'s (2015) *Self-Learning Account* is even narrower still, for that account suggests that people tend to adjust their completion time estimates based on the task just preceding the to-be estimated one, but if and only if the duration of the preceding one was misjudged in the first place.

Reference Class Forecasting and Uncertainty

Kahneman and colleagues (Kahneman & Tversky, 1977; Kahneman & Lovallo, 1993; Lovallo & Kahneman, 2003) suggest that people could make more accurate predictions if they take into account distributional data. They propose that the reference class upon which the predictions should be adjusted should consist of many meaningfully relevant projects and tasks. As stated earlier in this chapter, their reference class however does not include extreme outliers and can therefore be thought of as normally distributed (see e.g. Kahneman & Lovallo, 1993). It can be noted that the reference class idea gets narrower in the *Extended Inside-Outside Model*, as Buehler et al. (2010) and Buehler and Griffin (2015) propose that people could make more accurate predictions if they used their own memories as a source of distributional data. However, in most of their writings a reference class does not include all possible past similar tasks that are related to the current one, nor similar past tasks being performed by other people. They argue that these broader reference class types might not readily be available to people when making completion time predictions.

However, there have also been suggestions of widening the reference class approach further than the initial proposal by Kahneman and Tversky (1977). These have come from the mathematical modelling research that has tested the nature of probability and uncertainty (Taleb, 2012; Taleb, 2019a; Taleb, 2019b). Taleb (2012; 2019a) suggests that the reference class should not be normally distributed, as suggested by the original *inside-outside model* (Kahneman & Tversky, 1979; Kahneman & Lovallo, 1993; Lovallo & Kahneman, 2003). In the

initial approach of reference class forecasting, the outliers that do not fall within a certain range of the average are eliminated before further calculations are performed for the normally distributed reference class. Taleb (2012, pp. 284-5) points out that completion times of tasks and projects are not normally distributed and also not linear, but follow fat tailed distribution or convex function, which means that those tasks and projects that are completed late are often completed very much later than the average time, while there are hardly any projects that are completed a lot earlier than planned. Taleb (2012) stresses that it is exactly these outliers at the right end of the distribution, i.e. projects with extreme delays, which are important to use as part of the reference class predicting completion for a future project and hence they should not be deleted as outliers. The most important feature of the outliers that Taleb suggests should be included in the reference class is their unexpectedness. As Taleb writes, the projects in the fat-tails of the distribution, i.e. those with extreme delays, are those that may have been hit by so-called *Black Swan* events (Taleb, 2007). These so-called black swan events are defined as being unexpected high-impact events that have detrimental effects on a project (Taleb, 2007). Budzier and Flyvbjerg (2011) find mathematical evidence of these types of outliers when looking at the total distribution of a large sample of real-life ICT projects. Furthermore, when mathematically using this wider reference-class approach for predicting the completion times of real-life ICT projects they suggest that this method would be more precise than their earlier application of the normally distributed reference class forecasting (e.g. Flyvbjerg, 2006).

To sum up the implications of the accounts above for *The Control Model of Future Time Prediction*, it seems that the uncertainty and uncontrollability in the world and specifically in the environment of projects is another big culprit for causing the planning fallacy, on top of the psychological mechanisms described in the earlier sections of this chapter. In this thesis I will argue that additionally to the problem of uncertainty/uncontrollability leading to objectively longer task completion times – it is certainty, i.e. *control* over a task, that can in itself bias people's predictions of future time and make them prone to underestimations. It is proposed that these two forces act together in causing the planning fallacy – previously experienced task control making estimates shorter and uncertainty/uncontrollability of the future task making completion times longer, exacerbating the discrepancy and leading optimistic predictions to be biased predictions.

Past and Current Methods of Investigating the Planning Fallacy

Previous methods for investigating the planning fallacy in laboratory settings

One of the challenges in assessing the previous experimental evidence of how the situational/contextual variables interplay with the psychological causes of the planning fallacy lies in the fact that a vast diversity of tasks have been used. These range from academic tasks, to real-life projects to laboratory-style experiments. The limitation of previous meta-analyses into the planning fallacy literature is that they focused mainly on the length of the tasks and did not take into account the type of task used or, in relation to the investigations of this thesis, how controllable these tasks were. For example Buehler et al. (2010), Buehler and Griffin (2015) and Roy et al. (2005) considered the difference between short (lab tasks) and longer (often real-life) tasks, but did not account for the differences within these categories. Even when looking only at those tasks of relatively similar durations, e.g. those performed in the laboratory, the diversity of tasks used creates a problem when evaluating why tasks were underestimated or overestimated. Because of the inconsistency in the tasks used, it is hard to tell if over- and underestimation were due to the task used, and for example their controllability, or the other experimental manipulation employed in the study. To further complicate matters, even studies using the same task type did not always find consistent results. And sometimes studies using the same experimental manipulation employed different types of tasks, so one

cannot tell if their results are really due to the manipulation or the task differences.

Table 1 below provides a summary of the different types of laboratory tasks used in the psychology literature investigating the planning fallacy. Given that it is hard to retrospectively establish the controllability of these laboratory tasks, the table below classifies them according to five overarching task-categories: linguistic, mathematical, logical, visuomotor and visual. Each of these can be further subdivided. The linguistic category comprises several active linguistic tasks, such as essay writing, speech writing and letter writing. It also includes passive linguistic tasks involving reading. Another commonly used sub-category of tasks is corrective-linguistic tasks, such as spellchecking and text formatting. The last category of linguistic tasks belongs to the group of word-manipulation, in which anagrams are often used. One single study used answering demographic questions as another simple linguistic task. The next major category of tasks is that of mathematical tasks. These can be sub-divided into subtraction tasks, often in the form of balance sheets, counting tasks (e.g. counting sheets of paper) and digit-search tasks. The tasks in the third broad category have in common that they all employ some form of logical problem solving. Two big sub-categories can be drawn, that of logical order and logical searches. Tasks in the logical order category are: alphabetical order, alphabetical and numerical order, visual order and searching using logical order. The tasks used in the logical search category are: searching for general knowledge information using the web and searching for specific simple information in a product catalogue, a phone book and a library catalogue. The visuomotor

problem-solving category can be divided into four sub-categories including: objects assembly (e.g. PC stands, Lego toys and puzzles), object creation (e.g. origami), visuospatial problem-solving, such as the Tower of Hanoi task, and lastly a colouring task. The last category is that of visual tasks, which included passive watching of a video and estimating spatial distance using a walking speed estimate for flat paths and stairs. There are also three laboratory studies, not included in Table 1 below, which employed complex experimental tasks such as posting letters to pigeonholes or that involved social interaction, e.g. shopping for a chocolate bar and a stamp.

Table 1
Summary of experimental tasks used in previous planning fallacy research

Task Category	**Sub Category**	**Actual Task**	**Reference**
Linguistic	Active linguistic	Essay writing	Roy and Christenfeld (2008)
			Forsyth and Burt (2008)
			Koole and van't Spijker (2000)
			Pezzo, Pezzo and Stone (2006)
			Thomas and König (2018)
		Speech writing	Roy, Christenfeld and Jones (2013)
		Letter writing	Burt and Kemp (1994)
	Passive linguistic	Story reading	Pezzo, Litman and Pezzo (2006)
			Roy et al. (2013)
	Corrective linguistic	Spellchecking	Burt and Kemp (1994)
			Forsyth and Burt (2008)
			Roy et al. (2013)
			Francis-Smythe and Robertson (1995)
		Formatting	Kruger and Evans (2004)
			Halkjelsvik et al. (2012)
	Word manipulation	Anagram	Buehler et al (1997)
			Thomas et al. (2004a)
	Answer questions	Demographic form	Burt and Kemp (1994)
Mathematic	Subtraction	Balance Sheet	Burt and Kemp (1994)
			Forsyth and Burt (2008)

	Counting		Stack of papers	Roy and Christenfeld (2008)
				Roy, Mitten and Christenfeld (2008)
				Roy et al. (2013)
	Digit search		Mark digits	Pezzo et al. (2006)
Logical	Logical Order	Alphabetic Order	By name	Forsyth and Burt (2008)
		Alphabetic & Numeric Order	By name and year	Forsyth and Burt (2008)
			By type and year	Boltz and Yum (2010)
		Visual Order	Deck of cards	Burt and Kemp (1994)
		Search	Library book	Burt and Kemp (1994)
	Logical Order	General Knowledge	Web search	Rodon and Mayer (2011)
		Specific Simple Information	Catalogue info search	König (2005)
			Phone book	Forsyth and Burt (2008)
			Library catalogue	Forsyth and Burt (2008)
Visuomotor Problem Solving	Object Assembly		PC Stand	Byram (1997)
				Sanna et al. (2005)
			LEGO toy	Hinds (1999)
				Thomas et al. (2004b)
				Thomas et al. (2007)
				Thomas and Handley (2008)
				König et al. (2015)
				Thomas and König (2018)
			Puzzle	Buehler et al. (2005)
				Franchis-Smythe and Robertson (1995)
	Object Creation		Origami	Byram (1997)
				Roy and Christenfeld (2007)
				Schwab et al. (2013)
	Problem Solving		Tower of Hanoi	Thomas et al. (2003)
				Thomas et al. (2004a)
				Thomas et al. (2007)
				Thomas and Handley (2008)
	Colouring		Colouring task	König et al. (2015)
Visual	Video		Passive watching	Franchis-Smythe and Robertson (1995)
				Halkjelsvik et al. (2012)
	Spatial Distance (walking speed)		Flat path	Hanyu and Itsukushima (1995)
				Grealy and Shearer (2008)
			Stairs	Burt and Kemp (1994)
				Hanyu and Itsukushima (1995)
				Hanyu and Itsukushima (2000)
				Grealy and Sheerer (2008)

A new method of investigating the planning fallacy in a laboratory setting

It can be seen from Table 1 and the descriptions above that the types of tasks previously used to investigate the planning fallacy in laboratory settings are multiple and diverse. Importantly for the current thesis it is hard to compare and contrast these tasks in terms of their objective controllability. Furthermore the controllability of similar types of tasks might have varied across different experiments and also the different additional manipulations employed. Following on from the hypothesis stated above (Hypothesis 1) it is predicted that there is an effect of task controllability on future time estimation, with having experienced a more controllable task leading to shortened future task completion time estimates. In the current thesis I therefore propose the use of a task for which the objective amount of control can be more directly manipulated. The experimental task that will be employed (in Chapter 2 & Chapter 3) will be a contingency paradigm (following e.g. Msetfi, Murphy, Simpson & Kornbrot 2005), in which actions produce outcomes and the precise numbers of these actions and outcomes can be experimentally manipulated. The actual amount of control can be calculated using the measure of the one-way contingency between binary events (Allan, 1980; Allan & Jenkins, 1980; Vallee-Tourangeu, Murphy & Baker, 2005; Wasserman, Elek, Chatlosh & Baker, 1993). Following Allan (1980), the contingencies (ΔP) are defined by the difference between the conditional probabilities of the outcome occurring in presence $P(O|A)$ and absence of the action $P(O|\sim A)$. Previous studies have suggested that this paradigm is applicable for experiments that want to manipulate participants' objective control and

compare it to the ratings of perceptions of control (Dobson & Franche, 1989; Ackermann & DeRubeis, 1991; Haaga & Beck, 1995). Furthermore, this paradigm is chosen for the current investigation into the planning fallacy phenomenon, because of the ability to manipulate the objective amount of control over the task without affecting the duration of the task. In real-life, control over a task might often also lead to shorter task completion times. However, if in an experiment employing both task types, controllable tasks were always shorter than uncontrollable tasks, then one would not be able to establish whether predicting a shortened task completion time for a future task, as characteristic for the planning fallacy, was due to the amount of control over the past task or the shorter duration of the past task. Therefore, the paradigm used in this thesis held the task durations constant by matching the number of trials for both controllable and uncontrollable tasks, in order to investigate the effect of task controllability and exclude the possible influence of task duration. As Hypothesis 1 states, it is predicted that a shortening of future task complete times occurs because of the biasing effect of control over the task itself. However, to exclude the alternative hypothesis (Hypothesis 7), that people anchor their future task completion time predictions on a previously experienced duration, three experiments are described in Chapter 3 that independently manipulated both controllability and duration of the experimental task.

Summary of the Hypotheses of the Current Thesis

Hypothesis 1

The first hypothesis that will be investigated in this thesis is that enhanced *objective* control over a task leads to shortened predictions of future task completion times. It is proposed that predictions of future task completion times will be shorter following controllable tasks as compared to following uncontrollable tasks. The effect of objective control on task completion estimates will be investigated using experimental laboratory tasks in Chapter 2.

Hypothesis 2

The second hypothesis states that heightened *subjective* perceptions of control over a task will also lead to shorter task completion time estimates. This hypothesis will be investigated for experimental tasks in Chapter 2.

Furthermore, it will be investigated in Chapter 4, whether for real-life tasks, people who perceive themselves as being more in control over completing the task in a timely manner will predict shorter task completion times in comparison to people who do not see themselves as being in control over a timely task completion.

Hypothesis 3

The third hypothesis of this thesis, which will be explored in Chapter 2 (Experiment 2 & 3), states that depressed participants would be less prone to

shortened predictions of future task completion times following controllable tasks.

This hypothesis is proposed because mildly depressed people have been shown to have different perceptions of control as compared to non-depressed people. For example they are less prone to the illusion of control following uncontrollable tasks with high outcome probability. Furthermore, this hypothesis rests on previous suggestions that depressed people have different ways of processing time information and generally slowed down perception of time.

Hypothesis 4

The fourth hypothesis states that for real-life tasks, people who perceive themselves as having more control over possible facilitating factors (helpers) and impeding factors (hinderers) contributing to or working against their timely task completion will predict shorter task completion times in comparison to people who do not perceive themselves as being in control over these positive and negative factors. Furthermore, it is expected that it is especially a heightened perception of control over impeding factors that would lead to shortened time predictions. This will be investigated in Chapter 4.

Hypothesis 5

The fifth hypothesis of this thesis is that people who are made to think about negative causal factors (hinderers) that might affect their task completion in the future will be less likely to predict shortened completion times. Furthermore,

people who are made to think about positive causal factors (helpers) will be more likely to predict shortened completion times. This hypothesis will be investigated in Chapter 4. Taking into account suggestions from the previous literature, the ease of generation for both positive and negative causal factors will be kept constant (in this case, easy generation) in order to be able to assess the effect of valence of causal factors on its own.

Hypothesis 6

The sixth hypothesis of this thesis is that people with high desire for control would be more inclined to predict shorter task completion times than people with low desire for control. This line of reasoning will be tested in Chapter 2 (Experiment 3 & 4). It is also predicted that people with higher desire for control will predict shorter task completion times for real-life tasks, as investigated in Chapter 4.

Hypothesis 7

The seventh hypothesis of this thesis tests an alternative or additional mechanism for how controllability might lead to shorter task completion time estimates. This hypothesis states that people might use the duration of a previously experienced controllable task as an anchor for their future time predictions but do not use the duration of a previously experienced uncontrollable task as an anchor. This would be separate or additional to objective control over a previous task acting as a biasing factor for future task completion time estimates in itself. This hypothesis will be explored in Chapter 3

in which participants will be presented with two tasks of varying length and controllability before making their completion time estimates.

Chapter 2: The influence of objective controllability on past and future task completion time estimates

Introduction

The experiments in this chapter aimed at investigating Hypotheses 1, 2, 3, and 6 set out in Chapter 1. Hypothesis 1 states that more objective control over a task will lead to shortened predictions of future task completion times. Furthermore, the influence of subjective perceptions of control over the task on time estimations will be investigated. Hypothesis 2 states that higher subjective perceptions of control might also lead to shortened task completion time estimates. Two further hypotheses were investigated that refer to the individual difference variables that are thought to influence the planning fallacy. It is proposed in Hypothesis 3 that people who are depressed (or mildly depressed) would be less susceptible to shortened task completion time estimates following controllable tasks. Hypothesis 6 proposes that people with a high desire for control would be more prone to shortened task completion time estimates following controllable tasks.

A control judgement task was used to produce tasks that differed in their objective controllability by varying the contingency between actions and their

outcomes. An operant discrete-trial contingency task was employed, in which actions produced an outcome and the relation between the action and the contingency of the outcome was experimentally manipulated (Msetfi et al., 2005; Msetfi et al., 2013). There is evidence that increasing the probability (or outcome density) with which outcomes are presented, independent of actions, can lead to an enhanced (illusory) perception of control of uncontrollable tasks (i.e. zero contingencies), called the illusion of control (Alloy & Abramson, 1979; Matute, 1996; Msetfi, Kornbrot, Matute & Murphy, 2013). This effect has been shown using passive predictive tasks (Vallée-Tourangeu et al., 1998), free-operant procedures (Vallée-Tourangeu, Murphy & Baker, 2005) and operant discrete-trial procedures (Msetfi et al., 2005). Some studies, such as Msetfi et al. (2013), which used a more realistic task design, involving a virtual reality room, also reported this density effect at positive and negative (i.e. non-zero) contingencies. To investigate this illusory control the outcome probability in the following experiments was also manipulated and matched between contingency conditions to be able to discriminate between the effects of contingency and of outcome probability.

To sum up, the experiments of this chapter tested the relationship between objective control over a task, subjective perceptions of control and time estimation. Furthermore, from the second experiment onwards the effect of individual-difference variables on estimation of time was investigated.

Experiment 1

Introduction

The first experiment aimed to establish the relationship between the objective controllability of a task, the subjective perception of controllability and the estimation of the duration of that task. Furthermore, it was of interest whether the estimation of the past and future duration of the same task would be different, given that the models of the planning fallacy differ in their predictions about past time estimates. As discussed in Chapter 1, the original inside-outside model proposed by Kahneman and Tversky (1977), the *Extended Inside-Outside Model* (Buehler et al., 2010) and the *Anchoring and Adjustment Account* (Thomas et al., 2003) assume accurate memories of past task completion times. However, the *Memory-Bias Account* (Roy et al., 2005) and the *Self-Learning Account* (König et al., 2015) propose that previous task completion times are not (always) accurate and therefore bias future completion time predictions.

In this experiment Hypothesis 1 was tested, which stated that a more controllable experimental task as opposed to an uncontrollable experimental task would lead to shortened task completion time estimates. Control ratings were collected in order to measure the effect of the different contingencies and outcome probabilities on the subjective perceptions of control and how these subjective control ratings would relate to the task completion time estimates. Hypothesis 2 stated that higher perceptions of control would lead to shorter task completion time estimates.

Control ratings were collected at two points during the task in order to be able to investigate when participants would reach the asymptote of learning the association between their actions and the outcomes. This was investigated for the two contingency and the two outcome probability conditions. It was of interest how this would influence control ratings for each of the tasks.

Methods

Participants

Participants were volunteers recruited from the general and university student population. Participants were offered an honorarium for their participation with either money (£5 per 30min) or course credits. 61 participants took part in this experiment. The sample consisted of 32 females, 21 males and 8 participants with unspecified gender. The average age of the sample was 23.80 years (SD = 5.45).

Materials

All tasks were programmed and presented on a desktop computer (Apple Macintosh) using the MATLAB R2013b software (MathWorks, Cambridge, UK) and its extension Psychophysics Toolbox Version 3 (Brainard, 1997; Pelli, 1997). The stimuli used were drawings of fruit juice bottles (see Appendix A) made using GNU Image Manipulation Program (GIMP 2.8).

Design

This experiment combined a contingency task (see Allan, 1980; Allan & Jenkins, 1980; Murphy & Baker, 2004; Wasserman, Elek, Chatlosh & Baker, 1993) with time estimation as well as control estimation.

An operant discrete-trial procedure was used following some of the design aspects of Msetfi et al. (2005), in which participants learned about the effectiveness of their action in producing an outcome. Participants were required to provide control ratings and task completion time estimates. Two different contingencies were used to vary controllability, in one contingency condition participants had control over the occurrence of the outcome (a positive contingency) and in the other they had no control (a zero contingency). These contingencies were calculated by computing the difference (ΔP) between the probability of a response causing the occurrence of an outcome $P(O|A)$ and the probability of the outcome occurring in the absence of a response $P(O|\sim A)$ (see Allan, 1980; Allan & Jenkins, 1980). A positive contingency therefore denoted a controllable task, where the outcome was more likely to happen after an action had been performed than it was in absence of the action. A zero contingency denoted an uncontrollable task, where the likelihood of the outcome occurring was equal in presence and absence of the action. Outcome probability given action was also manipulated, with a low and a high probability being used.

A 2x2 within-subject design was employed, with contingency (0 and 0.5) and the outcome probability given an action (low and high). The 2x2 design yielded a total number of four conditions (see Table 2). Each participant was presented with all four conditions consisting of 32 trials each. The presentation of the four

conditions was randomised between participants.

ΔP = 0.5
OF: Low

	Outcome	No Outcome	
Action	8	8	P(O|A) = .5
No Action	0	16	P(O|noA) = 0

ΔP = 0
OF: Low

	Outcome	No Outcome	
Action	8	8	P(O|A) = .5
No Action	8	8	P(O|noA) = .5

ΔP = 0.5
OF: High

	Outcome	No Outcome	
Action	12	4	P(O|A) = .75
No Action	4	12	P(O|noA) = .25

ΔP = 0
OF: High

	Outcome	No Outcome	
Action	12	4	P(O|A) = .75
No Action	12	4	P(O|noA) = .75

Table 2: *The four experimental conditions, with two contingency levels (0 vs. 0.5) and two outcome probabilities given action P(O|A) (low vs. high). The numbers inside the four tables represent the indicative trial numbers for the four possible trial types (Action - Outcome, No Action - Outcome, Action - No Outcome, No Action - No Outcome). The actual trial numbers depended on the action frequency of each participant.*

Four outcome measures were collected in this experiment. The first two were measures of the perception of control. These were control ratings after half the trials (16 trials) in a condition and control ratings after all the trials (32 trials). The third and fourth outcome measures were measures of time perception. The first was a completion time estimate of the past task and the second was a completion time estimate of the future task.

Procedure

At the start of the session, participants completed a consent form and a demographic questionnaire. Then participants read the experimental instructions and were shown a sample trial (see Appendix A). Participants were asked to imagine working for a company that produced different fruit juices.

According to the cover story, that company had just received orders for different fruit juices and participants were required to fill juice bottles accordingly. To do so they had to operate different on-screen filling machines. Each of the four conditions was represented by a different filling machine and a new type of fruit juice. The experimental task involved learning how effective their action, a spacebar press (activating the bottle filling machine), was at producing an outcome (filled bottle). The cover story further stated that the bottle filling machines had been reported to be faulty and therefore the participants could expect that the filling machines would not always work as intended, i.e. sometimes the machines would not fill bottles after a spacebar press, and sometimes the bottles would be filled without the spacebar being pressed. Participants were then instructed to press the spacebar on half of the trials (50% of the time) in order to investigate how much control they had over the filling process. Participants were told that they would be working on the filling machine of a particular juice type until all the bottles for that particular batch were produced. This meant that participants did not know the number of bottles required or the total number of trials (including those trials that had an empty bottle as outcome) before performing the tasks. The experiment was programmed such that the total number of trials was equal in all four experimental conditions in order to keep the task duration constant. What changed between conditions was the contingency and outcome probability; this meant that the condition (batch) had a different number of full bottles. However, two of the conditions were matched in their number of full bottles (see Table 2, top right and bottom left). For all instructions see Appendix A.

Participants were then presented with a sample trial that was accompanied by verbal explanation. In this sample trial the juice type was different from those used in the experimental task (lemon juice – yellow colour). Following this presentation, participants were instructed (see Appendix A) about the control ratings and past and future completion time estimates they had to give at the end of every condition. Control ratings were collected on a scale from 0 to 100, where 0 denoted no control and 100 denoted total control. Time estimations were collected as direct estimates in minutes and seconds.

After 16 trials participants were presented with a rating screen, asking them to make the same rating about their control perception as described above. At the end of each condition participants were presented with the three rating screens described above (see Appendix A), on which they had to rate their perception of control and give an estimation of the duration of the past condition and a prediction of the duration of the next condition. At the end of all the conditions a black screen was presented reading *The End*. Participants were debriefed, thanked and given their honorarium.

Trial Structure

Each trial consisted of a 2 second fixation cross, 3 seconds response window and a 1 second outcome presentation, with a 2.5 seconds inter trial interval (ITI), yielding a total trial time of 7 seconds. Figure 3 shows the trial structure used in this experiment. This was followed by a response window lasting 3 seconds, in which participants could choose if they wanted to make a response, by pressing the spacebar on the keyboard, or not. Participants were told at the beginning of

the experiment that they would need to test the bottle-filling machine and so should press the spacebar approximately on half the trials (action required on 50% of trials). During the response window a red button-switch was shown, also containing the word *off*. This button-switch changed sides, turned green and displayed the word *on* when participants made a response. The response window remained active for 3 seconds, regardless of whether a response was made or not, in order to maintain the trial duration. This meant that when a participant withheld their response they saw the red button for 3 seconds. If participants made a response they saw the red button first and following their space-bar press the green button was shown for the remainder of the 3-second window.

The outcomes in the experimental task were represented by juice bottles. These were either filled with juice, i.e. colourful, or empty, i.e. white. The outcome was shown for 1 seconds. The response button (red or green respectively) was also shown underneath the outcome picture, in order to remind participants whether they had made a response on that trial or not. Four different juice types and juice colours were used in the experiments (apple – green, cherry – red, orange – orange and plum – blue) and these were randomised for each participant. The stimuli and response-button images can be seen in Appendix B.

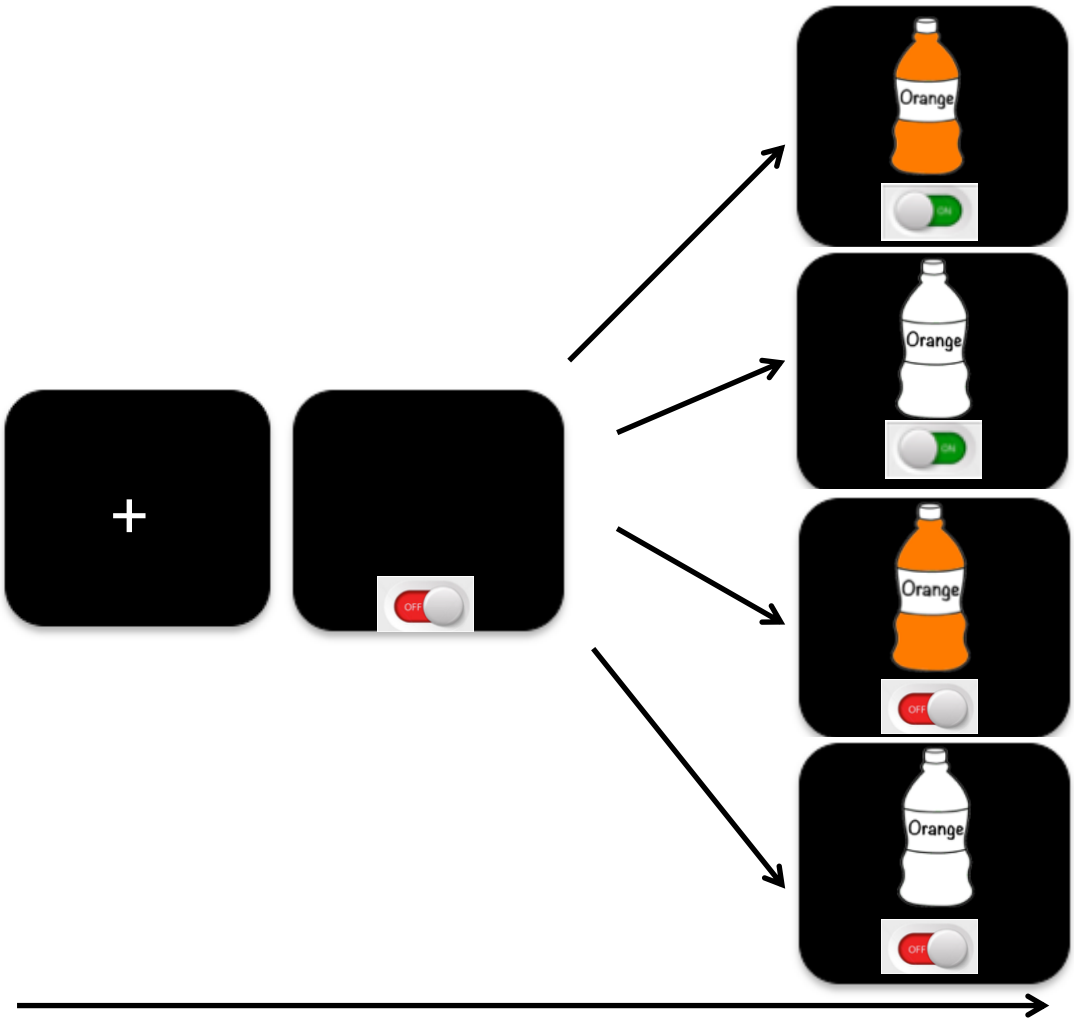

Figure 3: Example trial structure. The first screen shows the 2sec fixation cross, the second screen shows the 3sec response window, then the four possible action-outcome pairings are presented (Action - Outcome, No Action - Outcome, Action - No Outcome, No Action - No Outcome).

Results

Data Preparation

Extreme outliers were determined for the time estimation measures using the inter quartile range (IQR). Extreme outliers were defined as data points more than three interquartile ranges (IQRs) below the first quartile (Q1) or above the third quartile (Q3) ($x_1 \geq Q3 + 3 \times IQR$ and $x_1 \leq Q1 - 3 \times IQR$). Five participants

were removed as extreme outliers from all the analyses. Five participants had missing values in one of the levels of the time measures and were therefore removed from the analysis, leaving a sample of 51 participants. Four participants had missing values in the control measures. Missing values for the control measure were replaced by interpolation using the average scores for that condition of all participants.

Participants were instructed to perform an action on approximately 50% of trials (i.e. press the spacebar on half the trials). Action percentages were calculated for each participant and each condition (see Msetfi, Kumar, Harmer & Murphy, 2016). Those participants whose action percentage was above 85% or below 15% were deleted from the analysis. This was the case for one participant; however this participant had already been removed as an extreme outlier as stated above. Throughout the analyses reported here an alpha level of .05 and confidence intervals of 90 % for the effect sizes were used.

Control Ratings

As seen in Figure 4, control ratings were influenced by: contingency (0 vs. 0.5), outcome probability (low vs. high) and trial number (16 vs. 32). It was found that control ratings were higher after 16 trials (M = 49.294; SD = 15.331) than after 32 trials (M = 46.402; SD = 14.959), control ratings were also higher after the positive contingency condition (controllable task) (M = 56.456; SD = 16.418) than after a zero contingency condition (uncontrollable task) (M = 39.240; SD = 18.989) and they were higher following the high outcome probability condition

(M = 43.662; SD = 16.412) than the low outcome probability condition (M = 52.034; SD = 16.847). For all other means and standard errors see Figure 4 below.

This pattern of results was confirmed by conducting a 2x2x2 within-subjects repeated measures ANOVA investigating the control ratings after 16 trials and 32 trials at each level of contingency (0 vs. 0.5) and each level of outcome probability (low vs. high). There was a significant main effect of trial number, $F(1,50) = 4.962$, $p = .030$, ${}_p\eta^2 = .090$, 90% CI [.003, .206], a significant main effect of contingency, $F(1,50) = 35.265$, $p < .001$, ${}_p\eta^2 = .414$, 90% CI [.271, .558], and a significant main effect of outcome probability, $F(1, 50) = 12.956$, $p = .001$, ${}_p\eta^2 = .206$, , 90% CI [.064, .343]. Most interactions were clearly non-significant (all *F*s < .958, all *p*s > .332). The Trial Number x Contingency interaction approached significance $F(1,50) = 3.588$, $p = .064$, ${}_p\eta^2 = .067$, CI 90% [0, .195].

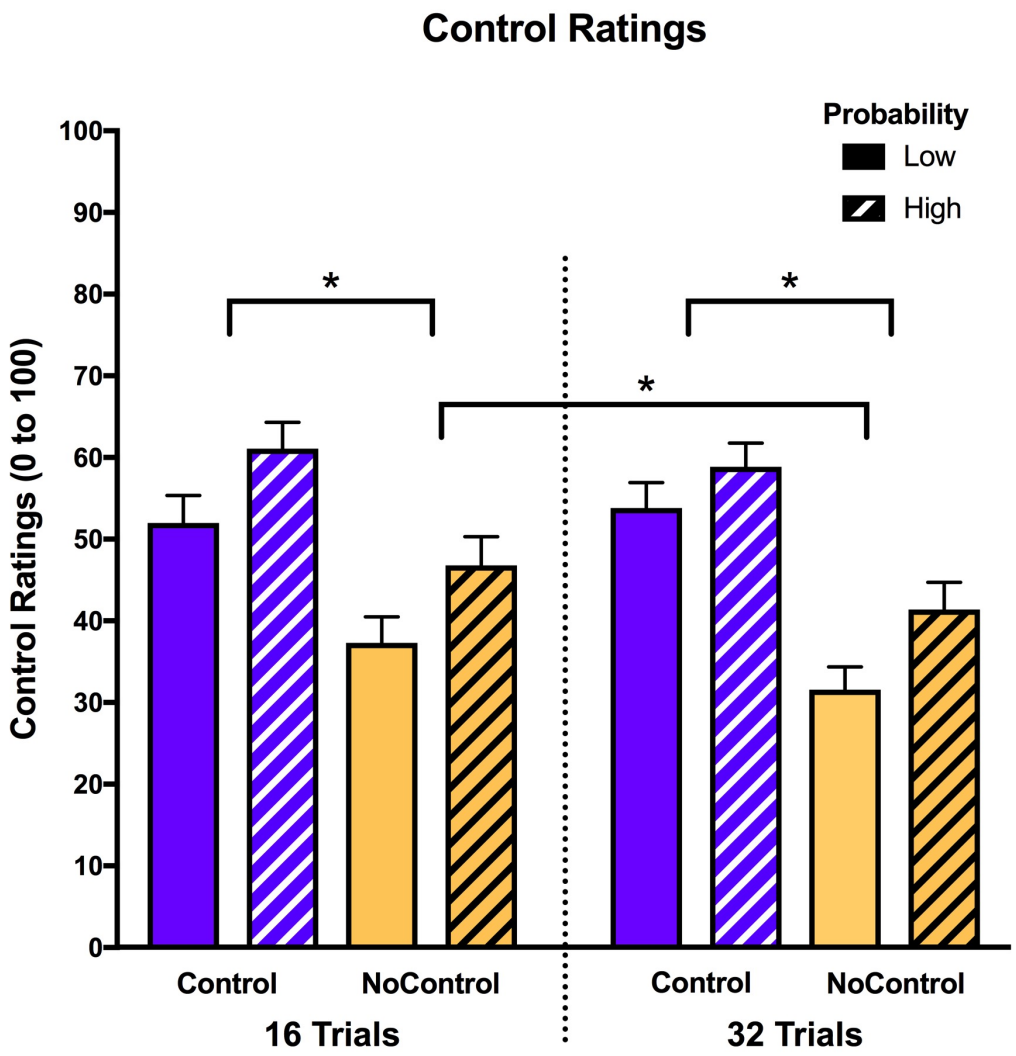

Figure 4. Mean control ratings (0-100) as a function of trial number (16 vs. 32), controllability of the task (control: ΔP = 0.5 vs. no-control: ΔP = 0) and outcome probability (low vs. high). Error bars represent standard error of the mean (SEM).

It was investigated whether it would take people longer to learn that they had no control than it took them to learn that they had control. This investigation was based on the Rescorla-Wagner Model (Rescorla & Wagner, 1972), which predicts that the asymptote of learning would be reached faster in the 0.5 contingency as compared to the 0 contingency, Therefore, it was tested whether control ratings would be the same after 16 trials and 32 trials for the 0.5 contingency condition (controllable task), but higher after 16 trials in comparison to after 32 trials in

the 0 contingency condition (uncontrollable task). A simple main effect analysis was carried out (Bonferroni corrected), even though the interaction between trial number and contingency did not reach the alpha level of 0.05. Simple main effect analysis revealed that after 16 trials there was a significant difference between the control ratings in the 0.5 contingency and the 0 contingency condition $F(1,50) = 17.779$, $p < .001$, $_p\eta^2 = .262$, CI 90% [.101, .408]. Furthermore, after 32 trials there was also a significant difference between the two contingencies $F(1,50) = 43.863$, $p < .001$, $_p\eta^2 = .467$, CI 90% [.291, .585]. Importantly for the investigation of the above stated hypothesis, there was a significant difference of control ratings after 16 trials as compared to after 32 trials only in the 0 contingency condition (uncontrollable task) $F(1,50) = 11.047$, $p < .002$, $_p\eta^2 = .181$, CI 90% [.046, .328]. It can be seen in Figure 4 that in the 0 contingency condition control ratings were higher after 16 trials in comparison to after 32 trials. These lower ratings could be taken to indicate that learning of the contingency was incomplete after 16 trials and that it continued during the subsequent trials in that condition. In the 0.5 contingency condition (controllable task) control ratings did not significantly differ after 16 in comparison to after 32 trials $F(1,50) = .008$, $p = .931$, $_p\eta^2 = .000$.

Time Estimation

Completion time estimates were collected for past and future tasks. The average condition duration, including the control question after 16 trials, was 284.96 seconds ($SD = 6.46$). Detailed averages for the four conditions can be seen in Table 3 below.

Table 3. Average actual task completion times as a function of controllability of the task (control: ΔP = 0.5 vs. no-control: ΔP = 0) and outcome probability (low vs. high).

Controllability	Control		No Control	
Probability	Low	High	Low	High
Mean	283.89	288.44	283.22	284.28
SD	7.772	18.969	4.817	5.604

The averages for the task completion time estimates are shown below in Table 4.

Table 4. Average future task completion time estimates as a function of controllability of the task (control: ΔP = 0.5 vs. no-control: ΔP = 0) and outcome probability (low vs. high).

Time	Past				Future			
Controllability	Control		No Control		Control		No Control	
Probability	Low	High	Low	High	Low	High	Low	High
Mean	284.37	283.2	284.75	277.98	268.29	265.33	281.22	281.96
SD	92.249	112.79	104.639	106.525	115.54	101.202	123.709	132.156

Time estimation errors were computed by subtracting actual completion times from estimated completion times. Therefore, if the time estimation error measure was equal to zero, this represented an accurate estimation of completion times. Negative time estimation errors represented an underestimation and positive time estimation errors represented an overestimation of completion times.

Completion time estimates for past tasks were not affected by the contingency manipulations in this experiment. However, there was an effect of contingency on completion time estimates for future tasks. The outcome probability manipulation did not influence completion time estimates for past or future tasks. When investigating the time estimation errors for past tasks one can see in

Figure 5 that time estimation errors were not different for the positive contingency (controllable task) (*M* = -2.384 ; *SD* = 92.548) and zero contingency (uncontrollable task) (*M* = -2.389; *SD* = 98.857) nor for the low outcome probability(*M* = 0.999; *SD* = 87.930) as compared to the high outcome probability (*M* = -5.774 ; *SD* = 99.327). However, as can also be seen in Figure 5, time estimation errors for future tasks were lower following a positive contingency (controllable task) (*M* = -19.354; *SD* = 101.184) than following a zero contingency condition (uncontrollable task) (*M* = -2.164; *SD* = 115.753). There was little difference in time estimation errors for future tasks following the low outcome probability (*M* = -8.804; *SD* = 114.327) in comparison to the high outcome probability (M = -12.715; *SD* = 107.532).

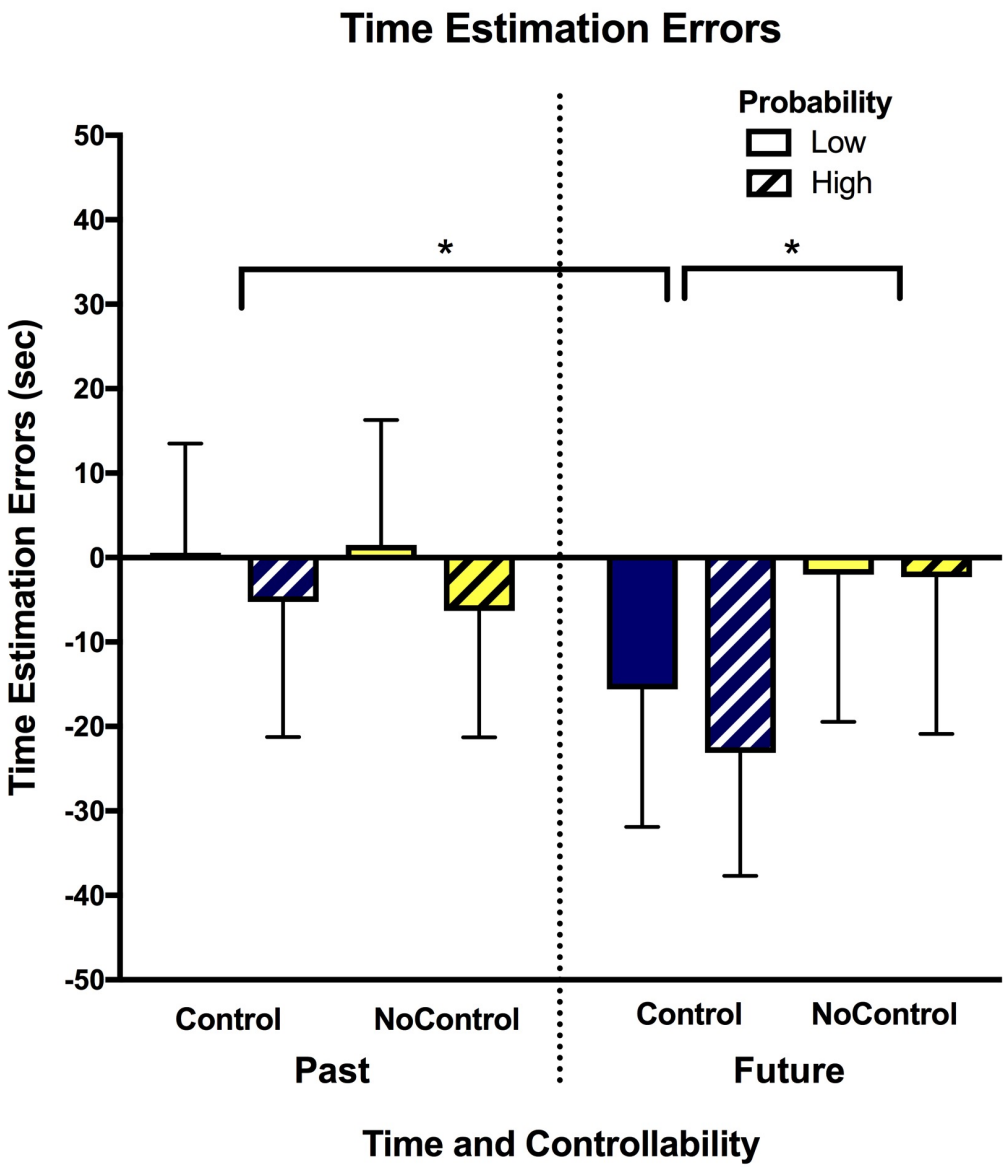

Figure 5. Mean time estimation errors (sec) for past and future tasks as a function controllability of the task (control: ΔP = 0.5 vs. no-control: ΔP = 0) and outcome probability (low vs. high) Error bars = SEM.

A 2x2x2 within-subjects repeated-measures ANOVA was carried out to analyse time estimation errors for past and future tasks (task time: past vs. future) as a function of contingency (0.5 vs. 0) and outcome probability (low vs. high). None of the main effects were significant (all *F*s < .1.519, all *ps* > .224). However, the Task Time (past vs. future) x Contingency (0.5 vs. 0) interaction approached significance $F(1,50) = 3.606$, $p = .063$, ${}_p\eta^2 = .067$, 90%CI [0, 0.196]. None of the

other interactions came close to the p = .05 significance level (all Fs < .201, all ps > .656).

The effect of contingency on time estimation errors was of special interest for completion time estimations for future tasks. Hypothesis 1 of this thesis stated that more controllability would lead to shortened estimates for completion times of future tasks, but not for past tasks. Therefore, the results of a simple main effects analysis (Bonferroni corrected) were investigated, even though the Task Time x Contingency interaction had not completely reached the significance level of alpha .05. The simple main effect analysis revealed that time estimation errors were significantly different for the past tasks vs. future tasks, but only following the positive contingency condition (controllable task) $F(1,50) = 5.528$, p = .023, ${}_p\eta^2$ = .100, 90%CI [0.008, 0.238]. The time estimation errors for past and future tasks did not differ following the zero contingency condition (uncontrollable task) (p = .980). Time estimation errors differed for the two contingencies only for future tasks, $F(1,50) = 4.771$, p = .034, ${}_p\eta^2$ = .087, 90%CI [.004, .223], but not for past tasks (F < .001, p > .999).

Condition Sequence Position

As this experiment had a repeated-measures design and participants were presented with a randomised sequence of four conditions, the effect of condition position within the sequence was also investigated in a separate analysis to the manipulations of interest. It was found that participants did not get more accurate in estimating past and future completion times with repeated exposure to the experimental task. This was confirmed by repeated-measures ANOVA

investigating the effect of condition position (1-4) on time estimation errors for past completion times which did not show a significant effect of condition position $F(3,150) = .375$, $p = .771$, $_p\eta^2 = .007$. This pattern was also confirmed for estimating future task completion times. A repeated-measures ANOVA investigating the effect of condition position (1-4) on time estimation errors for future completion times showed no significant effect of condition position $F(3, 150) = .661$, $p = .577$, $_p\eta^2 = .013$.

Control Ratings and Time Estimation

There was no relationship between control ratings and time estimation errors for past and future tasks. Bivariate two-tailed Pearson's correlations were performed between the control ratings and time estimation errors. No significant correlations between the two outcome measures were found (all ps > .111). No further analyses into the relationship between the two outcome measures were performed.

Discussion

The results concerning the control ratings showed that participants were sensitive to the contingency manipulation meaning that the two contingency conditions (ΔP = 0 vs. 0.5) were effective in producing different perceptions of the controllability of the experimental tasks, with the 0.5 contingency task being judged as more controllable than the 0 contingency task. The pattern of results was found after short exposure to the task of only 16 trials and was also found after longer exposure of 32 trials. It should also be noted that there was a general outcome probability effect for both contingencies, 0 and 0.5, with the high

outcome probability condition producing higher control ratings than the low outcome probability condition. Some previous literature has only found this outcome probability effect for zero contingencies (Alloy & Abramson, 1979; Vallée-Tourangeu et al., 2005, Msetfi. et al., 2005). In accordance with our results, other studies (e.g. Msetfi et al., 2013), using more realistic task scenarios (as explained above), found a outcome probability effects in negative, positive and zero contingency conditions. This could be seen as an indication of illusion of control.

It was found in this experiment that control ratings for the zero contingency condition (uncontrollable task) were higher after 16 trials and lower after 32 trials. The control ratings for the positive contingency (controllable task) did not differ after 16 and 32 trials. This could suggest that it takes longer to learn that one is out of control, than it does to establish a sense of control. Furthermore, this might also suggest that in the controllable condition learning only takes place during a few trials after which no further learning takes place.

It can also be seen in the results of Experiment 1 that the controllability of a situation did not seem to influence time estimation of the past duration of a just experienced task, perhaps contrary to the *Memory-Bias Account* (Roy et al., 2005), which states that the planning fallacy for future task durations is due to biased past task completion duration memories. The current experiment found that participants were relatively accurate in remembering their past task completion time, regardless of the experimental condition.

It should be noted that controllability seemed to shorten future task completion time predictions, which is in accordance with Hypothesis 1 of this thesis, that stated task completion time predictions would be shorter following controllable tasks as compared to uncontrollable tasks of the same duration. That this effect was only found for estimating future duration, might be linked to the general tendency for future time estimations to be more prone to underestimation biases, as seen in the planning fallacy phenomenon (Kahneman & Tversky, 1977; Buehler et al., 2010). Importantly, this was the first experimental investigation to show that the objective amount of control over a task could be seen as the cause of the future time underestimation bias.

Furthermore, it should be noted that no relationship between the two outcome measures was found, i.e. control ratings were not related to task completion estimates. This goes against Hypothesis 2, which suggested higher controllability perceptions to be linked to shortened task completion time estimates. In this experiment future task completion time estimates were only influenced by the objective amount of control over a task, as manipulated using contingencies, and not by subjective perceptions of control. Lastly, future task completion time estimates did not get more accurate with repeated exposure to the task.

Experiment 2

Introduction

The second Experiment followed up on the findings of Experiment 1, again investigating Hypothesis 1 and Hypothesis 2. It set out to replicate and extend the effect of controllability on future task completion time estimates using a between-subjects design and a different positive contingency condition (controllable task). Furthermore, given that no effect of the contingency manipulation was found for past completion time estimates in Experiment 1, this experiment focused only on the estimation of future time. To reduce the potential learning impact of having experienced many previous conditions, the within-subjects factors were reduced (varying only outcome probability within-subjects) and the between-subject factors were increased (varying contingency between-subjects). Lastly, in order to investigate the role of mood on the illusion of control and future task completion time predictions (see Hypothesis 3), a measure of depression was introduced using the Beck's depression inventory (BDI) (Beck, Ward, Mendelson, Mock & Erbaugh, 1961).

Methods

Participants

Participants were volunteers recruited from the general and university student population. Participants were offered an honorarium for their participation with either money (£5 per 30min) or course credits. There were 59 participants, who had an average age of 23.49 (*SD* = 7.10) and consisted of 33 females, 24 males and 2 participants with unspecified gender.

Materials

The materials used in Experiment 2 were the same as those in Experiment 1.

Measures

The Beck's Depression Inventory (BDI) (Beck et al., 1961) was used to measure depressive states in the participants. The BDI is a self-report measure with 21 questions relating to different typical aspects/symptoms of depression. The questions have five answer options, which are scored between 0 and 3. The total scores range from 0 to 63, with scores over 10 indicating mild depression, scores over 18 indicating moderate depression and scores over 30 indicating severe depression. The internal consistency for the 21 items of this measure was good in this experiment $\alpha = .79$.

Design

A 2x2 mixed-model design was employed with contingency being varied between-participants and outcome probability being varied within-participants. One level of contingency was changed from Experiment 1 where it had been ΔP = 0.5, to ΔP = 0.7 in the current experiment. The other level of contingency remained at ΔP = 0. The levels of outcome probability were low vs. high. Details of the four conditions can be seen in Table 5. The number of trials in a condition was increased to 40 trials, as compared to 32 trials in Experiment 1. Each trial lasted 7 seconds, leading to a total condition duration of 280 seconds. Each participant was presented with two conditions of both outcome probabilities (low & high) of one contingency (0 vs. 0.7). The order of the two frequencies was randomised between participants.

ΔP = 0.7, OF: Low

	Outcome	No Outcome	
Action	14	6	P(O|A) = .7
No Action	0	20	P(O|noA) = 0

ΔP = 0, OF: Low

	Outcome	No Outcome	
Action	10	10	P(O|A) = .5
No Action	10	10	P(O|noA) = .5

ΔP = 0.7, OF: High

	Outcome	No Outcome	
Action	17	3	P(O|A) = .85
No Action	3	17	P(O|noA) = .15

ΔP = 0, OF: High

	Outcome	No Outcome	
Action	17	3	P(O|A) = .85
No Action	17	3	P(O|noA) = .85

Table 5: *The four experimental conditions, with two contingency levels (0 vs. 0.7) and two outcome probabilities given action P(O|A) (low vs. high). The numbers inside the four tables represent the indicative trial numbers for the four possible trial types (Action - Outcome, No Action - Outcome, Action - No Outcome, No Action - No Outcome). The actual trial numbers depended on the action frequency of each participant.*

Two outcome measures were taken in this experiment. The first was a measure of the perception of control, i.e. control ratings at the end of the condition. The second outcome measure was future task completion time estimates.

The question about perception of control after half the trials in a condition was removed in order to keep total condition duration more constant within and between participants. Because there was no significant effect of contingency on past completion time estimates in Experiment 1 this question was also omitted for this and all further experiments.

Results

Data Preparation

As in Experiment 1, extreme outliers were defined as data points more than 3 interquartile ranges (IQRs) below the first quartile (Q1) or above the third quartile (Q3) ($x_1 \geq Q3 + 3 \times IQR$ and $x_1 \leq Q1 - 3 \times IQR$). Four participants were removed from all the analyses. As in Experiment 1 action percentages were calculated for each participant and each condition. The allowable ranges were between 85% and 15%. None of the participants in this experiment was outside these limits. This resulted in a final sample of 55 participants. As in Experiment 1, an alpha of .05 and effect size confidence intervals of 90% were reported.

Control Ratings

Control ratings in this experiment were influenced by the between-subject variable contingency but not by the within-subjects variable outcome probability. It was found that mean between-subject control ratings were higher following the positive contingency condition (M = 69.29, SD = 13.162) than after the zero contingency condition (M = 30.94, SD = 23.631), as can be seen in Figure 6. There was no difference in control ratings for the within-subjects variable probability of outcomes in the presence of action, with control ratings in the low probability (M = 49.89, SD = 27.902) being similar to the high probability (M = 51.04, SD = 30.480).

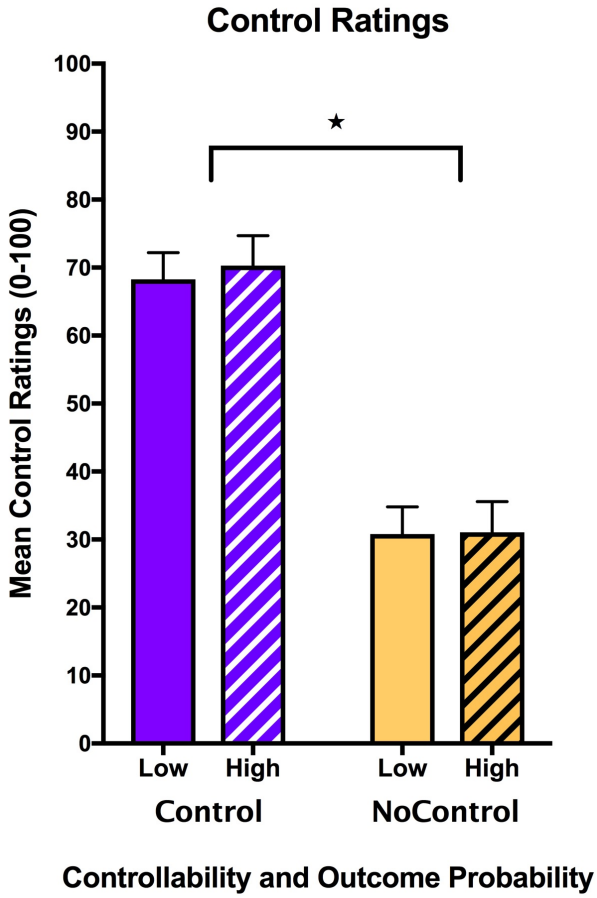

Figure 6. Mean control ratings (0-100) as a function of controllability of the task (control: ΔP = 0.7 vs. no-control: ΔP = 0) and outcome probability (low vs. high). Error Bars = SEM.

A 2x2 mixed-model repeated measures ANOVA was carried out to assess the effects of contingency (0 vs. 0.7) and outcome probability (low vs. high) on the control ratings at the end of each condition. There was only one significant effect, which was the between-subjects main effect of contingency $F(1,53) = 55.789$, $p < .001$, $_p\eta^2 = .513$, 90% CI [.347, .620], with control ratings for the 0.7 contingency condition being significantly higher than those for the 0 contingency condition, as can be seen in Figure 7. All other effects were not significant (all *F*s < .139, all *p*s > .711).

Control Ratings and BDI

No relationship between BDI scores and control ratings could be established. An analysis of Pearson's correlations was carried out for the control ratings and the BDI score ($M = 5.91$, $SD = 4.843$) and no significant relationship was found in the two contingency and two frequency conditions (all *p*s > .187).

Time Estimation

Completion time estimates were collected for future tasks. The average condition duration was 285.04 seconds ($SD = 4.756$), the means of the actual task completion times for the four conditions can be seen in Table 6.

Table 6. Average actual task completion times as a function of controllability of the task (control: ΔP = 0.5 vs. no-control: ΔP = 0) and outcome probability (low vs. high).

Controllability	Control		No Control	
Probability	Low	High	Low	High
Mean	285.88	285.37	286.10	282.76
SD	5.789	4.653	5.985	4.923

The average future task completion time estimates for the four conditions can be seen in Table 7.

Table 7. *Average future task completion time estimates as a function of controllability of the task (control: ΔP = 0.7 vs. no-control: ΔP = 0) and outcome probability (low vs. high).*

Controllability	Control		No Control	
Probability	Low	High	Low	High
Mean	231.43	213.11	215.74	243.3
SD	56.464	62.302	96.09	91.377

Time estimation errors were computed as in Experiment 1. As can be seen in Figure 7, the means of completion time estimates were generally negative, indicating an underestimation of future durations. It was also found that time estimation errors for future tasks did not differ greatly between-subjects following the positive (M = -63.356; SD = 53.320) and or zero contingency conditions (M = -54.912, SD = 83.453) (see Figure 7). The time estimation errors did also not differ greatly following within-subjects outcome probability conditions, with the low outcome probability (M = -62.263, SD = 76.530) producing similar estimation errors to the high outcome probability (M = -56.158 SD = 79.216) (see Figure 7). However, when investigating the time estimation errors for the two levels of outcome probability separately, it can be seen in Figure 7, that time estimation errors for the two outcome probabilities

were similar following the positive contingency condition (controllable task), but differed after the zero contingency (uncontrollable task), with the low outcome probability condition producing more negative time estimation errors than the high outcome probability condition.

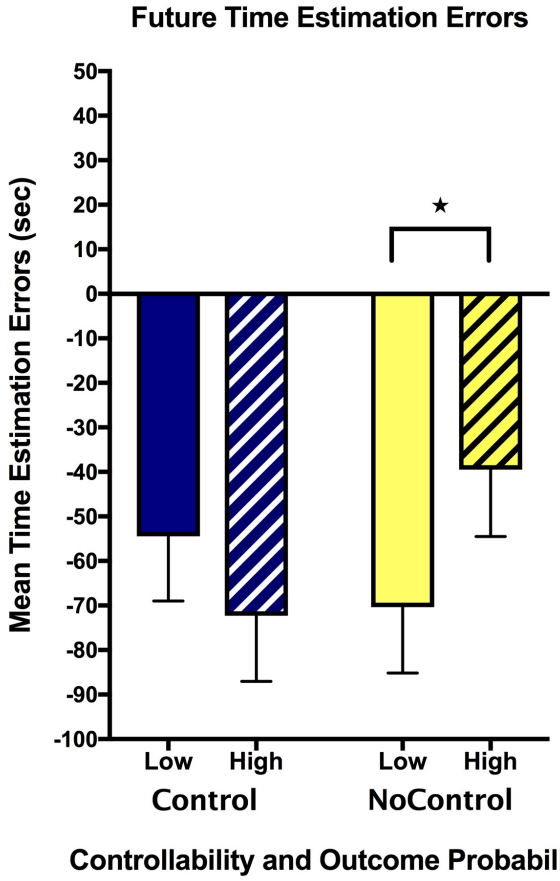

Figure 7. Mean time estimation errors (sec) for future tasks as a function of controllability of the task (control: ΔP = 0.7 vs. no-control: ΔP = 0) and outcome probability (low vs. high). Error Bars = SEM.

A 2x2 mixed-model repeated measures ANOVA was carried assessing the effects of contingency and outcome probability on time estimation errors for future tasks. There was a significant interaction between contingency and frequency $F(1,53) = 7.133$, $p = .010$, ${}_p\eta^2 = .119$, 90% CI [.016, .257], but no significant main effects (all Fs < .201, all ps > .655).

Simple main effects were computed (Bonferroni corrected) further investigating the significant interaction. These revealed that there was a significant difference in time estimation errors between the two outcome probabilities in the zero contingency (uncontrollable task) $F(1, 53) = 5.639$, $p = .021$, ${}_p\eta^2 = .096$, 90% CI (.007, .230), with the low outcome probability condition producing significantly more negative estimation errors. This is illustrated in Figure 7. However there was no effect of outcome probability in the positive contingency (controllable task) condition. Furthermore, time estimation errors for the two contingencies were not significantly different in the low outcome probability condition or high outcome probability condition (all Fs < .2.419, all ps > .126).

Time Estimation and BDI

There was no relationship between BDI and time estimation errors for future tasks. Pearson's correlations were computed for the BDI scores ($M = 5.91$, $SD = 4.843$) and the time estimation errors in the two contingency and two outcome probability conditions, they revealed no significant relationship (all ps > .091).

Condition Sequence Position

This experiment had a repeated-measures design in which participants were presented (counterbalanced) with two experimental conditions; therefore the effect of condition position on time estimation errors for future task completion times was investigated additionally to the manipulations of interest. It was found that participants did not get better at estimating future task completion times with repeated exposure to the task, as was confirmed by a paired-sample t-test

comparing the average estimation errors of the first and second conditions $t(54) = 1.708$, $p = .093$, $d = .207$.

Control Ratings and Time Estimation

No relationship between control ratings and time estimation errors for future tasks was found. As in Experiment 1, Pearson's correlations were performed to investigate the relationship between control ratings and time estimation errors. No significant correlation was found between the two outcome measures (all *p*s > .534).

Discussion

From the results of Experiment 2 it can be seen that participants in the two groups, those that were presented with the 0.7 contingency and those that were presented with the 0 contingency were able judge the amount of control they had over the experimental situation. However, when using this mixed-model design the within-subject factor outcome probability seemed not have an effect on control ratings, which goes against previous findings of the illusion of control that was found when participants were presented with only tasks of the same contingency but varying outcome probabilities (e.g. Alloy & Abramson, 1979; Msetfi et al., 2013).

The results of future time estimation errors show that there was no between-subject effect of contingency condition, with all conditions producing relatively large future underestimates (contrary to Hypothesis 1). There was a within-subject effect of outcome probability for the group presented with the uncontrollable zero contingency, with the low outcome probability producing significantly more underestimation as compared with the high outcome probability condition. This is a relatively surprising finding given that this condition did not differ in terms of control ratings from the zero contingency with high outcome probability. However, this is in line with previous research that suggests that the judged length of a time interval is dependent on the number of events or stimulus changes during that interval (Fraisse, 1984; Johnston, 2010), with fewer events leading to shorter time estimates. This outcome probability effect in the uncontrollable task might be explained by the idea that when experiencing fewer outcomes people also think they will be faster

performing the task in the future (i.e. fewer outcomes take less time). This effect might be overridden by the perception of control in the paradigm of Experiment 1 where there is a comparison between a controllable and uncontrollable task. Furthermore, as in Experiment 1, participants in this experiment did not seem to get more accurate in predicting their future task completion times with repeated exposure to the task.

The results of Experiments 1 and 2 taken together suggest that when people are able to directly compare the experience of a controllable and an uncontrollable task their predictions of future task completion times are shortened after having experienced a controllable task. However, when people only perform one of the two task types (controllable *or* uncontrollable) they always underestimate their future task completion times.

No effect of depression, as measured by the BDI, was found on either outcome variable, the perception of control and the estimation of future task completion times, which goes against Hypothesis 3. That there was no effect of BDI could be attributed to the fact that most participants had low BDI scores, well below the mild depression cut off point and the variation of scores in the sample was very low.

Experiment 3

Introduction

The third experiment set out to investigate the same Hypotheses (1, 2 and 3) as Experiment 2. These stated that having experienced a controllable but not an uncontrollable task would lead to shorter future task completion time estimates (Hypothesis 1). Furthermore, it was investigated whether subjective control perceptions would also be linked to future task completion time estimates (Hypothesis 2). Lastly, it was investigated whether mood, especially depressive mood, would have an effect on control perceptions and future task completion time estimates, therefore BDI scores were again collected (Hypothesis 3). This experiment improved on the between-subjects limitations of Experiment 2, which were thought to have resulted in the non-significant differences in future task completion time estimates between the two contingencies. Each participant was presented with both controllability conditions, i.e. both contingencies (ΔP = 0 and 0.7). To keep the number of conditions low for each participant, outcome probability was varied between-participants.

Methods

Participants

Participants were volunteers recruited from the general and university student population. Participants were offered an honorarium for their participation with either money (£5 per 30min) or course credits. 37 participants took part in this experiment, 31 of whom were female and six male. Ages were recorded as four

categories: 18-30, 30-40, 40-50 and 50+ years. There were 33 participants with ages between 18 and 30 years, 3 participants aged between 30 and 40 years and one participant with unspecified age.

Materials

Experiment 3 used the same materials as described in the previous two experiments.

Measures

As is Experiment 2, the Beck's depression inventory (BDI) (Beck et al., 1961) was used to measure depressive states in the participants. This measure had a good internal consistency for its 21 items in this experiment $\alpha = .81$.

Design

A 2x2 mixed-model design was used, with contingency of actions producing outcomes (0 vs. 0.7) being varied within-participants and outcome probability given action (low vs. high) being varied between-participants. As compared to Experiment 2, in Experiment 3 the between-subjects and within-subjects variables were swapped, in order to present each participant with both contingencies, i.e. the controllable and uncontrollable tasks, without increasing the number of conditions per participant. The overall contingencies were the same as in Experiment 2 (see Table 8). Again each participant completed two conditions, one for each contingency, and the order was randomised between participants.

ΔP = 0.7
OF: Low

	Outcome	No Outcome	
Action	14	6	P(O|A) = .7
No Action	0	20	P(O|noA) = 0

ΔP = 0
OF: Low

	Outcome	No Outcome	
Action	6	14	P(O|A) = .3
No Action	6	14	P(O|noA) = .3

ΔP = 0.7
OF: High

	Outcome	No Outcome	
Action	17	3	P(O|A) = .85
No Action	3	17	P(O|noA) = .15

ΔP = 0
OF: High

	Outcome	No Outcome	
Action	14	6	P(O|A) = .7
No Action	14	6	P(O|noA) = .7

Table 8: *The four experimental conditions, with two contingency levels (0 vs. 0.7) and two outcome probabilities given action P(O|A) (low vs. high). The numbers inside the four tables represent the indicative trial numbers for the four possible trial types (Action - Outcome, No Action - Outcome, Action - No Outcome, No Action - No Outcome). The actual trial numbers depended on the action frequency of each participant.*

Procedure

The procedure was almost the same as in Experiment 2. The only change was that in order to enhance perception of the outcome the outcome duration was increased to 2 seconds, yielding a total trial duration of 8 seconds and a total condition duration of 320 seconds.

Results

Data Preparation

Extreme outliers for the time estimation errors were calculated as in the previous experiments. One participant was found to be an extreme outlier and was removed from all the analyses. As in the previous experiments, action percentages were calculated for each participant and each condition. The

allowable ranges were between 85% and 15%. Two of the participants were outside these limits and were removed from the analysis. The remaining sample consisted of 34 participants. As in the first two experiments, alpha at .05 and confidence intervals for the effect sizes of 90% are reported.

Control Ratings

The within-subjects variable contingency had an effect on control ratings, however the between-subjects variable outcome probability following action did not produce an effect on control ratings. As can be seen in Figure 8, within-participants mean control ratings were higher after a positive contingency condition (controllable task) (M = 72.44; SD = 15.514) than after a zero contingency condition (uncontrollable task) (M = 28.56; SD = 22.050). There was no between-subjects difference in mean control ratings following a low (M = 49.158; SD = 12.207) as compared to a high outcome probability condition (M = 52.200; SD = 15.311).

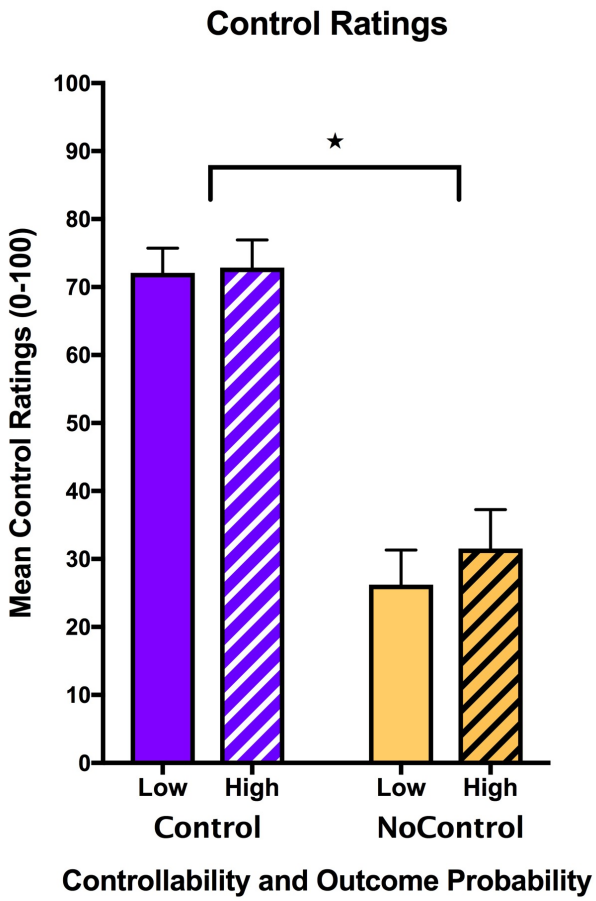

Figure 8. Mean control ratings (0-100) as a function of controllability of the task (control: ΔP = 0.7 vs. no-control: ΔP = 0) and outcome probability (low vs. high). Error Bars = SEM.

A 2x2 mixed-model repeated-measures ANOVA investigating the effect of contingency and outcome probability on control ratings yielded a significant main effect of contingency $F(1,32) = 86.359$, $p < .001$, ${}_p\eta^2 = .730$, 90% CI [.571, .803], with higher control rating following the 0.7 contingency condition (controllable task) as compared to the 0 contingency condition (uncontrollable task), as can be seen in Figure 8. Outcome probability did not produce a significant main effect, nor was Contingency x Outcome Probability interaction significant (all *F*s < .416, all *p*s > .523).

Control Ratings and BDI

BDI scores were not related to control ratings. Pearson's correlations were computed for the BDI scores (M = 5.76, SD = 4.363) and the control ratings in the two contingency and two outcome probability conditions. No significant relationship was found (all ps> .401).

Time Estimation

Completion time estimates were collected for future tasks. The average condition duration was 321.84 seconds (SD = 0.416). The average completion times for the four conditions can be seen in Figure 8.

Table 9. Average actual task completion times as a function of controllability of the task (control: ΔP = 0.5 vs. no-control: ΔP = 0) and outcome probability (low vs. high).

Controllability	Control		No Control	
Probability	Low	High	Low	High
Mean	321.81	321.89	321.81	321.88
SD	0.456	0.382	0.449	0.373

The average future task completion time estimates for the four conditions can be seen in Table 10 below.

Table 10. *Average future task completion time estimates as a function of controllability of the task (control: ΔP = 0.7 vs. no-control: ΔP = 0) and outcome probability (low vs. high).*

Controllability	Control		No Control	
Probability	Low	High	Low	High
Mean	299.05	293.33	326.68	339.33
SD	94.911	151.548	137.196	153.679

Time estimation errors were computed as in the previous experiments. It can be seen in Figure 9 that mean within-participant time estimation errors for future tasks were negative, showing an underestimation, following the positive contingency condition (controllable task) (*M* = -25.316; *SD* = 121.216). Mean within-participant time estimation errors were positive, showing an overestimation, following a zero contingency condition (uncontrollable task) (*M* = 10.426; *SD* = 142.689). Time estimation errors did not differ following the low (*M* = -8.939; *SD* = 106.995) in comparison to the high outcome probability condition (*M* = -5.552 *SD* = 148.538).

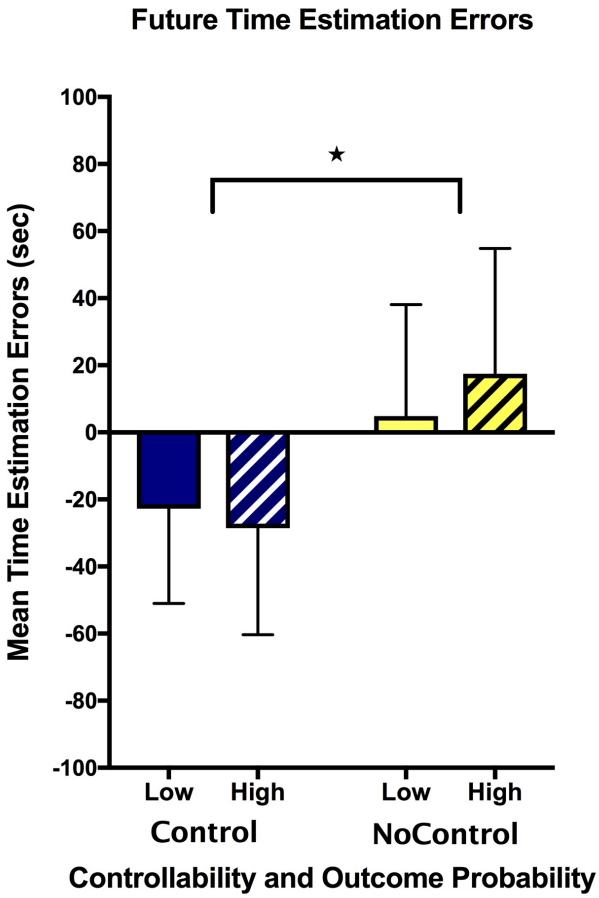

Figure 9. Mean time estimation errors (sec) for future tasks as a function of controllability of the task (control: ΔP = 0.7 vs. no-control: ΔP = 0) and outcome probability (low vs. high). Error Bars = SEM.

A 2x2 mixed-model repeated measures ANOVA investigating the effect of contingency and outcome probability on the time estimation errors for future tasks showed a significant main effect of contingency $F(1,32) = 5.808$, $p = .022$, ${}_p\eta^2 = .154$, , 90% CI [.012, .331], with the positive contingency condition (controllable task) producing significantly more negative estimation errors than the zero contingency condition (uncontrollable task), which can be seen in Figure 9. No other effects were significant (all Fs < .362, all ps > .552).

Time Estimation and BDI

BDI were not related to time estimation errors for future tasks. Pearson's correlations between the BDI scores ($M = 5.76$, $SD = 4.363$) and the time estimation errors in the two contingency and two outcome probability conditions revealed no significant relationship (all ps > .394).

Condition Sequence Position

As in Experiment 2, participants were presented with two experimental conditions in a counterbalanced repeated-measures design; therefore the effect of condition position on future task completion estimation errors was investigated. In contrast to the results of the previous two experiments it was found that participants' estimation errors were negative after the first condition and positive after the second condition. A paired-sample t-test revealed that this difference was significant $t(33) = -2{,}403$, $p = .022$, $d = .272$. However, it cannot be said that participants were more accurate after the second condition as one-

sample t-tests comparing the estimation errors against the value of zero (which would be accurate estimation) did not yield significant results after the first condition $t(33) = -1.126$, $p = .268$, $d = .193$ and neither after the second condition $t(33) = .469$, $p = .645$, $d = .080$.

Control Ratings and Time Estimation

It was found that control ratings were not related to time estimation errors for future tasks. Pearson's correlations were performed investigating the relationship between control ratings and time estimates. No significant correlations were found (all ps > .318).

Discussion

The results of Experiment 3 confirmed that varying the contingency within-participants was a more effective experimental design for investigating our hypotheses about the influence of controllability on control perceptions (Hypothesis 2) and future task completion time estimation (Hypothesis 1). As in Experiment 1, there was an effect of contingency (task controllability) on control ratings. It can also be noted that varying the factor of outcome probability between-participants eliminated the effect of outcome probability on the control ratings, with both outcome probabilities being rated as equally controllable, which goes against the findings of previous studies (e.g. Msetfi et al., 2005) that found an outcome probability effect at zero contingencies even when using a between-subjects design, where each participant was only presented with one condition. It could be, however, that other differences in task design between Msetfi et al. (2005) and the current study might have produced the difference in

results and that for the task employed in this experiment the use of a within-subjects design is needed to capture the outcome probability effect on control ratings.

For the measure of future task completion time estimates the results of Experiment 1 were also replicated, with having performed a controllable task (positive contingency) producing shorter future task completion time estimates as compared to the uncontrollable task (zero contingency). This supported Hypothesis 1. No relationship was found between subjective perceptions of control over the previous task and future task completion time underestimation, which goes against Hypothesis 2 and suggests that it is the objective controllability of the previous task that leads to the shortened future task completion time predictions. Lastly, participants did not increase in absolute estimation accuracy with repeated exposure to the task.

As in Experiment 2, no effect of depression, as measured by the BDI, was found on either outcome variable: the perception of control and the estimation of time, going against Hypothesis 3. However, again the sample used had very low depression scores, again well below the cut-off point of even mild depression.

Experiment 4

Introduction

This experiment set out to explore Hypothesis 1, stating that objective control over a task would lead to shortened future task completion time estimates. Furthermore, the effect of subjective perceptions of control on future task completion time estimates was investigated (Hypothesis 2). This experiment furthermore investigated how repeated exposure to the *same* type of task (controllable or uncontrollable) would influence the perception of control and estimation of future task completion times. This was intended to follow up on the results in Experiment 1, which found that control ratings after 16 trials were higher than those after 32 trials in the zero contingency condition but not in the positive contingency condition. Therefore, participants were presented with eight blocks of the same contingency (controllability), before being presented with eight blocks of the second contingency (controllability). Of interest was if control ratings would change as the blocks progressed. The Rescorla-Wagner model of associative learning (Rescorla & Wagner, 1979) would predict that positive contingencies would be learned faster than zero contingencies, and therefore the asymptote of learning would be reached sooner for controllable tasks as compared to uncontrollable tasks. We tested whether control ratings for uncontrollable tasks would start off higher and become lower as blocks progressed in comparison to control ratings for the controllable tasks that might not change as blocks progressed.

It was also investigated in this experiment how repeated exposure to the *same* type of task (i.e. either controllable or uncontrollable) would influence future task completion time estimates. It was of interest whether the effect of shortened task completion time estimates following controllable tasks, as found in Experiment 1 and Experiment 3, would be replicated with repeated exposure to controllable tasks. Furthermore, it was explored whether perceptions of control following repeated exposure to the same task would be related to future task completion time estimates.

In order to test Hypothesis 6 the desirability of control (DoC) (Burger & Cooper, 1979) was introduced as a personality measure. This scale measures how much control people desire in their everyday lives. The hypothesis was that people with higher DoC scores would be more inclined to predict shorter future task completion times following controllable tasks. This was especially following previous research that found a link between the desire for control and task completion time underestimation (Halkjelsvik et al., 2012).

Methods

Participants

Participants were volunteers recruited from the general and university student population. Participants were offered an honorarium for their participation with either money (£5 per 30min) or course credits. 76 participants took part in this experiment. There were 47 females, 26 were males and three participants with unspecified gender. The age range for 68 participants was between 18 and 30 years and for four participants it was between 30 and 40 years. Four participants did not specify their age.

Materials

The materials used in this experiment were the same as in the three experiments described above.

Measures

The desirability of control scale (DoC) (Burger & Cooper, 1979) was used to measure how much control participants desire in their everyday life. This scale is a self-report measure with 20 statements, where participants use a Likert scale from 1 to 7 to indicate how much the different statements apply to themselves. The internal consistency for the 20 items in this measure was good for this experiment $\alpha = .86$.

Design

This experiment had a 2x2 mixed-model design with contingency (0 vs. 0.5) being varied within-subjects, and probability of outcomes (low vs. high) being varied between-subjects (see Table 11).

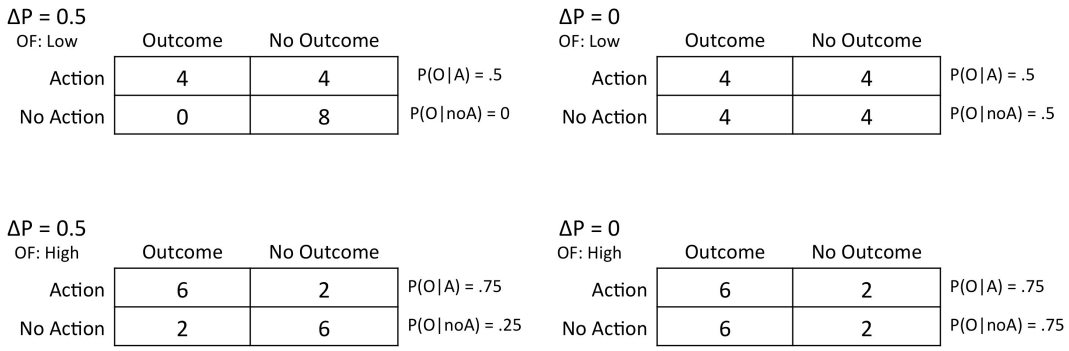

Table 11: *The four experimental conditions, with two contingency levels (0 vs. 0.5) and two outcome probabilities given action P(O|A) (low vs. high). The numbers inside the four tables represent the indicative trial numbers for the four possible trial types (Action - Outcome, No Action - Outcome, Action - No Outcome, No Action - No Outcome). The actual trial numbers depended on the action frequency of each participant.*

Participants were presented with 8 blocks of the same contingency (controllability) followed by 8 blocks of a second contingency (controllability), resulting in a total of 16 blocks. The two outcome probability conditions were varied between participants. These conditions were randomised between participants.

There were three outcome measures in this experiment. Control ratings were collected at the end of each block, and concerned the experience of all trials of that condition. The rating scale for the control ratings was changed from an

asymmetric scale as in past experiments to a symmetric scale. This scale also allowed negative ratings and thus ranged from -100 to 100 (see Appendix A). Furthermore, and new to this experiment, control ratings were also collected at the start of the experiment, before the experimental task had been presented. These were predictions about how much control participants expected to have (see Appendix A). The last outcome measure collected at the end of every block was future task completion time estimates, that were an estimation of how long the next block would take.

Procedure

Given that participants were presented with 16 blocks, the number of trials in a block were reduced to 16 trials, in order to keep the total experiment time under 45min. This yielded a total block duration of 128 seconds.

Results

Data Preparation

Extreme outliers were determined for completion time estimates following the procedure described in the previous experiment and 12 participants were flagged as extreme outliers. Action percentages were calculated as in previous experiments and 25 participants were flagged, as they had action percentages outside the acceptable limits. Looking at all the flagged participants, two of whom had more than one flag, a total number of 35 participants had to be removed from the experimental analysis, yielding a final data set of 42

participants. It is noted that participants struggled more than in previous experiments to keep their action percentages within the acceptable limits. This might be due to the reduced number of trials (only 16 per block) and also the increased number of blocks (16 in total), both of which might have made it more difficult for participants to follow the instructions of pressing approx. 50% of the trials. As in all previous experiments, an alpha of .05 and effect size confidence intervals of 90% were applied to all analyses in this experiment.

Control Ratings

It was found that control ratings differed between the zero contingency (uncontrollable task) and the positive contingency (controllable task) only in the high outcome probability condition and not in the low probability condition. As can be seen in Figure 10, in the high outcome probability condition the positive contingency produced higher control ratings than the zero contingency condition. No such effect of contingency was seen in the low outcome probability condition (see Figure 10). Furthermore, the two outcome probabilities differed in their effect on control ratings at both contingency conditions, with the high outcome probability condition producing higher control ratings than the low outcome probability condition. No effect of block number on control ratings was found (see Figure 11).

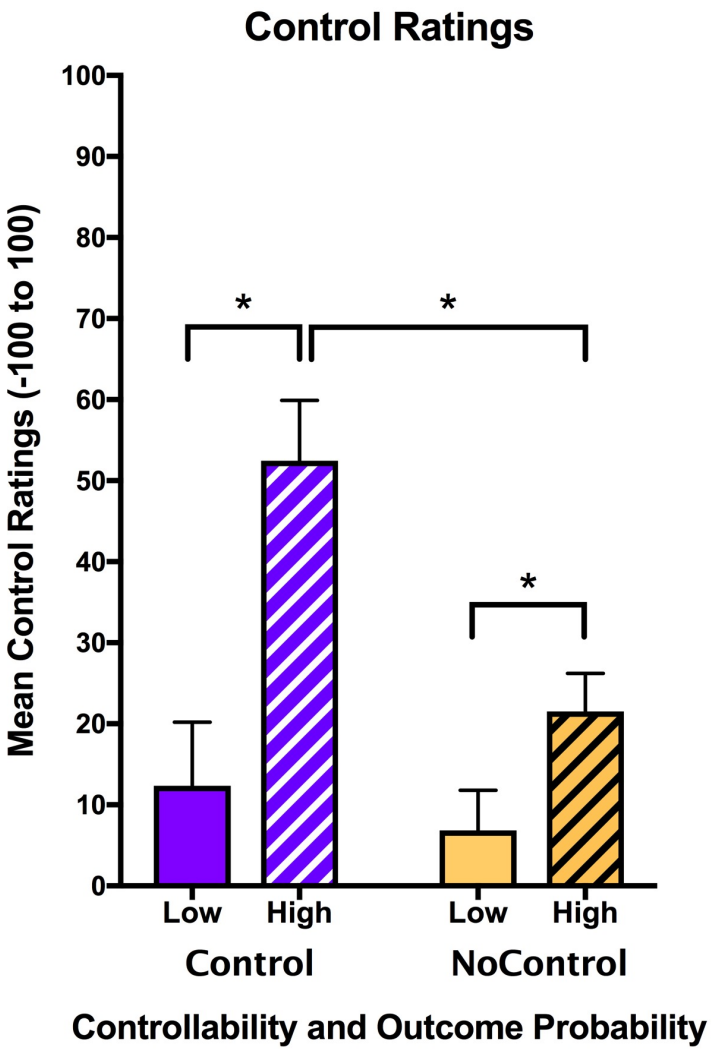

Figure 10. Mean control ratings (-100 to 100) as a function of controllability of the task (control: ΔP = 0.5 vs. no-control: ΔP = 0) and outcome probability (low vs. high). Error Bars = SEM.

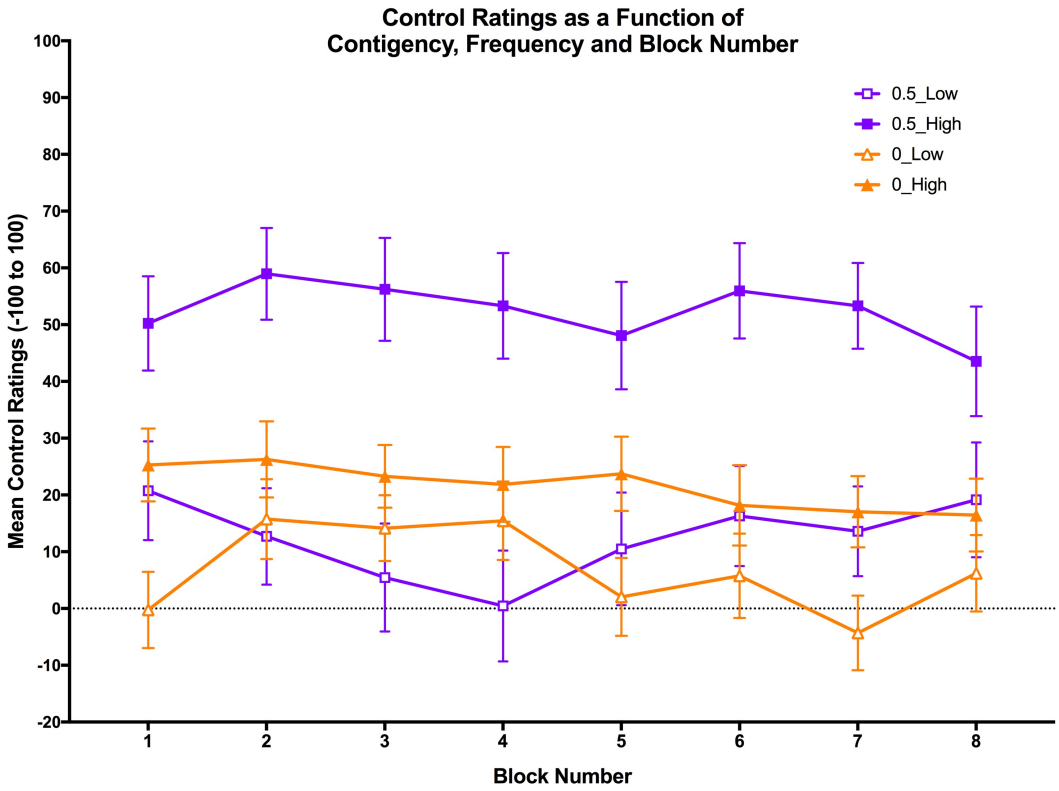

Figure 11. Mean control ratings (-100 to 100) as a function of contingency (0 vs. 0.5), outcome probability (low vs. high) and block number (1-8). Error Bars = SEM.

A 2x2x8 mixed-model repeated-measures ANOVA testing the effect of contingency and outcome probability on control ratings across the eight blocks yielded a significant main effect of contingency $F(1,40) = 11.817$, $p = .001$, ${}_p\eta^2 = .228$, 90% CI [.061, .390], with higher control rating following the positive contingency condition (controllable task) (M = 33.36; SD = 40.099) as compared to the zero contingency condition (uncontrollable task) (M = 14.52; SD = 23.103), (see also Figure 10). There was also a main effect of outcome probability $F(1,40) = 13.911$, $p = .001$, ${}_p\eta^2 = .258$, 90% CI [.081, .418], with higher control ratings in the high outcome probability (SD = 36.983; SD = 20.199) as compared to the low outcome probability (SD = 9.61; SD = 27.153) condition (see also Figure 10). Importantly, the Contingency x Outcome Probability interaction was significant

$F(1,40) = 5.751$, $p = .021$, ${}_p\eta^2 = .126$, 90% CI [.010, .284]. The three-way interaction Contingency x Outcome Probability x Block was also significant F(1,280) = 2.048, p = .049, ${}_p\eta^2 = .049$, 90% CI [0, .185]. However, for the three-way interaction the 90% confidence interval of the partial-eta squared effect size measure included zero, which indicates that not enough variance of the control ratings was explained by the three-way interaction to warrant further analysis. The main effect of Block and all other interactions were not significant (all *F*s < .1.548, all *ps* > .151).

The simple main effects (Bonferroni corrected) analysis investigating the significant interaction between contingency and outcome probability revealed that at the high level of outcome probability, there was a significant difference between the two contingency conditions, $F(1,40) = 17.879$, $p < .001$, ${}_p\eta^2 = .309$, 90% CI [.119, .463], with higher control ratings following the 0.5 contingency in comparison to the 0 contingency condition, which can be seen in Figure 10. The two contingency conditions did not differ significantly at low levels of outcome probability ($F = .516$, $p = .477$). Furthermore, the two outcome probabilities significantly differed in the 0.5 contingency condition, $F(1,40) = 13.722$, $p = .001$, ${}_p\eta^2 = .255$, 90% CI [.079, .415], with higher control ratings for the high outcome probability as compared to the low outcome probability condition, see Figure 10. In the 0 contingency condition the levels of outcome probability also differed significantly $F(1,40) = 4.588$, $p = .038$, , ${}_p\eta^2 = 103$, 90% CI [.002, .258].

DoC and Control Ratings

No relationship between of DoC scores (M = 98.03, SD = 11.554) and control ratings was found. Pearson's correlations were computed for the DoC scores and the control ratings in the two contingency and outcome probability conditions and revealed not significant correlations, when Bonferroni corrected for multiple comparisons (all ps > .035).

Control Ratings at the Start

It was found that control ratings at the start of the experiment, i.e. before the experimental task had taken place, were not related to control ratings at the end of each block or time estimation errors for future tasks. Pearson's correlations were performed for the control ratings at the start of the experiment and all the other outcome measures, none of which were significant (all ps < .353). Control ratings at the start of the experiment were also not related to the scores on the DoC scale. Performing Pearson's correlations showed no significance (p = .080).

Time Estimation

Completion time estimates were collected for future tasks. The average actual completion time for a block was 128.81 seconds (SD = 0.008). The average time estimate for a block was 152.01 seconds (SD = 80.307). Time estimation errors for future tasks were computed as in the previous experiments. It was found that time estimation errors became more positive as the blocks progressed (see Figure 12). There was no effect of contingency or outcome probability on time estimation errors for future tasks in this experiment (see Figure 13).

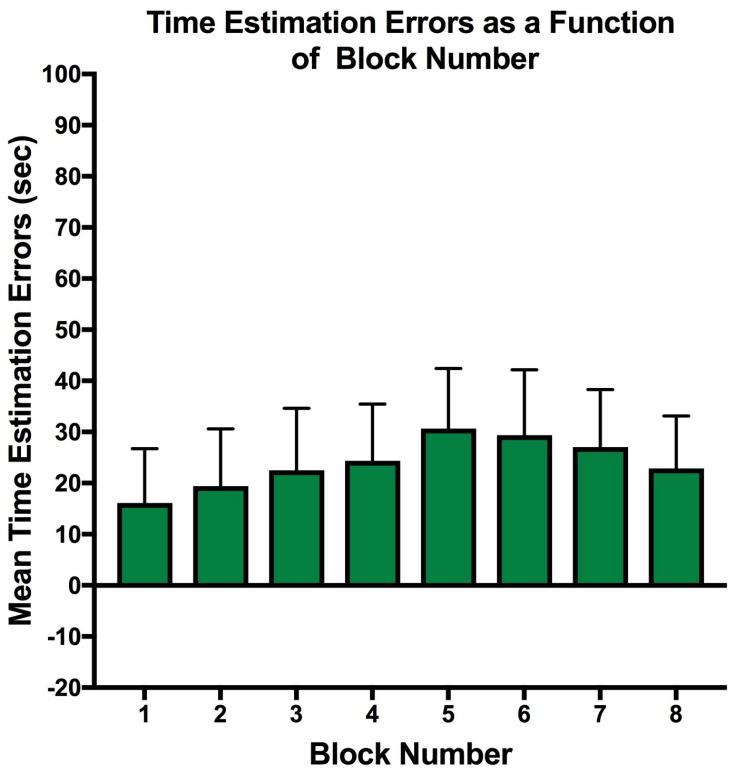

Figure 12. Mean time estimation errors (sec) as a function of block number (1-8). Error Bars = SEM.

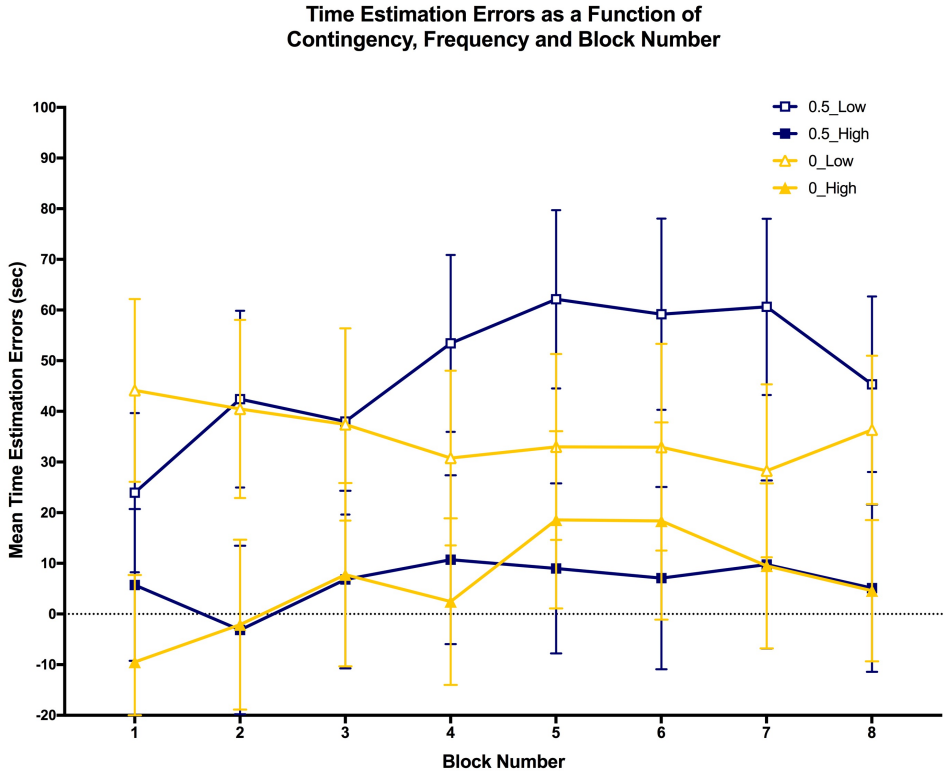

Figure 13. Mean time estimation errors (sec) as a function of contingency (ΔP = 0 vs. 0.5), outcome probability (low vs. high) and block number (1-8). Error Bars = SEM.

A 2x2x8 mixed-model repeated measures ANOVA was conducted testing the effect of contingency and outcome probability on the time estimation errors across the eight blocks. There was a significant main effect of block, $F(7, 280) = 2.370$, $p = .023$, ${}_p\eta^2 = .056$, 90% CI [.004, .082]. It can be seen in Figure 12 that the time estimation errors in the later blocks are more positive than in the earlier blocks, indicating that later blocks produced larger overestimations. Furthermore, there was a significant three-way Contingency x Outcome Probability x Block interaction $F(1,208) = 3.340$, $p = .002$, ${}_p\eta^2 = .077$, 90% CI [0, .041]. However, as for the control ratings in this experiment the 90% confidence intervals for the partial-eta squared effect size measure included zero. Indicating that the three-way interaction did not explain enough variance of the time estimation errors to warrant further analysis. Again, this is probably due to the relatively small sample and large number of degrees of freedom in this three-way interaction analysis. The main effect of contingency (positive M = 26.266; SD = 76.050 vs. zero M = 20.117; SD = 74.600), outcome probability (low M = 41.776; SD = 87.936 vs. high M = 6.296; SD = 53.385) and the other interactions were not significant (all Fs < .2.589, all ps < .115).

DoC and Time Estimation

No relationship between DoC scores (M = 98.03, SD = 11.554) and time estimation errors was found. Pearson's correlations were performed for the DoC scores and the time estimation errors in the two contingency and two outcome probability conditions and no significant relationship was found (all ps < .170).

Control Ratings and Time Estimation

Control ratings were found not to be related to time estimation errors for future tasks. Pearson's Correlations were performed investigating the relationship between control ratings and time estimation errors. No significant correlations were found (all *p*s > .211).

Discussion

The results of Experiment 4 show that subjective perceptions of control were influenced by the manipulation of action-outcome contingencies, with the positive contingency condition (controllable task) producing higher control ratings than the zero contingency condition (uncontrollable task). However, this effect was only significant in the high outcome probability condition, whereas in the low outcome probability conditions the control ratings were not significantly different between the positive and zero contingencies. This finding of an interaction between outcome probability and contingency goes against the findings of the first three experiments in this chapter. However, this difference in findings could be attributed to the fact that the blocks were cut to only 16 trials in total and therefore there were very few action-outcomes pairings, i.e. only four, in the low outcome probability positive contingency condition. It could be that for learning of controllability to take place, there needs to be more exposure to action-outcome pairings. It can be seen that even the slight increase to six action-outcomes pairings in the high outcome probability positive contingency condition was enough to yield a significant increase in the control ratings. It

would be interesting to investigate further how outcome probability and contingency interplay at low exposure rates, especially in light of previous research regarding how base rate differences affect contingency judgements (e.g. Vallée-Tourangeau et al., 1998, Msetfi et al., 2005).

The Rescorla-Wagner model of associative learning (Rescorla & Wagner, 1972) would predict asymptotic learning that would be seen through an effect of block number. Contrary to this prediction, there was no significant main effect of block on control ratings in our data. This could be attributed to the fact that learning was very fast and contingencies might have been learned in the first block already to asymptote. However, as stated above the positive contingency condition with low outcome probability was rated very similar to both zero contingency conditions, which seems to suggest that the contingency manipulation did not have the expected effect in that condition.

Contrary to Hypothesis 1, and the findings from Experiment 1 and Experiment 3, there was no effect of contingency on future task completion time estimates. In this experiment all future task completion times were slightly overestimated, which can be seen in the fact that mean time estimation errors were positive. This might seem to support the suggestion by Roy et al. (2008) (see also Buehler et al., 2010; Buehler & Griffin, 2015) that shorter tasks tend to be overestimated and longer tasks tend to be underestimated. However, in this experiment the tasks (blocks) were 2min 9sec long, which is longer than 1min 32 sec, which Roy et al. (2008) suggest would be the cut-off point between over- and underestimation of tasks. In their later study (Roy et al., 2013) the tentatively

suggested cut-off point between over- and underestimation was at 5min 23sec. As can be seen from these two studies (Roy et al., 2008; Roy et al., 2013) the role of task duration on future task completion time estimates is not completely clear. The experiments in this chapter found an underestimation for task durations between 4min 45sec and 5min 22sec, but no such underestimation for a task duration of 2min 9sec. The exact relationship between task duration and future task completion time underestimations should therefore be further explored, by varying durations on a continuum and keeping all other task characteristics and variables constant.

A possible alternative explanation for the findings of this experiment might be the low number of trials. In this experiment there were only 16 trials in each block, which is half the trials used for each condition in Experiment 1 and less than half the trials used for each condition in Experiment 2 and Experiment 3. It could therefore be that longer exposure to the experimental task is needed for future task completion time underestimations to occur. That future task completion time underestimation did not occur following the controllable task, might therefore be due to the low number of action-outcome pairings in this experiment. This suggestion is supported by the finding that the low outcome probability positive contingency condition, which was an objectively controllable task, had as low control ratings as the two zero contingency conditions, which were objectively uncontrollable tasks. It could be that even in the high outcome probability positive contingency condition action-outcome pairings were not numerous enough to produce an effect on future task completion time estimates. Furthermore, the other difference between this data set and those of Experiment

1 and Experiment 3, which found an effect of objective control on future task completion time estimates, is that there was much more variation in future task completion time estimates in this data set. This might have contributed to the non-significant results, even though for some participants objective controllability might have had an effect on future task completion time estimation. Again, it could be that more trials in a task are needed to get more consistent effects.

The personality measure of the desirability for control had no influence on control ratings at the beginning of the experiment or after every block. It had been predicted that people with higher DoC scores would rate their control over the zero contingency condition (especially with high outcome probability) as higher than those participants with lower DoC scores. However this was not the case. Furthermore, individual-differences in DoC had no effect on future task completion time estimates (Hypothesis 6). This might be seen as going against Halkjelsvik et al.'s (2012) study that reported participants with high DoC being more prone to future task completion time underestimations. However, Halkjelsvik et al. (2012) did report that future task completion time underestimation was more pronounced when there was a monetary incentive for speed, which was not present in our experiment. In the present experiment the manipulations of contingency and outcome probability were not found to be related to the individual difference measure of desirability of control.

General Discussion: Experiments 1-4

From the results of the experiments reported in this chapter one important conclusion can be drawn: the controllability of a previously experienced task can influence future task completion time estimates. The findings of Experiment 1 and Experiment 3 suggest that having experienced a controllable task (positive contingency condition) can lead to shortened future task completion time predictions, which is in support of Hypothesis 1. Furthermore, the results of Experiment 2 suggest that the effect of controllability on future task completion time estimation seems to be dependent on the participant experiencing both types of tasks, controllable and uncontrollable, and is not found when using a between-subject design. The results of Experiment 4 suggest that the effect of controllability on future task completion time estimation also depends on the number of trials and especially action-outcome pairings in a task.

The results of Experiment 1 and Experiment 3 in this chapter are in accordance with the *Extended Inside-Outside Model* of the planning fallacy proposed by Buehler et al. (2010) and Buehler and Griffin (2015). Buehler and Griffin (2015) state that the planning fallacy is characterised by a "paradoxical combination of optimism about the future with realism about the past" (p. 32). This was supported by the findings of Experiment 1, as past completion times were relatively accurate, and shortened task completion time estimates were only found for future tasks. The findings of Experiment 1 therefore go against the *Memory Bias Account* (Roy et al., 2005; Roy et al., 2007), which suggests underestimation of both past and future task completion times. This account

proposes that future task completion time underestimations are due to biases in remembering past durations.

Furthermore, the results of Experiment 1 and Experiment 3 go against the *Anchoring and Adjustment Account* of Thomas et al. (2003) which suggests that underestimation of future task completion times mainly occurs when a task is preceded by a shorter task, because future task completion time estimates are anchored on previous durations. However, Experiment 1 and Experiment 3 found shortened future task completion time predictions even though the durations of all conditions were equal. Therefore, anchoring on the previously experienced task duration would have been expected to produce relatively accurate future task completion time estimates. As future task completion times were only underestimated following controllable tasks and not following uncontrollable tasks it can therefore be suggested that controllability of the preceding task was the factor that influenced future task completion time estimates.

Furthermore, no relationship was found between control ratings and task completion time estimates in any of the experiments in this chapter. This means that no support was found for Hypothesis 2, which suggested higher controllability perceptions to be linked to shortened task completion time estimates. Therefore it seems that it is the objective controllability of a previous task that leads to shortened future task completion time estimates and not the subjective perception of controllability.

The experiments in this chapter found no clear relationship between individual difference factors, such as mood (Experiment 2 & Experiment 3) and desire for control (Experiment 4), and the measures of control perceptions and task completion time estimation. This goes against previous findings that suggested a relationship between depressive mood (e.g. Alloy & Abramson, 1979; Msetfi et al., 2013) and control perceptions, and also goes against Hypothesis 3. However, as stated before, it could be that the non-significant results were due to the current samples having very low depression scores (as measured by the BDI). This might also have contributed to the non-significant results for the relationship between mood and task completion time estimates. Experiment 4 found no relationship between the desirability of control and control perceptions and future task completion time estimates, as had been predicted by Hypothesis 6. Again, this goes against previous findings of a link between desirability of control and perceptions of control (Burger, 1986) and studies that found a link between desirability of control and future task completion time underestimation (Halkjelsvik et al., 2012). However this non-significant finding might be due to the limitations of Experiment 4 discussed above, in terms of the low trial number used in that experiment. Therefore, further investigations into the relationship between desirability of control and future task completion time estimation were carried out in the following chapters.

The findings presented in this chapter suggest a link between task controllability and future task completion time estimates. The findings of Experiment 1 and Experiment 3 suggest that future task completion times are shortened following

experience of a controllable but not following experience of an uncontrollable task.

Chapter 3: The effect of controllability duration on anchoring of future completion time estimates

Introduction

The results of the experiments in Chapter 1 suggested a relationship between task controllability and future task completion time underestimation, with future task completion times being shortened following controllable but not following uncontrollable tasks. This suggests a mechanism by which control over a previous task might directly shorten future task completion time estimates.

In the experiments described in Chapter 1 the actual durations of the experienced tasks were held constant, in order to investigate the direct relationship between controllability and future task completion estimates. This means that controllable and uncontrollable tasks were equally long. The *Anchoring and Adjustment Account* (Thomas et al., 2003) proposes that estimates for future task completion durations might be anchored on the duration of a previous task. The experiments in this chapter, therefore, investigated if anchoring might be an additional mechanism by which controllability might influence future task completion time estimation. If experiencing multiple tasks before making a future task completion time estimate, controllability might be a factor that makes people chose one previous duration over another to act as an anchor. The experiments in this chapter investigated the hypothesis (Hypothesis

7) that people would use the duration of a previously controllable task, but not the duration of a previously experienced uncontrollable task, as an anchor when making future task completion time predictions.

The inside-outside model (Kahneman & Tversky, 1977) and the *Extended Inside-Outside Model* (Buehler et al., 2010; Buehler & Griffin, 2015), on the other hand, suggest that the most effective way of avoiding future task completion time underestimation would be to compute the average of all past similar durations and adjust one's prediction based on this, which is called *reference class forecasting* (see Chapter 1). It has been suggested (Buehler et al., 1994) that people do not tend to take their previous task completion times into account when making future task completion time predictions, unless these are explicitly related to the task for which they are making the prediction. The three experiments in this chapter tested whether participants who were exposed to different task durations directly before making a future task completion time prediction would use these durations, and in particular the average of the experienced durations, as a basis for making future task completion time predictions. Given that these task durations were experienced just before the prediction was being made about the duration of a similar task, it was expected that participants would see the past durations as relevant for making the future task completion time estimate.

There were three possible ways in which participants could use these previous durations when making future task completion time estimates. They could either base their judgement on the last experienced task, as suggested in the *Anchoring*

and Adjustment Account; they could perform a form of intuitive *reference class forecasting* and take the average of all experienced durations; or they could, as is proposed in Hypothesis 8, base their predictions on the duration of the experienced controllable task and disregard the duration of the experienced uncontrollable task.

In the experiments of this chapter participants were presented with two tasks of differing controllability and different durations. It was predicted, in line with Hypothesis 7, that participants' future task completion time estimates would be longer if they experienced a long controllable task paired with a short uncontrollable task, and that their future task completion time estimates would be shorter if they had experienced a short controllable and a long uncontrollable task (see Figure 14).

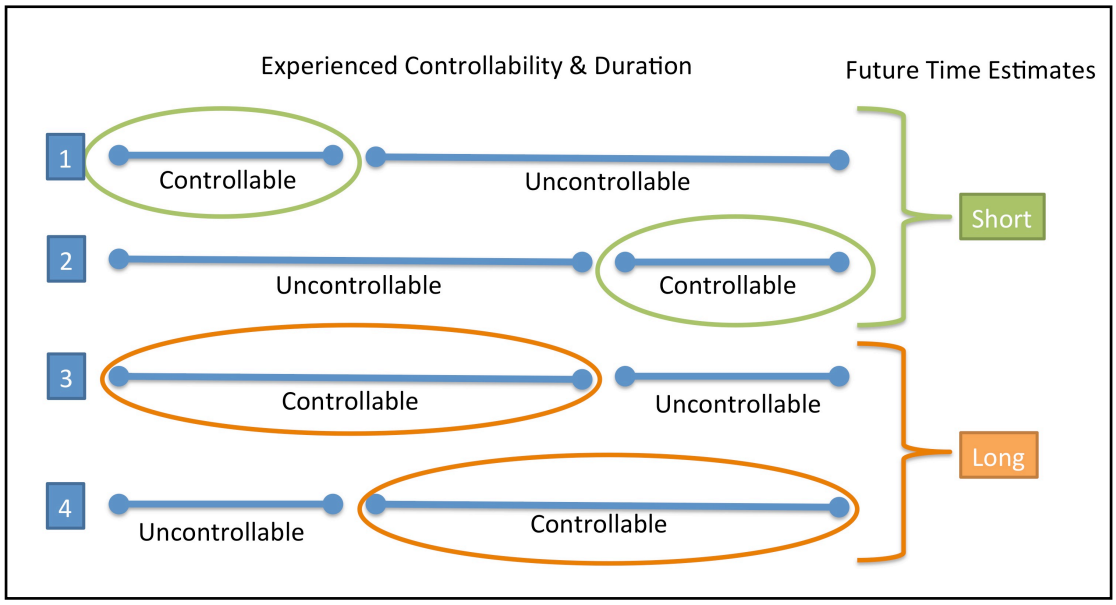

Figure 14. The four experimental conditions used in Exp. 6 and Exp. 8. The blue lines denote the condition durations (short/640sec vs. long/1600sec). The two controllabilities represent the two contingencies used (positive and zero). The hypothesis about the future task completion time estimates is shown on the far right.

Experiment 5

Introduction

This experiment investigated the hypothesis (Hypothesis 7) that participants who experienced multiple tasks before making future task completion time estimates would base their estimates on the duration of a previously experienced controllable task but not on the duration of a previously experienced uncontrollable task. This hypothesis was tested by presenting participants with two tasks differing in controllability (controllable vs. uncontrollable) and duration (10.6 min vs. 26.6min) before they made future task completion time estimates. It was investigated whether participants would indeed base their predictions on the duration of the controllable task, would take the average of both task durations as a basis for their predictions (intuitive reference class forecasting), or would base their predictions on the last, or perhaps the first, experienced task duration (anchoring on a previous task).

It was also investigated how participants would estimate their levels of control when exposed to two consecutive contingency tasks (a positive and a zero contingency). It was tested whether participants would average the two experienced contingencies when rating how much control they had, if they would base their control ratings on the last (or perhaps the first) experienced contingency, or if they would rate their control only based on one of the two experienced contingencies.

Methods

Participants

Participants were volunteers recruited from the general and university student population. Participants were offered an honorarium for their participation with either money (£5 per 30min) or course credits. There were 51 participants, 32 of whom were female, 18 were male and one was of unidentified gender. The ages were divided into four categories: 18-30, 30-40, 40-50 and 50+ years. There were 46 participants between the ages of 18 and 30 years, two participants between the ages of 30 and 40 years, one participant was between 40 and 50 years old and one participant did not report their age.

Materials

The Materials used in this experiment were the same as in the experiments in Chapter 2.

Measures

As in Experiment 5 of Chapter 2, the desirability of control scale (Burger & Cooper, 1979) was used to measure how much control participants desire in their everyday life. The 21 items of this scale had an acceptable internal consistency in this experiment $\alpha = .72$

Design

This experiment had a 2x2 mixed-model design. Two levels of contingency (0.5 vs. 0) and two levels of task duration (10.6min vs. 26.6min) were employed. This difference in duration was produced by varying the number of trials between 80 (see Table 12, top row) and 160 (see Table 12, bottom row); and furthermore by varying the ITI between 2 seconds and 4 seconds. To make the distinction between the long and short conditions greater the condition with 80 trials was always paired with the 2 second ITI and the condition with 160 trials was always paired with the 4 second ITI.

ΔP = 0.5
Duration: Short

	Outcome	No Outcome	
Action	40	0	P(O|A) = 1.0
No Action	20	20	P(O|noA) = .5

ΔP = 0
Duration: Short

	Outcome	No Outcome	
Action	20	20	P(O|A) = .5
No Action	20	20	P(O|noA) = .5

ΔP = 0.5
Duration: Long

	Outcome	No Outcome	
Action	80	0	P(O|A) = 1.0
No Action	40	40	P(O|noA) = .5

ΔP = 0
Duration: Long

	Outcome	No Outcome	
Action	40	40	P(O|A) = .5
No Action	40	40	P(O|noA) = .5

Table 12. *The four experimental conditions, with two contingencies (0 vs. 0.5) and two durations (short vs. long). The numbers inside the four tables represent the indicative trial numbers for the four possible trial types (Action - Outcome, No Action - Outcome, Action - No Outcome, No Action - No Outcome). The actual trial numbers depended on the action frequency of each participant.*

Following the findings of Experiment 4 in the previous chapter, that suggested that controllability did not have an effect on future task completion time

estimation if there were too few action-outcome pairings, more action-outcome pairings were used in this experiment (min. 40 action-outcome pairings in the low outcome probability condition).

The two contingencies (0 & 0.5) were paired with the two durations (short & long), yielding four pairings (0-short, 0-long, 0.5-short, 0.5-long), as can be seen in Table 12. The pairing order was counterbalanced between-participants yielding four experimental conditions (see Figure 15).

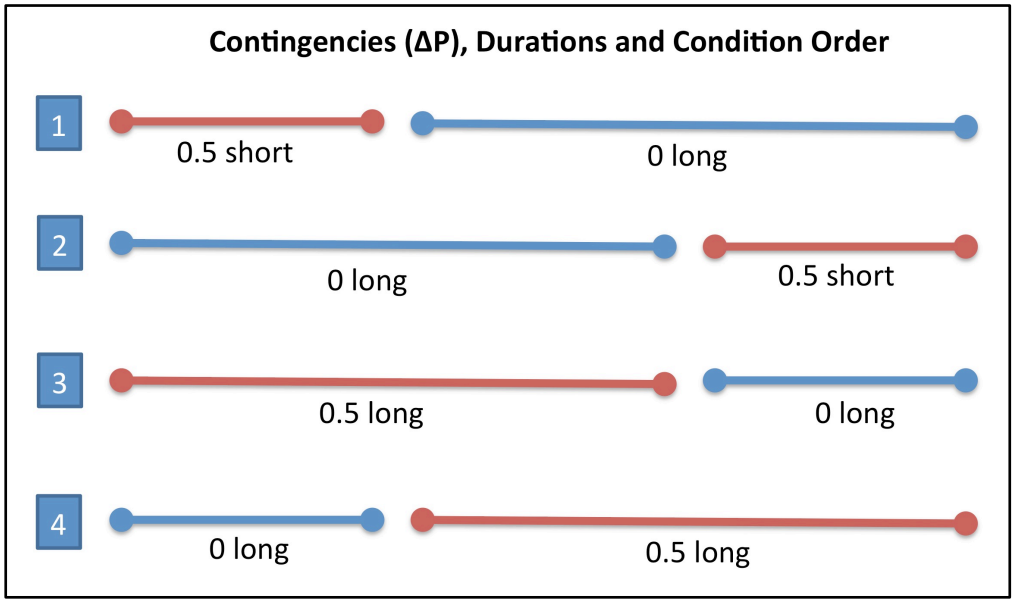

Figure 15. The four experimental conditions used in this experiment, made up of two contingencies (0 vs. 0.5), two durations (short vs. long), and two condition orders. The controllable conditions are marked in red and the uncontrollable marked in blue.

Two outcome measures were taken in this experiment. As in the previous chapter, participants had to give control ratings and future task completion time estimates (see Appendix A).

Procedure

Each participant was presented with one of the four experimental conditions, consisting of two experimental tasks as shown in Figure 15. After completing the two experimental tasks participants rated their perception of control (for the previous two tasks/conditions) and estimated how long one further (hypothetical 3rd) experimental task would take. The questions are presented in Appendix A. Control ratings were also collected at the start of the experiment, before participants were exposed to the two experimental tasks (see Appendix A).

Results

Data Preparation

Extreme outliers were determined for the future task completion time estimates using the inter quartile range (IQR). Extreme outliers were defined as data points more than 3 interquartile ranges (IQRs) below the first quartile (Q1) or above the third quartile (Q3) ($x_1 \geq Q3 + 3 \times IQR$ and $x_1 \leq Q1 - 3 \times IQR$). Five participants were found to be extreme outliers and were removed from all the analyses. As in all previous experiments action percentages were calculated for each participant and each condition. The allowable ranges were between 85% and 15%. Two participants had action percentages outside the limits – however these had also been extreme outliers for the time estimation measure and had therefore already been removed from the sample. An alpha of .05 and effect size confidence intervals of 90% were applied to all analyses in this experiment. Furthermore, 90% confidence intervals were also provided for the R^2 statistic.

Control Ratings

No effect of the duration of the controllable task (controllable duration) or contingency order was found on control ratings. The grand mean of control ratings was 29.24 (*SD* = 31.56). The mean control ratings were not different following the short control duration (0.5-short & 0-long) (M = 24.00; SD = 31.834) as compared to the long control duration (0.5-long & 0-short) (M = 34.26; SD = 31.150). Furthermore, control ratings did not differ following the contingency order 0.5 then 0 (M = 27.13; SD = 33.599) as compared to the 0 then 0.5 contingency order (M = 31.67; SD = 29.679). The mean control ratings for each of the four experimental conditions can be seen in Figure 16. A 2x2 between-subjects univariate ANOVA was carried out analysing the effect of contingency order (0.5 then 0 vs. 0 then 0.5) and controllable duration (0.5-short & 0-long vs. 0.5-long & 0-short) on the control ratings. The main effect of contingency order was not significant, nor was the main effect of controllable duration, and the Contingency Order x Controllable Duration interaction was also non-significant (all *F*s < .1.849, all *p*s > .181).

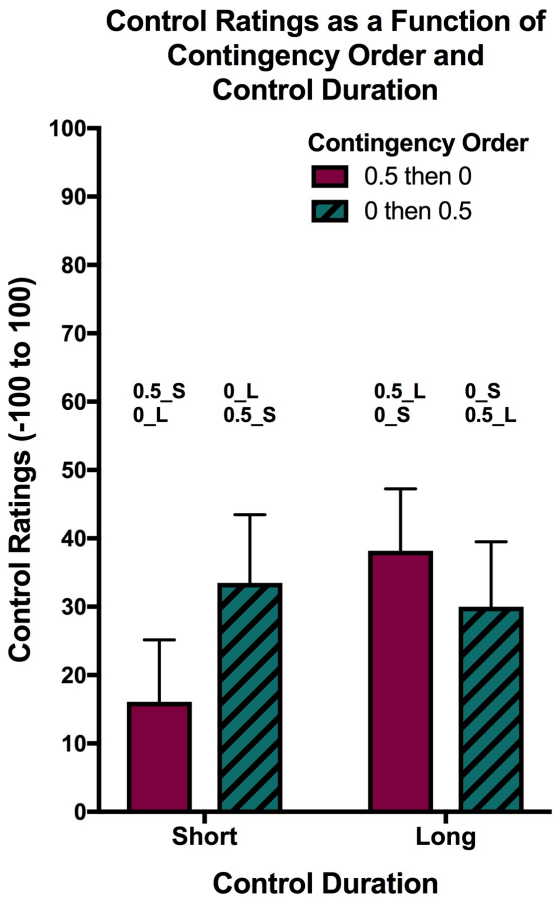

Figure 16. Mean control ratings (-100 to 100) as a function of controllable duration (0.5-short & 0-long vs. 0.5-long & 0-short) and contingency order (0.5 then 0 vs. 0 then 0.5). Error Bars = SEM.

Control Ratings before the experimental task

Control ratings before the experimental task were not related to the other variables measured in this experiment. A Pearson's correlation analysis was carried out to assess the relationship between control ratings before the experimental task, control ratings after the experimental task, time estimates and DoC. Control ratings before the experimental task were not significantly related to control ratings after the experimental task nor were they significantly related to any of the other measures (all *ps* > .239).

DoC and Control Ratings

It was found that DoC scores (M = 96.27, SD = 12.09) were not related to control ratings. The scores of the individual difference measure DoC were entered into a Pearson's Correlation analysis with the control ratings, no significant relationship was found (p = .357).

Time Estimation

In this experiment, future task completion time estimates were kept as direct measure without the calculation of time estimation errors, as participants were presented with two task durations before making their future completion time estimates. It can be seen in Figure 17, that the mean future completion time estimates, following the long-controllable task seem to be higher (M = 959.13; SD = 394.99) than those following the short-controllable task (M = 773.86; SD = 235.812), regardless of duration order. No difference between the time estimates for the two duration orders was observed (short M = 865.45; SD = 264.944 vs. long M = 871.82; SD = 405.834). It can also be seen in Figure 17 that the future task completion time estimates were not the average of the two experienced durations (1600sec+640sec)/2 = 1120sec. The grand mean of future task completion time estimates (M = 868.56; SD = 337.22) was lower than the average (1120sec) of two actual task durations $t(44) = -5.002$, $p < .001$, $d = -0.74$. However, the grand mean was also higher than the short task duration (640sec) $t(44) = 4.547$, $p < .001$, $d = 0.68$.

A 2x2 between-subjects univariate ANOVA was carried out analysing the effect of duration order (short-long vs. long-short) and controllable duration (0.5-short &

0-long vs. 0.5-long & 0-short) on future completion time estimates. The main effect of the controllable duration approached significance, $F(1, 41) = 3.403$, $p = .072$, ${}_p\eta^2 = .077$, 90% CI [0, .223]. However, the 90% confidence interval of the partial eta-squared effect size did include zero, so no further analysis was performed investigating this variable. The main effect of duration order and the interaction term were not significant (all Fs < .108 , all ps > .744).

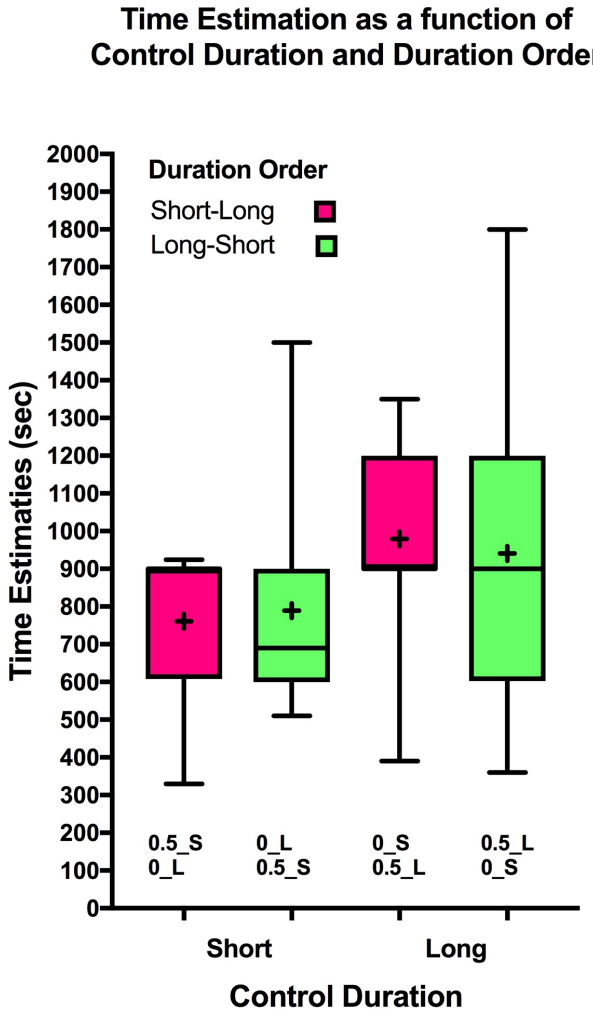

Figure 17. Future task completion time estimates (sec) as a function of controllable duration (0.5-short & 0-long vs. 0.5-long & 0-short) and duration order (short-long vs. long-short). Hinges represent 25th to 75th percentiles, whiskers represent min. and max. values, line plotted at median and cross plotted at mean.

DoC and Time Estimation

It was found that scores on the desirability of control scale (DoC) (M = 96.27, SD = 12.09) predicted future task completion time estimates, with higher scores on the DoC scale producing longer future task completion time estimates. To assess the effect of the DoC scores on future task completion time estimates a simple linear regression analysis was carried out, with DoC scores as a predictor of future completion time estimates. The regression analysis found that DoC significantly accounted for 11.5% of the variance in future completion time estimates, R^2 = .115, 90%CI [.009, .288], adjusted R^2 = .093, $F(1, 42)$ = 5.434, p = .025. It was found that DoC significantly predicted future completion time estimates (β = .338, $t(43)$ = 2,331, p = .025). The line of best fit for this model is given by the equation as follows: future task completion time estimates = -51.48 + (9.55 x DoC) as can be seen in Figure 18. This indicates that higher DoC scores lead to longer future task completion time estimates.

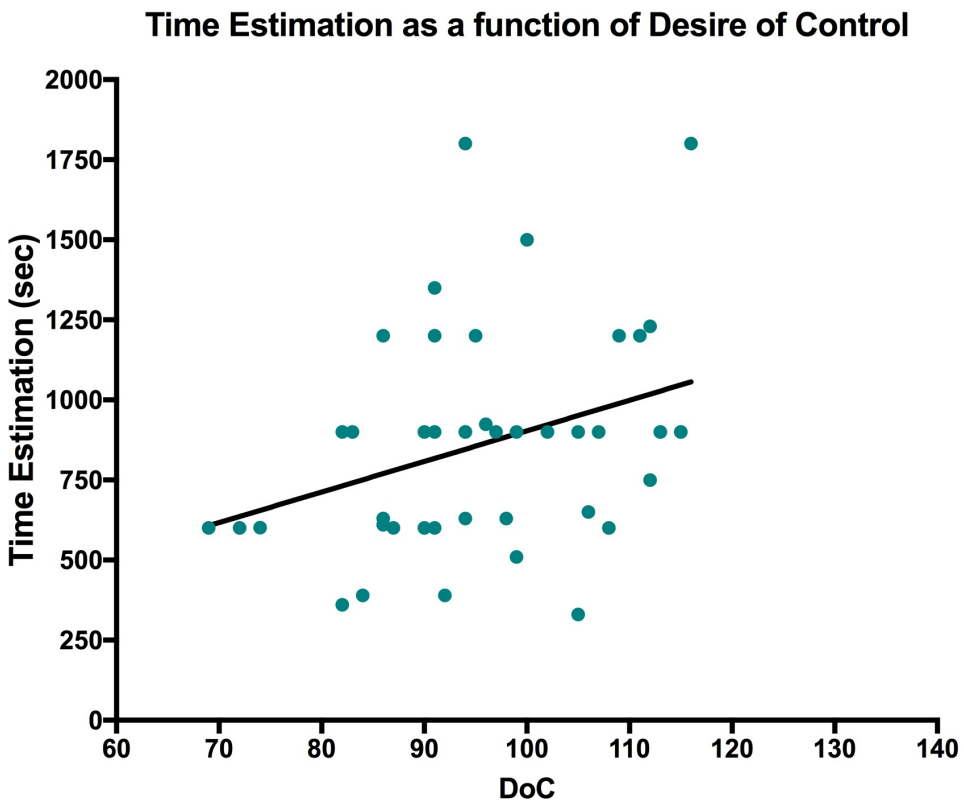

Figure 18. Future task completion time estimates (sec) as a function of desirability of control scores. Line of best fit for the regression model is plotted.

Control Ratings and Time Estimates

It was found that control ratings were not related to future task completion time estimates. Pearson's correlations were computed between the control ratings and the future task completion time estimates; the correlation was not significant (p = .741).

Discussion

When participants had to estimate future task completion times after having experienced two tasks of different controllability and duration, there was a trend for future task completion durations to be estimated as shorter following a short-controllable task and longer following a long-controllable task. This was

seen independent of the order in which the controllable and uncontrollable tasks were presented. This trend is in line with Hypothesis 7 that states that the duration of a controllable task, but not of an uncontrollable task, will be used as anchor for estimating future task durations. However, it should be noted that this trend only approached significance, and therefore further experiments were carried out, described in this chapter, to investigate the anchoring effect of controllable task durations.

Furthermore, it could be suggested that estimates of future task completion times were not the average of the two presented durations, suggesting that a form of automatic *reference class forecasting* might not have been performed. However, it cannot be completely excluded that an imperfect average might have been computed. Future task completion time estimates, however, were also not lower than the short duration, which would have been a more severe form of future task completion time underestimation. The *Anchoring and Adjustment Account* of the planning fallacy (Thomas et al., 2003), which suggests that future task completion time estimates are anchored on the preceding task, might have predicted future task completion time estimates to be anchored on the most recent experienced duration, but this was not the case.

Lastly, the findings in this experiment suggested that there might be a relationship between desire for control and future task completion time estimates, in support of Hypothesis 6. It was found that people with higher DoC scores predicted longer future task completion times than participants with lower DoC scores. This is contrary to previous findings (Halkjelsvik et al., 2012)

that suggested people with high desire for control to be more prone to underestimating task completion times. However, Halkjelsvik et al. (2012) found that people high on DoC were more prone to future task completion time underestimation if incentivised for speedy task completion, which was not the case in the current experiment.

The results of Experiment 5 also revealed that the control ratings were not different for the different experimental conditions, therefore no influence of the manipulated variables on the control ratings was found. Furthermore, there was no relationship between the individual difference variable desire for control and the reported control ratings.

Experiment 6

Introduction

Experiment 6 also investigated Hypothesis 7, which stated that future task completion times would be anchored on the duration of previously experienced controllable task. However, in contrast to Experiment 5, this experiment explored whether controllability would also influence predictions of future task completion durations when none of the previously experienced tasks was completely uncontrollable. As in Experiment 5 participants were presented with two experimental tasks of different durations. However, in this experiment none of the tasks was uncontrollable, i.e. a zero contingency condition, but one of the

tasks had a higher positive contingency than the other (ΔP = 0.25 vs. 0.5). This change in contingency was made in order to investigate whether a relative difference in the actual control of the two tasks would confirm the trend seen in Experiment 5, without any of the two tasks being completely uncontrollable. Specifically it was tested whether participants would anchor their future task completion time predictions on the duration of the more-controllable (0.5 contingency) task, thereby showing an anchoring effect even with this relative and smaller difference in task control.

Furthermore a new personality measure was introduced, the intolerance of uncertainty scale (Freeston, Rhéaume, Letarte, Dugas & Ladouceur, 1994; Buhr & Dugas, 2002). This scale together with the desirability of control measure was used to further investigate the influence of individual difference variables relating to control and uncertainty on future task completion time estimation (Hypothesis 6).

Methods

Participants

Participants were volunteers recruited from the general and university student population. Participants were offered an honorarium for their participation with either money (£5 per 30min) or course credits. 57 participants took part in this experiment. Of these, 41 were female and 16 were male. The ages were divided into four categories: 18-30, 30-40, 40-50 and 50+ years. 47 participants belonged to the first age category, 6 participants belonged to the second age

category, and 3 participants belonged to the third age category.

Materials

The Materials used in this experiment were the same as in the previous experiment.

Measures

As in the previous two experiments the desirability of control scale (Burger& Cooper, 1979) was used to measure how much control participants desire in their everyday life. The 21 items of this scale had a questionable internal consistency in the sample of this experiment $\alpha = .67$. Furthermore the intolerance of uncertainty scale (Freeston et al., 1994; Buhr & Dugas, 2002) was introduced to measure how intolerant participants were to uncertainty in everyday life. The intolerance of uncertainty scale is a 27 item self-report measure that uses a 5-point Likert scale. Scores for the 27 items are added together to yield the total score, with a maximum score of 135. This scale showed a good internal consistency in this experiment, $\alpha = .95$.

Design

The design of Experiment 6 was identical to Experiment 5, the only difference being that the 0 contingency was replaced by a 0.25 contingency (see Table 13).

ΔP = 0.5
Duration: Short

	Outcome	No Outcome	
Action	40	0	P(O|A) = 1.0
No Action	20	20	P(O|noA) = .5

ΔP = 0.25
Duration: Short

	Outcome	No Outcome	
Action	20	20	P(O|A) = .5
No Action	10	30	P(O|noA) = .25

ΔP = 0.5
Duration: Long

	Outcome	No Outcome	
Action	80	0	P(O|A) = 1.0
No Action	40	40	P(O|noA) = .5

ΔP = 0.25
Duration: Long

	Outcome	No Outcome	
Action	40	40	P(O|A) = .5
No Action	20	60	P(O|noA) = .25

Table 13. *The four experimental conditions, with two contingencies (0.25 vs. 0.5) and two durations (short vs. long). The numbers inside the four tables represent the indicative trial numbers for the four possible trial types (Action - Outcome, No Action - Outcome, Action - No Outcome, No Action - No Outcome). The actual trial numbers depended on the action frequency of each participant.*

Procedure

The procedure was the same as in Experiment 5.

Results

Data Preparation

As in the previous experiment, extreme outliers for the future task completion time estimates were determined. No extreme outliers were found in this experiment. Again action percentages were calculated for each participant and each condition, the allowable ranges were between 85% and 15%. Four participants had action percentages outside these allowable limits and were removed from the analysis. An alpha of .05 and effect size confidence intervals of

90% were applied to all analyses in this experiment. Furthermore, 90% confidence intervals were also provided for the R^2 statistic.

Control Ratings

There was no effect of the duration of the more-controllable task, i.e. the 0.5 contingency, or contingency order on control ratings. The mean control ratings were not different following the short more-control duration (0.5-short & 0.25-long) (M = 29.73; SD = 34.075) as compared to the long more-control duration (0.5-long & 0.25-short) (M = 30.37; SD = 40.940). Furthermore, control ratings did not differ following the contingency order 0.5 then 0.25 (M = 24.43; SD = 38.797) as compared to the 0.25 then 0.5 contingency order (M = 36.36; SD = 35.408). The mean control ratings for the four conditions can be seen in Figure 19. The grand mean for control ratings in this experiment was 30.06 (*SD* = 37.37). A 2x2 between-subjects univariate ANOVA was carried out analysing the effect of contingency order (0.5 then 0.25 vs. 0.25 then 0.5) and more-controllable duration (0.5-short & 0.25-long vs. 0.5-long & 0.25-short) on the control ratings. No effects proved to be significant. The main effect of more-controllable duration was not significant, nor was the main effect of contingency order and the interaction term (all Fs < .1.280, all ps > .263).

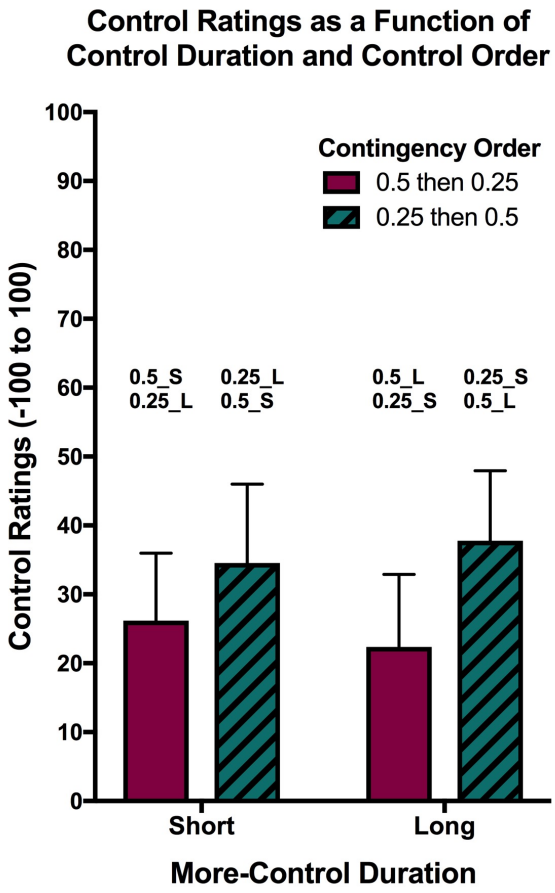

Figure 19. Mean control ratings (-100 to 100) as a function of more-controllable duration (0.5-short & 0.25-long vs. 0.5-long & 0.25-short) and contingency order (0.5 then 0.25 vs. 0.25 then 0.5). Error Bars = SEM.

Control Ratings before the experimental task

Control ratings before the experimental task were not related to any of the other variables in this experiment. A Pearson's correlation analysis was carried out for prospective control ratings before the experimental task, the individual difference measures DoC, intolerance of uncertainty (IoU), future task completion time estimates and the control ratings after the experimental task. Control ratings before the experimental task were not significantly correlated to any of the other measures (all *p*s > .091).

DoC, IoU and Control Ratings

It was found that scores on the intolerance of uncertainty scale predicted control ratings, and higher IoU scores led to lower control ratings. It was first investigated if the DoC scores (M = 95.02, SD = 14.25) correlated with the IoU scores (M = 66.25, SD = 19.53) by performing a Pearson's correlation. The scores on the two individual difference measures did not correlate with each other (p = .883), which could be seen as indication that they were measuring separate constructs.

Therefore, a multiple linear regression analysis was performed with DoC and IoU scores entered (enter method) as a predictor of control ratings. The multiple linear regression analysis showed that the regression model was not significant overall R^2 = .088, 90% CI [.004, .240], adjusted R^2 = .052, $F(1, 49)$ = 2.407, p = .101. However, it was found that IoU significantly predicted control ratings (β = -.295, $t(51)$ = -2,166, p = .035). The line of best fit for IoU as a predictor of control ratings is given by the equation as follows: control ratings = -68.08 - 0.57 x IoU. As can be seen in Figure 20, the line of best fit indicates that higher IoU scores lead to lower control ratings.

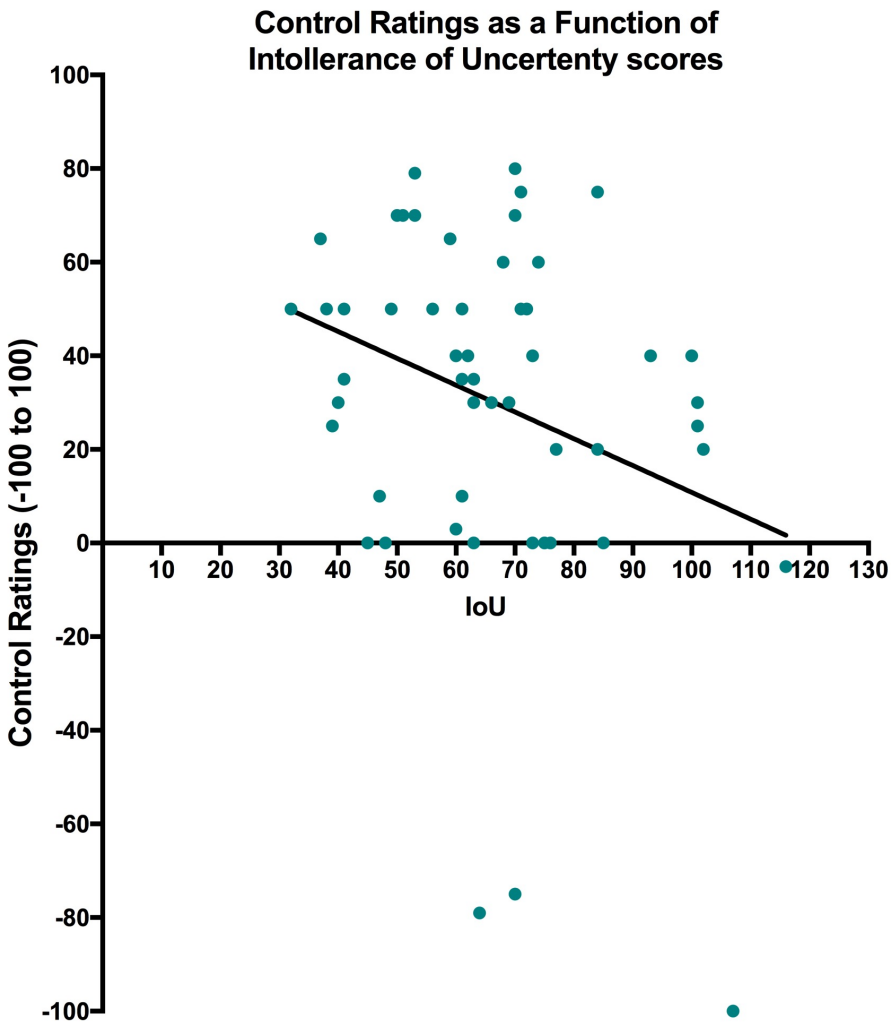

Figure 20. Showing control ratings as a function of intolerance of uncertainty scores. Line of best fit for IoU scores as a predictor in the regression model is plotted.

Time Estimation

Again as in Experiment 5, the future task completion time estimates were kept as direct measure without the calculation of time estimation errors. It can be seen in Figure 21, that completion time estimates for the four conditions did not differ greatly from each other. Time estimates following the more-control short duration (0.5-short & 0.25-long) (M = 998.54; SD = 393.473) were not different from those following the more-control long duration (0.5-long & 0.25-short) (M = 903.04; SD = 330.981). Furthermore time estimates did not differ following the

duration order short-long (M = 992.48; SD = 378.179) as compared to the duration order long-short (M = 898.42; SD = 343.818). The grand mean of future task completion time estimates was 949.89 seconds (*SD* = 362.67) However, similar to the data in Experiment 5 all mean future task completion time estimates lie between the actual short task duration and the average of the two actual task durations. The grand mean of future task completion time estimates was significantly higher than the short task duration (640sec) $t(52) = 6.221$, $p < .001$, $d = 0.85$. The grand mean of future task completion time estimates was also significantly lower than the average of the two actual task durations (1120 sec) $t(52) = -3.415$, $p < .001$, $d = -0.47$.

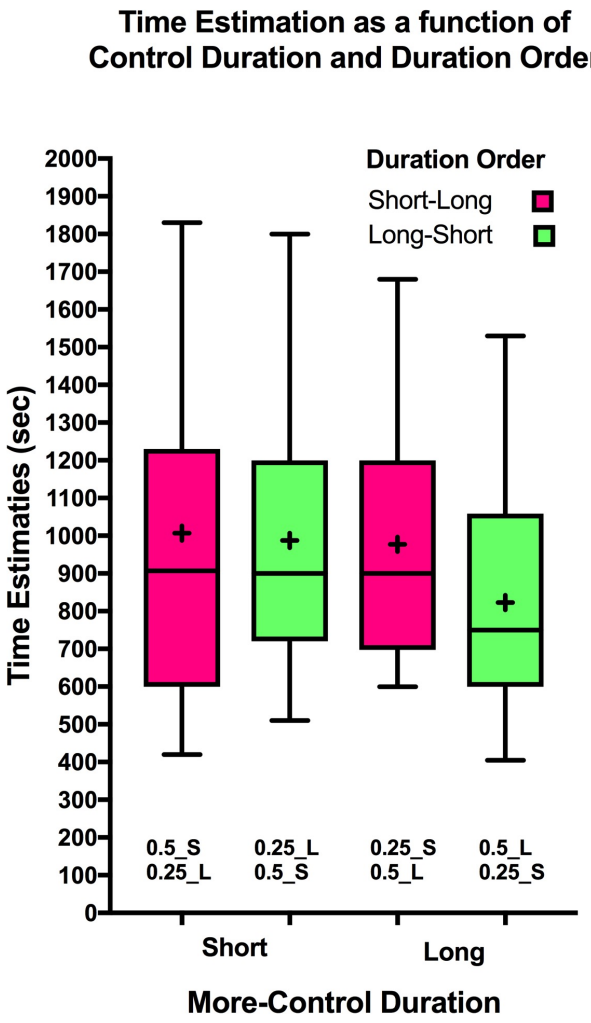

Figure 21. Future task completion time estimates (sec) as a function of function of more-controllable duration (0.5-short & 0.25-long vs. 0.5-long & 0.25-short) and duration order (short-long vs. long-short). Hinges represent 25th to 75th percentiles, whiskers represent min. and max. values, line plotted at median and cross plotted at mean.

A 2x2 between-subjects univariate ANOVA was carried out analysing the effect of duration order (short-long vs. long-short) and more-controllable duration (0.5-short & 0.25-long vs. 0.5-long & 0.25-short) on the future task completion time estimates. None of the effects were found to be significant. The main effect of more-controllable duration was not significant, nor was the main effect of duration order or the interaction term (all *F*s > .917, all *p*s < .343).

DoC, IoU and Time Estimation

It was found that neither DoC scores (M = 95.02, SD = 14.25) nor IoU scores (M = 66.25, SD = 19.53) predicted future task completion time estimates. A multiple liner regression analysis was performed in which DoC and IoU scores were entered (enter method) as a predictor for future task completion time estimates. Contrary to the findings of Experiment 5, DoC scores did not significantly predict future task completion time estimates (p = .449). IoU scores approached significance as a predictor (p = .05) of future task completion time estimates, but will not be further discussed as they did not meet the significance criterion of alpha .05.

Control Ratings and Time Estimates

Control ratings were found not to be related to future task completion time estimates. A Pearson's correlation analysis was run between control ratings and future task completion time estimates, the two measures were not significantly related to each other (p = .725).

Discussion

The results for the future task time completion time estimates suggest that time estimates were not influenced by the duration of the more controllable task or the order of the two durations, going against Hypothesis 7. The trend identified in Experiment 5, for the duration of the controllable task to act as an anchor for future task completion time predictions, was not replicated in this experiment. However it should be noted that the difference between this experiment and Experiment 5 was that in this experiment none of the experimental tasks were

completely uncontrollable (i.e. zero contingency condition). That there was no effect of duration order, might speak against anchoring of future task duration estimates on the last experience task duration, as proposed by the *Anchoring and Adjustment Account* of the planning fallacy (see Thomas et al., 2003). The average of future task duration estimates for all groups was lower than the average of the two experienced durations but higher than the short experienced duration.

There was no relationship between the two individual difference measures and future task completion time estimates, going against Hypothesis 6. This might seem surprising given the findings of Experiment 5, which found a relationship between DoC and future task completion time estimates. It should also be pointed out that the two samples did not differ in their average DoC scores, so this cannot be taken as a reason for the differing results. It could be that DoC only had an effect on future task completion time estimates when one of the experienced tasks was completely uncontrollable. To investigate this idea further the DoC measure was included in the next experiment, which again employed an uncontrollable (zero contingency) task and a controllable (positive contingency) task.

Similar to the results of Experiment 5, control ratings were not influenced by any of the experimental manipulations. However, the individual difference variable introduced in this experiment was found to be a predictor of control ratings, with participants with higher intolerance of uncertainty scores giving lower average control ratings than participants with lower intolerance of uncertainty scores. This is especially noteworthy given that both of the contingencies in this

experiment were positive. It seems that people high on the intolerance of uncertainty scale feel less in control when presented with a mixture of differently controllable tasks. Furthermore, it should be noted that the two individual difference scales used in this experiment did not correlate with each other, so it could be assumed that they measure different aspects of the relationship people have with control and uncertainty in their everyday lives.

Experiment 7

Introduction

This experiment investigated the trend found in Experiment 5 for controllable tasks to act as an anchor for future task completion time predictions (Hypothesis 7). In this experiment participants were presented with two experimental tasks of differing durations (short and long) as in the previous two experiments. In order to explore the trend found in Experiment 5 further, the two tasks also differed in their controllability, one was controllable and one was uncontrollable. This experiment introduced a greater difference in controllability between the tasks, by increasing the difference between the two contingencies (0 vs. 0.75) in comparison to Experiment 5. Furthermore, it was of interest how experiencing these two different contingency conditions would influence control ratings. Lastly, the two individual-difference measures used in Experiment 6, the desirability of control scale and the intolerance of uncertainty scale, were employed again to investigate the relationship between individual-difference factors and future task completion time estimates in more detail (Hypothesis 6).

Methods

Participants

Participants were volunteers recruited from the general and university student population. Participants were offered an honorarium for their participation with either money (£5 per 30min) or course credits. 45 participants took part in this

experiment, 31 of whom were female and 14 were male. Ages were divided into four categories: 18-30, 30-40, 40-50 and 50+ years. There were 38 participants with ages between 18 and 30 years, 6 participants who were between 30 and 40 years old and 1 participant that was between 40 and 50 years old.

Materials, Measures and Procedure

The materials, measures and procedure were the same in Experiment 6. The 27 items of the intolerance of uncertainty scale showed good internal consistency in this experiment, $\alpha = .90$. The 20 items of the desirability of control scale showed acceptable internal consistency in this experiment, $\alpha = .71$

Design

Experiment 7 was identical to Experiment 6, the only difference being that the 0.5 contingency was replaced by a 0.75 Contingency (see Table 14).

ΔP = 0.75
Duration: Short

	Outcome	No Outcome	
Action	40	0	P(O|A) = 1.0
No Action	10	30	P(O|noA) = .25

ΔP = 0
Duration: Short

	Outcome	No Outcome	
Action	20	20	P(O|A) = .5
No Action	20	20	P(O|noA) = .5

ΔP = 0.75
Duration: Long

	Outcome	No Outcome	
Action	80	0	P(O|A) = 1.0
No Action	20	60	P(O|noA) = .25

ΔP = 0
Duration: Long

	Outcome	No Outcome	
Action	40	40	P(O|A) = .5
No Action	40	40	P(O|noA) = .5

Table 14. *The four experimental conditions, with two contingencies (0 vs. 0.75) and two durations (short vs. long). The numbers inside the four tables represent the indicative trial numbers for the four possible trial types (Action - Outcome, No Action - Outcome, Action - No Outcome, No Action - No Outcome). The actual trial numbers depended on the action frequency of each participant.*

Results

Data Preparation

As in the previous experiments, extreme outliers were determined for the future task completion time estimates. There were no extreme outliers in this experiment. As previously described, action percentages were calculated for each participant and each condition, the allowable ranges were between 85% and 15%. No participant had to be removed based on the action percentage check. An alpha of .05 and effect size confidence intervals of 90% were applied to all analyses in this experiment. Furthermore, 90% confidence intervals were also provided for the R^2 statistic.

Control Ratings

Contingency order and controllable duration had no influence on control ratings. The mean control ratings were not different following the short controllable duration (0.75-short & 0-long) (M = 37.17; SD = 37.259) as compared to the long controllable duration (0.75-long & 0-short) (M = 38.95; SD = 27.551). Furthermore, control ratings did not differ following the contingency order 0.75 then 0 (M = 29.91; SD = 30.366) as compared to the 0 then 0.75 contingency order (M = 46.14; SD = 33.450).

The details of the average control ratings for the four conditions can be seen in Figure 22. The grand mean of control ratings was 38.02 (*SD* = 32.621). A 2x2

between-subject univariate ANOVA was carried out analysing the effect of contingency order (0.75 then 0 vs. 0 then 0.75) and controllable duration (0.75-short & 0-long vs. 0.75-long & 0-short) on the control ratings. None of the variables showed a significant effect on control ratings, with the main effect of controllable duration being non-significant, as well as the main effect of contingency order being non-significant. The interaction was also not significant (all Fs < 2.656, all *ps* > .111).

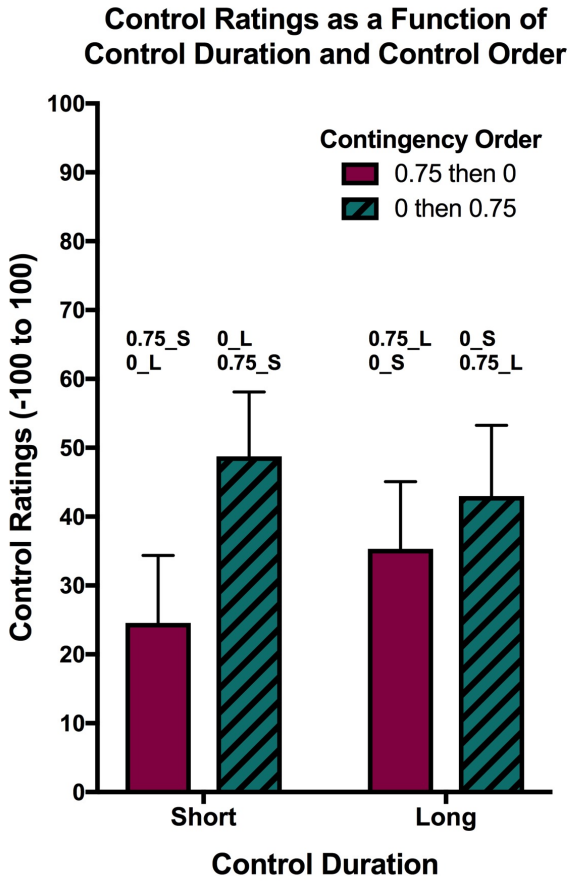

Figure 22. Mean control ratings (-100 to 100) as a function of controllable duration (0.75-short & 0-long vs. 0.75-long & 0-short) and contingency order (0.75 then 0 vs. 0 then 0.75). Error Bars = SEM.

Control Ratings before the experimental task

Control ratings before the experimental task were not related to any of the other variables in this experiment. Pearson's correlations were computed for prospective control ratings before the experimental task, the individual difference measures DoC, IoU, future task completion time estimates and the control ratings after the experimental task. Control ratings before the experimental task were not significantly correlated to any of the other measures (all *p*s > .254).

DoC, IoU and Control Ratings

No relationship between DoC or IoU scores and control ratings was found. The individual difference measures desirability of control and intolerance of uncertainty were entered into a Pearson's Correlation Analysis with the control ratings, and no significant relationship was found for the DoC or IoU scores and the control ratings (all *p*s > .579).

Time Estimation

Following the procedure from the previous two experiments future task completion time estimates were kept as a direct measure without the calculation of time estimation errors. The means of the future task completion time estimate for the four conditions can be seen in Figure 23. Time estimates following the control short duration (0.75-short & 0-long) (M = 802.29; SD = 406.841) were not different from those following the control long duration (0.75-long & 0-short) (M = 871.67; SD = 442.299). Furthermore time estimates did not differ

following the duration order short-long (M = 936.36; SD = 449.659) as compared to the duration order long-short (M = 737.39; SD = 374.299). The grand mean of future task completion time estimates was 834.67seconds (*SD* = 420.32). As in the previous experiments it can be seen that this grand mean was significantly lower than the average of the two actual task durations (1120sec) [$t(44) = -4.554$, $p < .001$, $d = -.67$] but significantly higher than the short task duration (640 sec) [$t(44) = 3.107$, $p = .003$, $d = .46$].

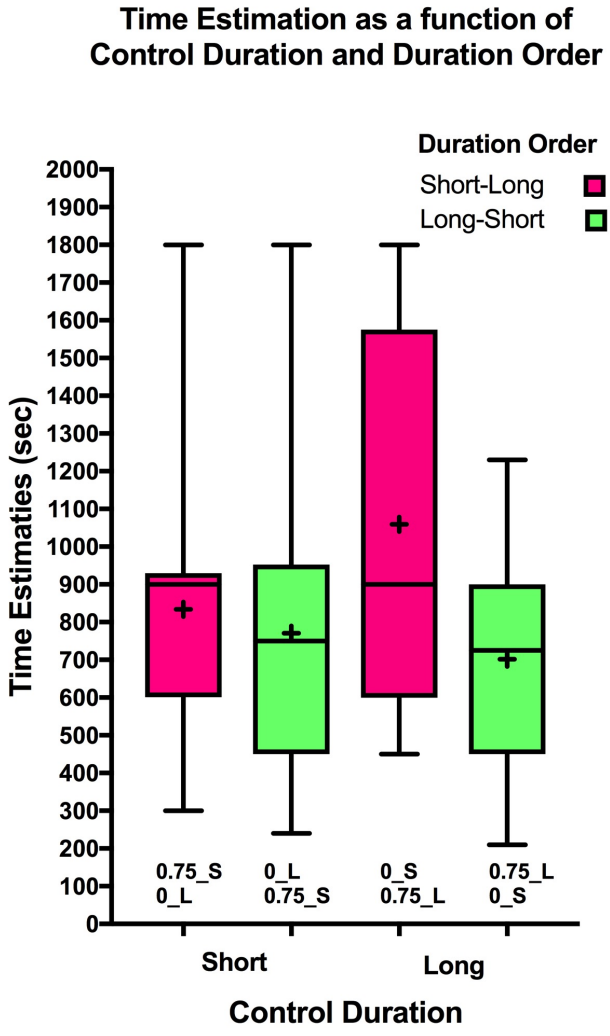

Figure 23. Future task completion time estimates (sec) as a function of function of controllable duration (0.75-short & 0-long vs. 0.75-long & 0-short) and duration order (short-long vs. long-short). Hinges represent 25th to 75th percentiles, whiskers represent min. and max. values, line plotted at median and cross plotted at mean.

A 2x2 between-subjects univariate ANOVA was carried out analysing the effect of duration order (short-long vs. long-short) and controllable duration (0.75-short & 0-long vs. 0.75-long & 0-short) on the future task completion time estimates. There was no significant main effect of duration order or controllable duration. The interaction between controllable duration and duration order was also not significant (all *F*s < .2.898, all *p*s > .096).

DoC, IoU and Time Estimation

The individual difference measures desirability of control and intolerance of uncertainty were not related to future task completion time estimates. The individual difference measures desirability of control and intolerance of uncertainty were entered into a Pearson's Correlation Analysis with the future task completion time estimates. No significant relationship was found (all *p*s > .926).

Discussion

It was found that the duration of the controllable task and the order of the presented durations did not have an effect on the future task completion estimates. The results of this experiment did therefore not support Hypothesis 8, which predicted that the duration of the controllable task would act as an anchor when predicting future task completion times. This finding also goes against the trend that was observed in Experiment 5, which was the reason this further investigation had been performed. This finding suggests that the duration of the controllable task might not be used as an anchor when predicting future task completion time durations even when the difference between the controllable

and uncontrollable task is relatively large in terms of their contingency difference (0 vs. 0.75). However, future task completion times were also not based on the average of the two experienced durations nor on the most recently (or first) experienced duration.

As in Experiment 5 and Experiment 6 there was no effect of the experimental manipulations on the control ratings. Furthermore, no relationship between the individual difference measures desire for control and intolerance of uncertainty and future time estimates or control ratings was found, going against Hypothesis 6.

General Discussion: Experiments 5-7

In the experiments of this chapter Hypothesis 7 was tested, which stated that participants would use the duration of a just experienced controllable task, but not the duration of an uncontrollable task, as an anchor for their future task completion time predictions. The results of Experiment 5 suggested that future task duration estimates might be anchored on the duration of a controllable task, as a trend in this direction was found. However, this trend was not confirmed by Experiment 7, which employed tasks of greater contingency difference and had therefore been expected to produce a larger effect on future task duration estimates. From the results of Experiment 6 it could be suggested that if two controllable tasks are experienced that are only slightly different in their controllability, then future task duration estimates are not anchored on the

duration of the more controllable tasks. There was also no clear indication that participants based their future task completion time predictions on the average of the two previously experienced durations, which might have been a form of spontaneous *reference class forecasting*. Nor was there support for the suggestion that the last (or first) experienced duration was used as an anchor for future task completion time estimation, which might have been seen as support for the *Anchoring and Adjustment Account* (Thomas et al., 2003).

Furthermore, no clear relationship between the individual difference measures and the future task duration estimates was found. Experiment 5 found a relationship between desire of control and future task completion estimates, but this effect was not replicated in the following experiments. Experiment 6, on the other hand, found an effect of intolerance of uncertainty on future task completion estimates, however again this effect was not replicated in Experiment 7. Therefore, no clear conclusion can be drawn and more research is needed to investigate the relationship between these individual difference measures and future task completion time estimation.

From the experiments above it can be seen control ratings were not influenced by contingency order or contingency duration pairings. Furthermore, no clear relationship emerged between the individual difference measures and the control ratings. In Experiment 6 it was found that intolerance of uncertainty was negatively related to control ratings, however this finding was not replicated in Experiment 7.

To sum up, the experiments of this chapter did not provide support for Hypothesis 7, which stated that the duration of controllable tasks would be used as anchors when predicting future task completion time durations, even though a trend in the expected direction had been found in Experiment 5. There was no clear evidence to suggest how people form their future task completion time estimates, as they were not based on either of the previously experienced durations, nor on the average of the two durations, nor based on the first or last experienced duration. Therefore further research is needed to investigate how people form future task completion time estimates after having experienced multiple tasks of different durations and controllability.

Chapter 4: Completion time estimates and perception of control for real-life tasks

Introduction

Previous experiments into the planning fallacy in real-life contexts have found that people generally tend to underestimate their task completion times. This tendency was found for academic tasks (Buehler et al., 1994; Newby-Clark et al., 2000; Buehler & Griffin, 2003; Sanna & Schwarz, 2004; Sanna et al., 2005; Peetz et al., 2010; Buehler et al. 2012; Min & Arkes, 2012; Wiese et al., 2016) as well non-academic tasks such as Christmas shopping (Buehler & Griffin, 2003; Kruger & Evans, 2004; Peetz et al., 2010), wedding planning (Min & Arkes, 2012), filing tax return forms (Buehler et al., 1997; Newby-Clark et al., 2010) and getting ready for a date (Kruger & Evans, 2004).

The experiments in this chapter were designed to look at people's estimates of future task completion times in relationship to real-life, academic and non-academic tasks. Three experiments were conducted that investigated the accuracy of these real-life future task completion time estimates by comparing them to actual task completion times. Following on from literature that suggests that the planning fallacy is linked to general optimism bias (e.g. Kahneman & Lovallo, 1993; Shepperd et al., 2013) and further literature that suggests higher perceptions of control leading to greater optimism bias (Weinstein, 1980;

Shepperd, et al., 2015; Harris, 1996; Klein & Helweg-Larsen, 2002), this chapter investigated Hypothesis 2, that people who perceive themselves more in control over completing the task in a timely manner will predict shorter task completion times than people who perceive themselves as being less in control. Therefore, control perceptions over timely task completion were measured before and after the completion of the real-life tasks investigated in this chapter.

Furthermore, linking the above hypothesis to the findings of attributions made for successful and unsuccessful task completions (Weiner, 1979; Weiner, 1985), Hypothesis 4 proposed that people who feel more in control over facilitating and preventative factors for their timely task completion would predict shorter task completion times than people who feel less in control over these factors. Furthermore, it was expected that this effect would be especially strong for people who perceived themselves as having higher control over possible preventative factors for their timely task completion. This reasoning followed research on optimism bias and control perception (Weinstein, 1980) that found people to display greater *optimism bias* if they felt more in control over negative events. To test this hypothesis, participants in the experiments of this chapter had to list possible helpers and hinderers before task completion and also list actual helpers and hinderers after they had completed the tasks. Furthermore, control ratings for the reported facilitating and preventative factors (helpers and hinderers) were collected. This was inspired by the attribution model of Weiner (1979; 1985), which proposed controllability as an additional dimension of attributions. Of interest was also if the perception of control over facilitating and

preventative factors reported before the completion of the task would differ from control perceptions after task completion.

Generally people are seen to be prone to causal-oversimplification or causal reductionism (Mumford & Anjum, 2018; Kahneman & Lovallo, 2003). It could be argued that completion time estimates are underestimated because people do not take into account all the possible factors that might influence their timely task completion. Previous research found mixed results in relation to induced focus on obstacles before future task completion time predictions (Byram, 1997; Hinds, 1999; Sanna & Schwarz, 2004; Sanna et al., 2005; Min & Arkes, 2012). Some studies (Sanna & Schwarz, 2004; Sanna et al., 2005; Min & Arkes, 2012) suggested that thinking about a few (as compared to many) obstacles before making future task completion time estimates could reduce the tendency to underestimate task completion times. To investigate whether the valence of factors that are thought about before making task completion time estimates is of importance, participants in the last experiment of this chapter were split into two groups, one of which had to report only facilitating factors and the other only preventative factors before making their task completion time estimates. The hypothesis (Hypothesis 5) was that participants who were made to think about possible impediments to timely task completion would be less prone to underestimating their task completion times in comparison to participants who were made to think about possible facilitating factors for timely task completion.

Experiment 8

Introduction

This experiment aimed at investigating whether control perceptions for a real-life task, in this case the submission of an undergraduate thesis, would influence future completion time estimates for that task. It was expected, following previous research that suggested a link between optimism bias and heightened perceptions of control (Weinstein, 1980; Shepperd et al., 2013; Shepperd et al., 2015; Harris, 1996; Klein & Helweg-Larsen, 2002), that participants who felt more in control over finishing the task in a timely manner would predict shorter completion times than participants who felt less in control over finishing the task in a timely manner (Hypothesis 2). Furthermore, it was predicted that participants who reported higher control over possible facilitating and preventative factors for timely task completion would be more prone to underestimating their completion times than participants who reported lower control over these factors (Hypothesis 4). This effect was expected especially for the perception of control over negative factors (see Weinstein, 1980).

This experiment also investigated the types of factors that people would list as preventative and facilitating factors for timely task completion. The factors that participants listed were categorised by the experimenters into two internal (action and mental) and three external (people, work, circumstance) categories, adapting previous categorisations of participants' thoughts about factors affecting past and future task completion (Buehler et al., 1994; Buehler et al.,

1997; Newby-Clark et al., 2000; Buehler & Griffin, 2003; Sanna & Schwarz, 2004; Sanna et al., 2005; Peetz et al., 2010; Buehler et al., 2012; Wiese et al., 2016).

This experiment differed in a few ways from the above-cited previous investigations. Firstly, participants had to report what would help or hinder them to finish the task at their predicted time, and not, as in some studies, what would lead to a success on the task following the estimated completion, i.e. a good grade in an exam after predicting when their revision would be finished (Sanna & Schwarz, 2004) or successful (but not necessarily timely) completion of the task (Sanna et al., 2005). Furthermore, the experiments in this chapter specifically looked at past and future helpers rather than the broader categories of *past experiences* and *future plans*, which have often been used in previous research (e.g. Buehler et al., 1994; Buehler & Griffin, 2003; Buehler et al., 2012). These previously used categories could include positive and negative items and are therefore not specific enough to be compared to past or future impediments (hinderers). Furthermore, the previously used category of *future plans* also narrows down the items that can be listed to actions performed by the person who is completing the task, and does not include positive mental states or actions that can be helpfully performed by others contributing to task completion. Therefore, participants in the current experiment were asked to list any factor that might help or hinder them to complete their task at their predicted/desired time.

To investigate Hypothesis 4, which stated that participants who perceive themselves to be more in control over facilitating and preventative factors would

predict shorter task completion times than participants who did not feel in control over these factors, control ratings for each of the factors listed were also collected. Lastly, following previous research (Halkjelsvik et al., 2012) it was tested whether having a high desire for control would be linked to future task completion time underestimations (Hypothesis 6).

Methods

Participants

This experiment was conducted over two academic years with two groups of final year experimental psychology undergraduate students. In the first year 20 participants submitted full responses for the first session and 11 participants completed the full set of question for the second session after the deadline, which was a 55% response rate for this self-selecting sample. In the second year 16 participants completed the first session and 11 participants completed the second session, which was a 69% response rate for this self-selecting sample. This yielded a total of 36 participants for session one and 22 participants for session two, which was a total response rate of 61%. Of the total number of participants, 29 were female and 7 were male. The average age of all participants was 20.94 years (*SD* = 0.89).

Materials

Lime Survey (version 3.0) software package was used for creating the online version of the questionnaires. The questionnaire was distributed using direct emails to all final year experimental psychology undergraduate students.

Measures

The measures collected in this experiment were in relation to an upcoming deadline of the participants, in this case their undergraduate thesis. This was a 'hard' deadline, with penalties in the form of mark-subtraction for late submission (more marks being subtracted for every extra day). Two new types of questionnaires were designed (see Appendix C) that measured participants' task completion time estimates and control perceptions. One of the questionnaires was administered before and one after the deadline. The questionnaire in the first session consisted of four different measures. The first was a future time estimation measure. For this, participants had to predict when they would submit their undergraduate thesis, by picking a date and a time. The dates ranged from 1 week before to 1 week after the actual deadline. The next measure of the questionnaire was concerned with the perception of control over the timely submission. Participants were asked to rate, on a scale from 0 to 100, the total amount of control they felt they had over submitting the thesis at their predicted time. The third and fourth measures of the questionnaire asked participants to think about the 5 most important things that might help and 5 most important things that might hinder them to submit at their predicted time (see Appendix C). For each of these 5 helpers and 5 hinderers participants also had to rate the amount of control (scale: 0-100) they predicted to have. The

desirability of control scale (Burger & Cooper, 1979) was used to measure how much control participants desire in their everyday life (see Appendix E). The 20 items of this scale showed a good internal consistency for this sample, $\alpha = .82$

The questionnaire in the second session, after the deadline, consisted of 3 measures. For the first measure participants had to indicate when (date and time) they had actually submitted their undergraduate thesis. The date options ranged from 1 week before to 2 weeks after the actual deadline, with a comment option if they had submitted later than 2 weeks after the deadline. The second measure was a rating of the amount of control (scale: 0-100) participants had felt over submitting their undergraduate thesis at their predicted time. For the third measure participants had to indicate the 5 most important things that had helped and 5 most important things that had hindered them to submit their undergraduate thesis at their predicted time. Again control ratings for the 5 helpers and 5 hinderers were collected.

Design

This study used a longitudinal (two-session) correlational design that was non-experimental but quantitative and qualitative. The outcome variables were: predicted submission time, actual submission time, total control rating (before & after the deadline), 5 helpers and helpers control ratings (before & after the deadline), 5 hinderers and hinderers control ratings (before & after the deadline), and desirability of control scores.

Procedure

Both questionnaire sessions were conducted online. In the first session, which took place 12-17 days before the undergraduate thesis submission deadline, participants were presented with an information sheet and a consent form before starting the questionnaire. Demographic data was also collected. Following this the questionnaire described in the section above and DoC scale were administered. Participants were also given the opportunity to add comments at the end of the online session: they were able to specify if they had received an extension to their deadline or if they were generally granted extra-time for submissions. After that participants were thanked and reminded that there would be a second part of the online study after their deadline. The second session took place 14 to 21 days after the deadline. The second questionnaire described in the section above was administered and participants were given the opportunity to add extra comments at the end. After this participants were debriefed, thanked and reimbursement was arranged.

Results

Data Preparation

Outliers for the predicted completion times were determined using the inter quartile range (IQR). Outliers were defined as data points more than 1.5 interquartile ranges (IQRs) below the first quartile (Q1) or above the third quartile (Q3) ($x_1 \geq Q3 + 1.5 \times IQR$ and $x_1 \leq Q1 - 1.5 \times IQR$). One participant was removed from the analysis. As this study used the exact same procedure in both years and the task of the participants, i.e. the specifications for their

undergraduate thesis, was not altered between year groups, the two groups were analysed together. Alpha level of .05 and confidence intervals of 90% for the effect sizes were used for the analyses in this experiment.

Predicted and Actual Completion Times

It was found that in the first year this study was conducted the whole sample of participants who completed the first part of the study predicted submitting their undergraduate thesis on average 42.61 hours (*SD* = 44.09) before the deadline. For the 10 students that completed the second part of this study the average actual submission time was 13.55 hours (*SD* = 76.79) after the deadline (predicted average completion time for those 10 participants had been 51.7 hours (*SD* = 44.75) before the deadline). The average estimation bias for the 10 participants that completed both sessions was 65.25 hours (SD = 78.98), which means that on average participants estimated submitting their undergraduate thesis 65.25 hours earlier than they actually did.

In the second year this study was conducted the whole sample of participants who completed the first part of the study predicted submitting their undergraduate thesis 17.62 hours (*SD* = 63.69) before the deadline, but those 11 that completed the second part of the study actually submitted earlier than that, namely 30.68 hours (*SD* = 75.29) before the deadline (predicted average completion time for those 11 participants had been 42.27 hours (*SD* = 29.53) before the deadline). The average estimation bias for the 11 participants that completed both sessions was 11.59 hours (*SD* = 87.09), meaning those 11

participants expected to submit 42.27 hours before the deadline but actually submitted 30.86 hours before the deadline.

Because the two year groups seemed to differ in their predicted and actual submission time, year group was entered as a between-subject variable into the subsequent analysis. A repeated-measures ANOVA was performed for the completion times (predicted vs. actual) for the two year groups. It was found that the predicted and actual completion times were significantly different $F(1,19) = 4{,}452$, $p = .048$, ${}_p\eta^2 = .190$, 90%CI [0.001, 0.410]. There was no effect of year group and surprisingly there was also no significant interaction between year group and completion times (predicted vs. actual) (all Fs < .2.171, all ps > .157). The predicted and actual completion times did also not significantly correlate (Pearson's correlation analysis) with each other ($p = .996$).

Time Estimation and Control Ratings

There was no relationship between predicted completion times, actual completion times or estimation bias (actual-predicted completion times) and any of the collected control ratings. Pearson's correlations were computed for the relationship between predicted completion times, actual completion times, estimation bias and the six control ratings, total control (before & after deadline), average helper control (before & after deadline) and average hinderer control (before & after deadline). No significant correlations were found (all ps > .144).

The data set was then split into two groups, those participants that submitted their thesis earlier than they had expected (pessimistic bias) and those that submitted later than they had expected (optimistic bias). The two participants that submitted exactly at their predicted time were excluded from the analysis, as their sample size would have been too small for the analysis. Of interest was if participants that were optimistically biased in their completion time predictions would have different total control ratings (before vs. after the deadline) and average helper and hinderer control ratings (before vs. after the deadline) as compared to participants that were pessimistically biased in their completion time predictions.

When comparing total control ratings before and after the deadline for participants that were pessimistically biased (i.e. submitted their thesis earlier than they had expected) and those who were optimistically biased (i.e. submitted their thesis later than they had expected), it was found that those participants that had been pessimistic in their completion time predictions had lower total control ratings before the deadline as compared to after the deadline (see Table 15). Total control ratings did not differ before and after the deadline for participants that had been optimistic in their completion time predictions (see Table 15). This was confirmed by a 2x2 mixed-model repeated-measures ANOVA that investigated total control ratings before and after the deadline as a function of bias (optimistic vs. pessimistic). This analysis found a significant Bias x Time interaction $F(1,17) = 4.707$, $p = .045$, ${}_p\eta^2 = .217$, 90% CI [.003, 445]. All other effects were non-significant (all Fs < .2.974, all ps > .103).

Furthermore, it was found that helpers were generally rated as less controllable before as compared to after the deadline (see Table 15). This was confirmed by a 2x2 repeated-measures ANOVA testing the difference between average helper control ratings before and after deadline as a function of bias (optimistic vs. pessimistic). This analysis found a main effect of time (before vs. after the deadline) $F(1,17) = 5.957$, $p = 0.26$, ${}_p\eta^2 = .259$, 90% CI [.019, .480]. None of the other effects were significant (all *F*s <.867, all *p*s > .365). No difference between average control ratings for helpers and hinderers, before and after the deadline, was found for participants that had been pessimistic or optimistic in their task completion estimates (see Table 15). This was confirmed by a 2x2 repeated-measures ANOVA testing the difference between average hinderer control ratings before and after the deadline as a function of bias (optimistic vs. pessimistic), which found no significant effects (all *F*s > .341, all *p*s > .567).

Table 15. *Showing average total control, helper control and hinderer control ratings before and after the deadline as a function of time estimation bias (optimistic vs. pessimistic). SD in brackets.*

	Control Total		Helper Average		Hinderer Average	
Deadline	Before	After	Before	After	Before	After
Pessimistic	50.00 (24.495)	76.25 (17.017)	50.75 (5.620)	64.00 (7.659)	40.75 (17.153)	39.00 (8.406)
Optimistic	71.00 (14.417)	68.00 (24.770)	46.33 (17.747)	52.53 (18.5904)	39.00 (8.406)	39.00 (8.406)

Time, Control and Individual Difference Measures

There was no relationship between the individual difference measure of desirability of control and the predicted completion times, actual completion times, estimation bias or any of the control ratings. All Pearson's correlations showed non-significant results (all *p*s> .429).

Helper and Hinderer Categories and Control Measures

All the helpers and hinderers that participants stated were split into two overarching categories – internal vs. external, following attribution theories such as Weiner (1980). Because the different types of helpers and hinderers people listed were of interest in this experiment in terms of their associated control ratings, the two overarching categories were further subdivided. The internal category was split into action and mental and the external category was split into people, work and circumstances. Two experimenters scored the categories independently, they agreed on 84.5% of the categorizations. Where there was a conflict in categorization this was resolved through discussion and a consensus was found. The frequencies (in %) of the five helper and hinderer categories before (BD) and after (AD) the deadline can be seen in Table 16 below.

Table 16. *Frequencies of reported helpers and hinderers (before and after the deadline) as a function of category (internal mental, internal action, external people, external work, external circumstances).*

		Helper		Hinderer	
		BD	AD	BD	AD
Internal	Mental	28.57 %	19.04 %	28.57%	28.57%
	Action	22.29 %	21.90 %	6.29 %	3.81 %
External	People	25.14 %	33.33 %	17.71 %	17.14 %
	Work	7.43 %	8.57 %	13.14 %	17.14 %
	Circumstances	16.57%	17.14 %	34.28%	33.33 %

A univariate 2x2x5 ANOVA was carried out investigating the effect of helpers vs. hinderers, before vs. after the deadline and the five categories (internal mental, internal action, external people, external work, external circumstances) on control ratings. It was found that there was a significant main effect of helpers vs. hinderers $F(1,540) = 29.181$, $p < .001$, ${}_p\eta^2 = .051$, 90%CI [0.025, 0.084], with helpers having higher average control ratings ($M = 56.385$, $SEM = 29.634$), than

hinderers (M = 41.761, SEM = 34.872). Furthermore, there was a main effect of category $F(4,540) = 50.161$, $p < .001$, ${}_p\eta^2 = .271$, 90%CI = [0.216, 0.316]. There was no difference between control ratings for helpers and hinderers before or after the deadline and none of the interactions was significant (all Fs < 1.766, all ps >. 184).

The average control ratings for the five helper and hinderer categories can be seen in Figure 24 below. To further investigate the main effect of category and compare the individual categories to each other pairwise comparisons (with Bonferroni-adjusted 95% confidence intervals and p-values) were analysed. When investigating the internal categories it was found that the internal action category had significantly higher control ratings than all the external categories (people, work and circumstances) (all ps ≤ .001). The internal action category had control ratings that were at least 24.56, 95% CI [9.339, 39.782] points on the control rating scale higher than the three external categories. However, it was not significantly different from the internal mental category (p = .874). The internal mental category also had significantly higher control ratings than all the external categories (people, work and circumstances) (all ps < .001). The internal mental category had control ratings that were at least 16.47, 95% CI [4.792, 28.150] points on the control rating scale higher than the three external categories. Lastly, it was found that the external people and external circumstances categories had the lowest control ratings, lower than the external work category (all ps < .002). The external people and circumstances categories had control ratings that were at least 15.68, 95% CI [3.832, 27.528] points on the control rating scale lower than the external work category. The external people

and circumstances categories were not significantly different from each other (p > .9).

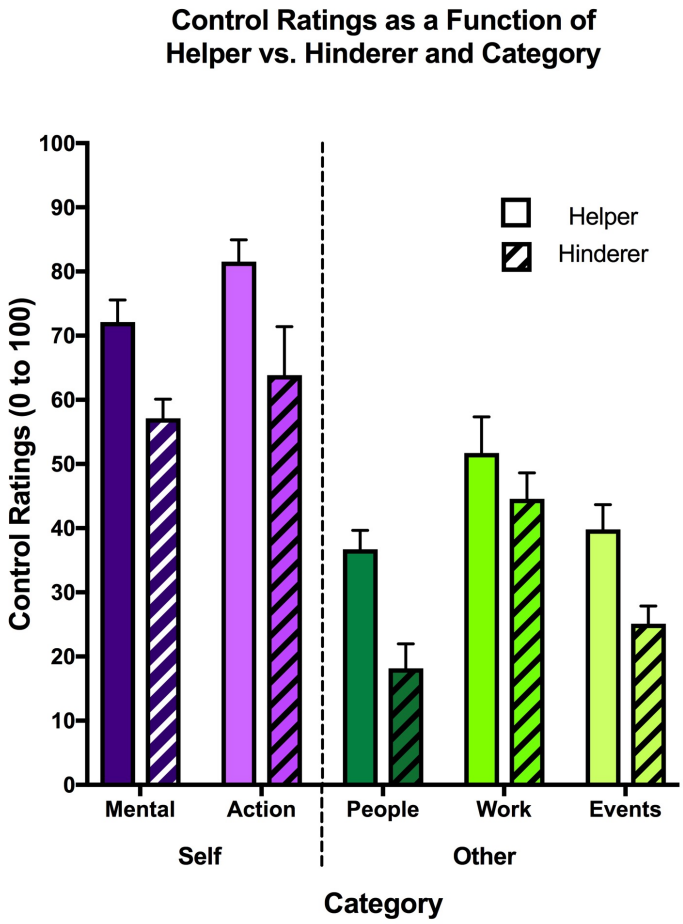

Figure 24. Showing control ratings (0-100) for the reported helpers and hinderers as a function of category (internal mental, internal action, external people, external work, external circumstances/events). Error bars = SEM.

Discussion

Experiment 8 was the first experiment to investigate the relationship between future task completion time estimates and the perception of control in the context of real-life tasks. This experiment confirmed the general tendency of people to underestimate their future completion times. This was shown by the

fact that undergraduates predicted finishing their thesis sooner than they actually did. This is in accordance with previous research that reported future task completion time underestimations for academic tasks (Buehler et al., 1994; Newby-Clark et al., 2000; Buehler & Griffin, 2003; Sanna & Schwarz, 2004; Sanna et al., 2005; Peetz et al., 2010; Buehler et al. 2012; Min & Arkes, 2012; Wiese et al, 2016).

When investigating how the perception of control related to completion time estimates in relation to Hypothesis 2, it was found that participants who were pessimistically biased (i.e. submitted their thesis earlier than they had expected) had lower total control ratings before the deadline as compared to after the deadline. Participants who were optimistically biased (i.e. submitted their thesis later than they had expected) did not differ in their total control ratings before or after the deadline. However, no other relationship between the reported control perceptions and the completion time estimates was found.

Furthermore, when investigating the control ratings for the helpers and hinderers that participants reported for finishing their thesis at their predicted time, it could be seen that participants generally rated their control as higher over helpers than over hinderers. For those participants who completed both sessions, it was also found that they rated their control over helpers before the deadline lower than after the deadline. However, no direct support was found for Hypothesis 4, which stated that participants who perceived themselves to be more in control over facilitating (helpers) and especially preventative factors (hinderers) would predict shorter task completion times. Furthermore, no

support for Hypothesis 6 was found, that predicted a relationship between the individual-difference factor desirability of control and task completion time estimates. Furthermore, no relationship between desirability of control and any of the control perception measures was found.

When splitting helpers and hinderers into five categories, two relating to the participants themselves (internal) and three relating to external factors, it could be seen that the highest control ratings were for helpers and hinderers in the internal categories. These were higher than the control ratings of all the external categories. It is interesting to note that before the deadline, most of the helpers mentioned belonged to the internal mental, internal action and external people categories, each representing approximately 1/4th of the total reported helpers. After the deadline, most helpers mentioned belonged to the internal action (1/4th) and external people (1/3rd) categories. The least mentioned category for helpers (before and after the deadline) was the external work (or absence of other work) category (approx. 8%). For the hinderers, it was found that most of the mentioned items (before and after the deadline) belonged to the internal mental and external circumstances categories, approx. 1/3rd each. Internal action was the least mentioned category of hinderers (before and after the deadline) with only 5% of mentions.

Experiment 9

Introduction

This experiment followed on from Experiment 8 in investigating the same hypotheses. However, of interest was whether the results would be the same for self-selected tasks, of academic and non-academic nature with external and self-imposed deadlines. This followed earlier research that found future task completion time underestimation for both academic (Buehler et al., 1994; Newby-Clark et al., 2000; Buehler & Griffin, 2003; Sanna & Schwarz, 2004; Sanna et al., 2005; Peetz et al., 2010; Buehler et al. 2012; Min & Arkes, 2012; Wiese et al, 2016) and non-academic tasks (Buehler & Griffin, 2003; Kruger & Evans, 2004; Peetz et al., 2010; Min & Arkes, 2012; Buehler et al., 1997; Newby-Clark et al., 2010; Kruger & Evans, 2004).

As in Experiment 8 it was tested in the current experiment whether people who perceived more control over their timely task completion would be more prone to underestimating their task completion times (Hypothesis 2). Furthermore, it was predicted that people who rate their control over facilitating and preventative factors higher would be more prone to underestimating their task completion times (Hypothesis 4). It was also of interest how individual difference measures, such as the desire for control and intolerance of uncertainty, would relate to control perceptions and task completion time estimates (Hypothesis 6). It was predicted that participants with higher desire for control and higher intolerance of uncertainty would predict shorter task

completion times (see Halkjelsvik et al., 2012) than people with low scores on these measures. Furthermore, this study introduced a computerised contingency task, similar to the uncontrollable tasks used in previous chapters, to investigate whether participants' control perceptions over an uncontrollable experimental tasks would be related to their control ratings of the real-life task and their completion time estimates for the real-life task.

Methods

Participants

Participants were volunteers recruited from the general and university student population. In this experiment 119 participants took part in session one (before the deadline) and 95 participants returned for session two (after the deadline), which represented an 80% response rate. Of these participants 18 were part of a practical psychology class and completed the study as part of their course requirements. 12 participants had to be deleted from the data set due to incomplete or inadequate answering of the online questionnaires. A further 12 were deleted because their deadline had been externally changed between session one and session two and lastly 5 more participants had to be excluded from the data set because they did not finish their selected task by the time they completed session two. The remaining data set consisted of 90 participants who completed session one (66 of which also completed session two – response rate of 73%) with an average age of 22.37 years (*SD* = 8.68 years). Of these

participants 56 were female and 34 were male. Furthermore 83 were undergraduate students and 7 were non-students.

Materials

This online questionnaire was created using the Lime Survey (version 3.0) software. The online computerised task was created using the Gorilla Experiment Builder (www.gorilla.sc) (Anwyl-Irvine, Massonnié, Flitton, Kirkham & Evershed, 2018). The questionnaire was distributed using a direct link to the study.

Measures

Two similar questionnaires were used as in Experiment 8 (see Appendix C). However, for this experiment the tasks for which the completion times had to be estimated were self-selected. This meant that in the questionnaire in session one participants had to indicate a task for which they had an upcoming deadline in the next two weeks. There was no restriction on the type of deadlines. Participants had to indicate the deadline type (e.g. tutorial assignment, visa application). Furthermore, they stated the deadline task, i.e. what they had to do for the deadline (e.g. read articles and write essay, fill out online visa forms). They then indicated if the deadline was of academic or non-academic nature and if a deadline had been self-imposed or externally imposed. In the second part of the questionnaire participants indicated what date and time the deadline for their chosen task was. The rest of the questionnaire was the same as in Experiment 8. The questionnaire in session two was again very similar to the one in Experiment 8. However, at the beginning of the questionnaire participants

were asked to re-state the deadline type and deadline task that they had chosen. This was intended as a memory-check to make sure that participants remembered what task they had chosen in session one (participants would have been deleted if their two task did not match up, however that was not the case for anyone). Furthermore, participants had to re-state when their deadline had been, again this was intended as a memory-check. Then participants were asked if their deadline had externally been changed. The rest of the questionnaire was the same as in Experiment 8.

The desirability of control scale (Burger & Cooper, 1979) was used to measure how much control participants desire in their everyday life (see Appendix E). The 20 items of this scale had a good internal consistency for the sample in this experiment, $\alpha = .82$. Furthermore, the intolerance of uncertainty scale (Freeston et al., 1994; Buhr & Dugas, 2002) was used to measure intolerance to uncertainty in everyday life (see Appendix F). The 27 items of the IoU scale had a good internal consistency in this experiment, $\alpha = 95$.

Design

As in Experiment 8, this study used a longitudinal (two-session) correlational design that was non-experimental but quantitative and qualitative. Different measures were collected at session one and at session two. In session one the measures collected were: deadline type, deadline task, deadline time at session one (deadline1), predicted submission time (predicted time), total control rating, 5 helpers and helpers control ratings, 5 hinderers and hinderers control ratings, and desirability of control scale scores. In session two the following measures

were collected: deadline type, deadline task, deadline time at session two (deadline 2), actual submission time (actual time), total control rating, 5 helpers and helpers control ratings, 5 hinderers and hinderers control ratings, and intolerance of uncertainty scale scores.

Lastly, participants performed an online version of the contingency task described in Chapter 2 and Chapter 3. They were presented only with one condition of a zero contingency (ΔP = 0) with 40 trials (see Table 17). The trials were 6 seconds long and consisted of a 1 second fixation cross, 3 second response window, 1 second outcome presentation and 1 second ITI.

ΔP = 0	Outcome	No Outcome	
Action	15	5	P(O|A) = .75
No action	15	5	P(O|noA) = .75

Table 17: Zero contingency task (ΔP = 0). Probability of outcomes as a function of action P(O|A) = .75 and probability of outcomes as a function of no action P(O|noA) = .75. Indicative trial numbers shown inside the table.

Procedure

Both questionnaires were administered online. In session one, participants received an information sheet, filled out a consent form and demographic data was collected. After this participants filled out the questionnaire described above and also completed the DoC scale. At the end of the online session they were given the option to leave additional comments about their deadline and were reminded that they would be contacted again in the week after their deadline. In the week after the deadline participants filled out the second questionnaire

described above and completed the IoU scale, after which they also had the opportunity to leave additional comments about their deadline. Lastly, participants were re-directed to an online version of the contingency task described in Chapter 2. The instructions were very similar to those in Experiment 2, slightly adapted for the online environment (see Appendix A). The main change was that participants only had to rate their perception of control at the end of the task but no time perception measure was taken. Furthermore a 0 to 100 control rating scale was used (see Appendix A). After this the participants were debriefed and thanked.

Results

Data Preparation

As the deadlines that participants reported in session one and session two did not match in many cases, it was decided to compute five time estimation measures. Firstly the estimation bias was calculated by taking the difference between predicted and actual completion times. Then the difference between predicted completion times and deadline1 (expressed in hours before/after the deadline), the difference between actual completion times and deadline 1 (expressed in hours before/after the deadline), the difference between actual completion times and deadline 2 were computed. Lastly, the difference between the two deadlines (with negative scores indicating that deadline 2 was earlier than deadline 1 and positive scores indicating that deadline 2 was later than deadline 1) was calculated.

Deadline reported in session 1 and deadline reported in session 2

When comparing the deadline dates and times that participants indicated in session one (deadline 1) of the study with those that they indicated in session Two (deadline 2), it was found that only 33.85% of participants reported the same deadline in both sessions and 66.15% of participants reported non-matching deadlines. Furthermore, of those that reported non-matching deadlines, 27.69% reported an earlier deadline the second time, and 38.46% reported a later deadline in session two of the study.

The deadline difference (deadline 1 vs. deadline 2) was split into three categories (deadline 2 same as deadline 1, deadline 2 earlier than deadline 1 and deadline 2 later than deadline 1). It could be seen that those whose deadline 2 was earlier than deadline 1, reported a deadline 2 on average as being 96.90 hours (SD = 128.674) earlier than deadline 1. Those who reported deadline 2 as being later than deadline 1, said that deadline 2 was on average 105.026 hours (SD = 81.148) later than deadline1. This difference between deadline 1 and deadline 2 was statistically significant, as confirmed by a univariate ANOVA $F(2,63) = 31.153$, $p < .001$, ${}_p\eta^2 = .497$, 90% CI [.175, .457].

Predicted and Actual Completion Times

It was found that the 90 participants who took part in session one chose tasks with deadlines that were on average 125.74 hours (SD = 93.710) away (approx. 5.2 days). They predicted finishing their task on average 21.92 hours (*SD* = 47.805) before the deadline 1, i.e. deadline they stated in session one. Those 66

participants that took part in session two actually finished on average 15.60 hours (*SD* = 114.692) later than deadline 1, i.e. the deadline they stated in session one (these 66 had an average completion time prediction of 23.84 hours (SD = 44.44) before the deadline). However, when investigating the difference between their actual task completion times in comparison to deadline 2 (the deadline stated in session two) it could be seen that participants' lateness was reduced, as they finished their tasks on average 'only' 2.08 hours (*SD* = 83.190) after deadline 2, i.e. the deadline they stated in session two. Furthermore, it could be seen that participants were optimistically biased in their predictions as they finished their task on average 39.45 hours (*SD* = 118.277) later than they had predicted.

That participants were optimistically biased was confirmed by a repeated-measures ANCOVA comparing the predicted submission times in relation to deadline 1 with the actual submission times in relation to deadline 1, which found that actual completion times were significantly later than predicted completion times $F(1, 63) = 5.561$, $p = .021$, ${}_p\eta^2 = .081$, 90%CI [.006, .200].

Two covariates were entered into this ANCOVA, the first was the distance of deadline 1 from the date of completing session one (deadline distance). Some studies (e.g. Peetz et al., 2010) suggest that people are more optimistically biased when predicting for tasks further in the future, hence we chose this variable as a covariate. The second covariate was the difference between deadline 1 and deadline 2, as we found was a significant difference between the two deadlines investigating this covariate was of interest. The ANCOVA found that there was a

significant main effect of the covariate deadline distance $F(1,63) = 10.683$, $p = .002$, ${}_p\eta^2 = .145$, 90% CI [.035, .275]. Furthermore, there was also a significant main effect of the covariate deadline difference $F(1,63) = 91.364$, $p < .001$, ${}_p\eta^2 = .592$, 90% CI [.455, .678]. Importantly, this main effect was qualified by a significant interaction between predicted and actual completion times and deadline difference $F(1, 63) = 32.097$, $p < .001$, ${}_p\eta^2 = .338$, 90% CI [.182, .463].

To investigate these significant covariates further, their effect on estimation bias (difference between predicted and actual completion times) was investigated. The deadline difference (deadline 1 – deadline 2) and deadline distance (time of questionnaire completion – deadline 1) variables were entered as predictors in a simultaneous multiple regression analysis. This regression analysis found that deadline difference was a significant predictor of estimation bias and accounted for 35% of the variance in estimation bias $R^2 = .37$, 90% CI [.198, .510] $F(2,63)=18.517$, $p<.001$. It was found that deadline difference significantly predicted estimation bias ($\beta = .576$, $p < .001$), but deadline distance did not ($\beta = -.116$, $p = .257$). The regression equation was: estimation bias = 31.22 + 0.61 x deadline difference, see Figure 25.

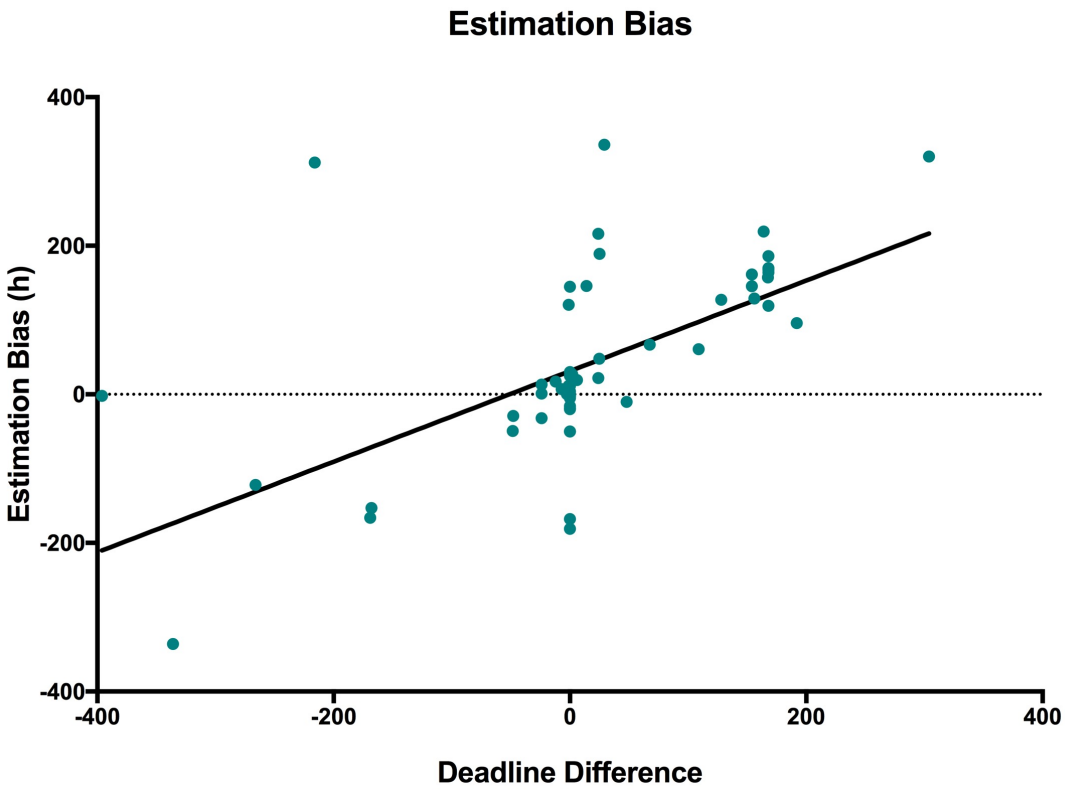

Figure 25. Estimation bias as a function of deadline difference. The line of best fit is plotted as predicted by the regression model.

The relationship between predicted and actual completion times was also investigated by testing their relationship in terms of correlations. It was found by computing Pearson's correlations that predicted and actual completion times (as compared to deadline 1) were not significantly correlated with each other (p = .371).

Time Perception Measures, Control Measures and Individual Difference Measures

The relationship between estimation bias and the other measures: total control ratings (before and after the deadline), helpers and hinderers control ratings (before and after the deadline), desirability of control scores, intolerance of uncertainty scores and control ratings in the zero contingency task was

investigated using Pearson's correlations. It was found that estimation bias was not correlated with the control ratings and individual difference variables collected (all *p*s > .104).

The data was then split into two groups, depending on the time estimation bias of the participants (pessimistic vs. optimistic). Two participants were removed from the analysis who submitted exactly at their predicted time as their sample size was too small for the analysis. It was investigated whether time estimation bias would have an effect on the control measures (total control rating, average helper control rating, average hinderer control rating) before and after the deadline. The three control measures did not differ for participants who were optimistically or pessimistically biased before or after the deadline (see Table 18). This was confirmed by performing three 2x2 mixed-model repeated-measures ANOVAs, which found no significant effect of estimation bias on any of the three control measures, nor difference between control ratings before or after the deadline (all *F*s < 1.807, all *p*s > .184).

Table 18. *Showing average total control, helper control and hinderer control ratings before and after the deadline as a function of time estimation bias (optimistic vs. pessimistic). SD in brackets.*

	Control Total		Helper Average		Hinderer Average	
Deadline	Before	After	Before	After	Before	After
Pessimistic	83.8	81.72	68.73	62.42	46.98	49.42
	(12.271)	(17.542)	(16.302)	(16.907)	(15.544)	(19.287)
Optimistic	79.1	77.95	64.01	64.51	43.48	45.53
	(16.333)	(15.505)	(18.167)	(16.387)	(15.933)	(17.563)

Time, Control and the Contingency Task's Control Ratings

No relationship between the time estimation measures, the control perception measures and the ratings of control in the contingency task were found; all Pearson's correlations were non-significant (all *p*s > .077.). When splitting the participants into those with an optimistic and those with a pessimistic time estimation bias no significant difference between their control ratings (see Table 19) of the zero contingency task was found as analysed by independent-sample t-tests (p = .313).

Table 19. *Average contingency task (ΔP = 0) control ratings as a function of time estimation bias. SD in brackets.*

ΔP = 0	Contingency Task Control Rating
Pessimistic	36.77 (25.246)
Optimistic	26.96 (28.792)

Helpers and Hinderers and their Associated Control Ratings

As in the previous experiment the helpers and hinderers that participants stated were then split into five categories: internal mental, internal action, external people, external work, external circumstances. Two experimenters scored the categories independently, they agreed on 84.6% of the categorizations. Where there was a conflict in categorization this was resolved through discussion and a consensus was found.

The frequencies (in %) of the five helper and hinderer categories before (BD) and after (AD) the deadline can be seen in Table 20 below.

Table 20. *Frequencies of reported helpers and hinderers (before and after the deadline) as a function of category (internal mental, internal action, external people, external work, external circumstances).*

		Helpers		Hinderers	
		BD	AD	BD	AD
Internal	Mental	26.96 %	29.41 %	30.22 %	34.12 %
	Action	40.43 %	35 %	17.61 %	20.30 %
External	People	7.61 %	11.47 %	8.26 %	8.53 %
	Work	4.13 %	4.71 %	13.91 %	12.94 %
	Circumstances	20.87 %	19.41 %	30 %	24.12 %

As in Experiment 8, a 2x2x5 univariate ANOVA was carried out assessing the effect of helpers vs. hinderers, before vs. after the deadline and the five categories (internal mental, internal action, external people, external work, external circumstances) on control ratings. This analysis showed that there was a significant main effect of helpers vs. hinderers $F(1,1580) = 33.753$, $p < .001$, ${}_p\eta^2 = .021$, 90%CI [.011, .034] , with helpers having significantly higher control ratings, see Figure 26. There was furthermore a significant main effect of category $F(4, 1580) = 109.500$, $p < .001$, ${}_p\eta^2 = .217$ 90%CI [.508, .712]. And importantly there was a significant Helper/Hinderers x Category interaction $F(4,1580) = 3.343$, $p = .010$, ${}_p\eta^2 = .008$, 90%CI [.001, .015].

To explore this interaction further simple main effects were computed (Bonferroni corrected). There was a significant simple main effect of category on the control ratings of the hinderers $F(4,1580) = 62.593$, $p < .001$, ${}_p\eta^2 = .137$, 90%CI [.110, .160] and also a significant simple main effect of category on the control ratings of the helpers $F(4,1580) = 53.990$, $p < .001$, ${}_p\eta^2 = .120$, 90%CI [.095, .144]. When looking at the effect of hinderers vs. helpers at each of the five

categories it was found that the simple main effect of helpers vs. hinderers was significant in internal action $F(1, 1580) = 35.753$, $p < .001$, $_p\eta^2 = .022$, 90%CI [.012, .036] and internal mental categories $F(1, 1580) = 22.819$, $p < .001$, $_p\eta^2 = .014$, 90%CI [.006, .025] and also in the external circumstances category $F(1, 1580) = 32.508$, $p < .001$, $_p\eta^2 = .20$, 90%CI [.010, 033]. There was no significant effect of helpers vs. hinderers on control ratings in the external people and circumstances categories (all *F*s < 3.848, all *p*s > .05).

To investigate the significant interaction further, pairwise comparisons were analysed exploring how control ratings differed at each level of category for helpers vs. hinderers. It was found that in the helper category the internal categories differed significantly from all the external categories (all *p*s < .001). As can be seen in Figure 27 the two internal categories were associated with at least 20.748, 95% CI[6.601, 34.896] higher scores on the control rating scale than the three external categories. Furthermore, the internal action category had significantly higher [13.99, 95%CI (20.907, 7.072)] control ratings than the internal mental category ($p < .001$). However, the three external categories were not significantly different from each other in relation to their control ratings (all *p*s > .9)

When investigating the hinderer categories, it was found (as illustrated in Figure 26) that the internal action category had at least 15.891, 95% CI [7.885, 23.896] higher control ratings than all other categories, including the internal mental category. These differences were all significant (all *p*s > .001). It was also found that the internal mental category had at least 16.368, 95% CI [5.638, 27.097]

significantly higher control ratings than the external people and external circumstances categories (all *p*s < .001), but was not significantly different from the external work category (*p* > .9). When investigating the three external categories it could be seen that external work was associated with at least 15.201, 95% CI [2.995, 27.407] significantly higher control scores than the external people and external circumstances categories (all *p*s < .005), which did not significantly differ from each other (*p* > .9).

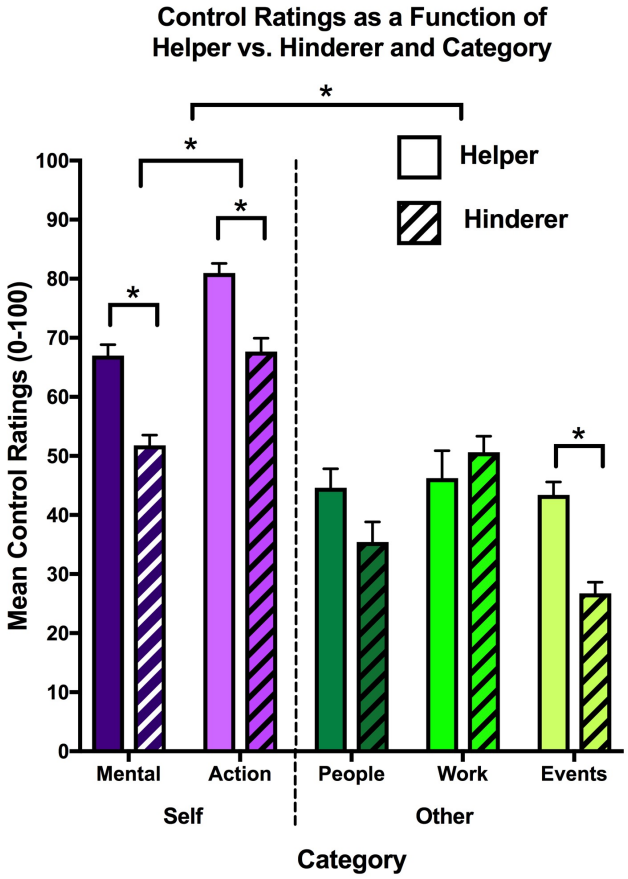

Figure 26. Showing control ratings (0-100) for the reported helpers and hinderers as a function of category (internal mental, internal action, external people, external work, external circumstances/events). Error bars = SEM.

Discussion

Experiment 9, which looked at a variety of different deadline types, also found significant future task completion time underestimations, meaning that most participants underestimated how long their task completion would take them. This is in line with previous research that found similar effects for both academic (Buehler et al., 1994; Newby-Clark et al., 2000; Buehler & Griffin, 2003; Sanna & Schwarz, 2004; Sanna et al., 2005; Peetz et al., 2010; Buehler et al. 2012; Min & Arkes, 2012; Wiese et al, 2016) and non-academic tasks (Buehler & Griffin, 2003; Kruger & Evans, 2004; Peetz et al., 2010; Min & Arkes, 2012; Buehler et al., 1997; Newby-Clark et al., 2010; Kruger & Evans, 2004).

Surprisingly, participants struggled to recall the precise deadline that they mentioned in session 1 when they were asked to report their completion times in session 2. This erroneous memory was found for 66% of the participants and was present even though they correctly recalled the type of task for which they had the deadline. It should be noted that almost one-third of participants reported an earlier deadline in session 2, and slightly over one-third of participants reported a later deadline in session 2 than in session 1. It was therefore found that estimation bias was also linked to these differences in reported deadlines.

Contrary to the findings of Experiment 8, optimistic vs. pessimistic time estimation bias was not linked to total control perception or control over helpers or hinderers. This goes against Hypothesis 2 that predicted participants with higher control perceptions over the timely completion of the task would predict

shorter task completion times than participants with lower control perceptions. Furthermore, the results of this experiment also did not find evidence in support of Hypothesis 4 that predicted higher control perceptions over helpers and especially over hinderers would lead to shortened task completion time estimates. Lastly, Hypothesis 6 was also not supported by the results of this experiment, as no relationship between the individual differences measures desirability for control and intolerance of uncertainty, future task completion time perceptions or any of the control measures was found.

When looking at the reported helpers and hinderers – split into the same five categories as in Experiment 8 – it was found that control ratings were higher for helpers in comparison to hinderers. Furthermore, it was found that for helpers, the two internal categories had higher control ratings than all the external categories, and furthermore, the internal action category had higher control ratings than the internal mental category. The three external categories did not differ in their control ratings. For the hinderers, the internal action category had higher control ratings than all the other four categories, including internal mental. The internal mental category had higher control ratings than the external people and external circumstances categories, but did not differ from the external work category. The external people and external circumstances categories had the lowest control scores, lower than the external work category. When looking at the difference between helper and hinderer control scores, it was found that helpers had significantly higher control ratings in the internal mental, internal action and external circumstances categories.

Furthermore, it was found that most helpers (before and after the deadline) belonged to the internal mental (approx. 28%) and internal action (over 1/3rd) categories. The fewest helpers mentioned were in the external people (9.5%) and external work (4.5%) categories. When looking at the reported hinderers (before and after the deadline), most of them belonged to the internal mental (1/3rd) and external circumstances (1/4th) categories. The fewest hinderers were in the external people category (8.5%).

Experiment 10

Introduction

This experiment investigated the hypothesis (Hypothesis 5) that task completion time predictions would be influenced by the type of information considered before making the prediction. Following on from previous research (Sanna & Schwarz, 2004; Sanna et al., 2005) it was proposed that participants who were made to think about impeding factors before making completion time predictions would be less prone to underestimating their completion times as compared to participants who had to think about facilitating factors (Hypothesis 5). A difference in the perception of control over these facilitating and impeding factors was expected, with helpers being rated as more controllable than hinderers. Furthermore, in this experiment it was investigated what relationship prediction accuracy of helpers and hinderers would have with future task completion time estimates and control ratings. In order to explore this relationship participants had to indicate after task completion which of the

predicted helpers/hinderers had actually occurred. As in the previous experiment it was investigated whether the individual difference variables desirability of control and intolerance of uncertainty would be related to completion time estimates. Following previous research (Halkjelsvik et al., 2012) it was predicted that participants high in desire for control and intolerance of uncertainty would predict shorter task completion times than people higher on these individual-difference variables (Hypothesis 6). Lastly, as in Experiment 9, it was of interest whether perception of control in an uncontrollable experimental task would be related to perceptions of control in the real-life task and to real-life completion time estimates.

Methods

Participants

This experiment followed a pilot study that was conducted with master's students during a class on research-methods. This pilot study included 48 participants who performed the first session of the online experiment. Following this pilot study, 38 participants were recruited. These participants were all first year undergraduates reading experimental psychology and were offered course credits for their participation. Of the sample, 28 participants were female and 10 were male. The average age was 18.71 years (*SD* = 0.73). 27 of these participants also completed the second part of this experiment after the deadline, which is a 71% response rate.

Materials

The online questionnaire was created using the Gorilla Experiment Builder (www.gorilla.sc) (Anwyl-Irvine et al., 2018). The questionnaire was distributed using unique participation links.

Measures

Two questionnaires were used in this experiment. The first questionnaire, which was used in session one, was similar to those in session one of the previous two experiments, but a few changes were introduced. In this experiment the undergraduate students had to pick an essay deadline that was coming up in the next two weeks. Participants first had to indicate when their essay deadline was before completing a similar questionnaire to the one described Experiment 8. The main difference in the questionnaire was that the measure of helpers and hinderers was collected *before* task completion time estimates were given. Furthermore, participants were split into two groups. The first group only had to indicate helpers and the other group only had to indicate hinderers. Furthermore, a short additional questionnaire was added in which participants had to respond to further questions. These questions related to: the number of other essays/assignments they were currently working on, the amount of external pressure to complete the essay by the deadline (scale: 0-100), the amount of internal pressure to complete the essay by the deadline (scale: 0-100), the priority of this essay as compared to their other essays/submissions (scale: 0-100), their interest in the topic of the essay (scale: 0-100), how prone they usually were to procrastination (scale: 0-100), and how likely they felt they were to procrastinate during the completion of the current essay (scale: 0-100).

The questionnaire can be found in Appendix C. The desirability of control scale (Burger & Cooper, 1979) was used to measure how much control participants desired in their everyday life (see Appendix E). The 20 items of this scale had an acceptable internal consistency in the sample of this experiment, $\alpha = .72$.

The questionnaire in session two was different from those in the previous experiments. In the first part participants were shown the deadline they had indicated in session one. Participants had to indicate whether they had submitted their essay and if so what date and time they had submitted it. Furthermore, they had to indicate whether their initial deadline had changed. Participants were then asked to rate the total amount of control they felt they had had over submitting their essay at their predicted time. After this, depending on which group they had been in, participants were shown the five helpers or five hinderers that they had stated in session one and had to indicate whether each of them had indeed helped/hindered them to submit at their predicted time (yes/no answer). Participants were given the opportunity to leave additional comment about their deadline. The questionnaires can be found in Appendix C. Lastly, the intolerance of uncertainty scale (Freeston et al., 1994; Buhr & Dugas, 2002) was used to measure intolerance to uncertainty in everyday life (see Appendix F). In this study, the 27 items of the IoU scale showed good internal consistency, $\alpha = .94$.

Design

The variables that were measured for all participants in this experiment were their predicted submission times and their total control perception over

submitting their assignment at their predicted time (scale: 0-100). The variable that was manipulated between-participants in this experiment was whether participants had to report things that would help vs. things that would hinder them to submit their essay at their desired time. Participants in the helper group had to list the five things that were most likely to help them submit at their desired time and indicate how much control they felt over these helpers (scale: 0-100). Participants in the hinderer group had to list the five things that were most likely to hinder them to submit at their desired time and rate their control (scale: 0-100) over the hinderers.

In session two after the deadline participants had to indicate their actual submission times and also whether the helpers or hinderers that they had indicated in session one had actually contributed to their submission. Furthermore, following the procedure of Experiment 9, session two also included the intolerance of uncertainty scale and the short online contingency task. As in Experiment 9 participants were presented only with one condition of a zero contingency ($\Delta P = 0$) with 40 trials (see Table 21). The trials were 6 seconds long and consisted of a 1 second fixation cross, 3 second response window, 1 second outcome presentation and 1 second ITI. After performing this experimental task control ratings (0-100) were collected.

ΔP = 0	Outcome	No Outcome	
Action	15	5	P(O|A) = .75
No action	15	5	P(O|noA) = .75

Table 21: Zero contingency task (ΔP = 0). Probability of outcomes as a function of action P(O|A) = .75 and probability of outcomes as a function of no action P(O|noA) = .75. Indicative trial numbers shown inside the table.

Procedure

There were two sessions in this experiment that were completed online 20 days apart. In session one participants received an information sheet and filled out a consent form, after which their demographic data was collected. Following this, participants completed the questionnaire described above. In the last part of session one participants completed the desire of control scale. At the very end of the online session they were given the option to leave additional comments about their deadline and were reminded that they would be contacted again in the week after their deadline. Session two took place 20 days after session one. The questionnaire described above was administered followed by the IoU scale. At the end participants were re-directed to an online version of the same contingency task as in Experiment 9. After this participants were de-briefed and thanked.

Results

Data Preparation

Extreme outliers were calculated for the predicted submission times using the inter quartile range (IQR) as follows: $x_1 \geq Q3 + 3 \times IQR$ & $x_1 \leq Q1 - 3 \times IQR$. Following this three participants were excluded from the analysis. Furthermore, two participants had to be excluded because their deadline had changed between session one and session two. And one participant had to be excluded because they did not follow the instructions correctly.

Predicted and Actual Submission Times

Participants chose essay deadlines that were on average 94.10 hours away (*SD* = 61.871) (approx. 3.9 days). They predicted to finish their essay on average 18.93 hours (*SD* = 34.39) before their deadline. For the 27 participants that took part in the second part of this study and reported their actual completion times, the average completion time was 13.24 hours (*SD* = 19.64) before their deadline. Participants in the helper group predicted to finish their essays on average 18.54 hours (*SD* = 45.028) before the deadline; their actual completion times were on average 9.12 hours (*SD* = 14.080) before the deadline. Participants in the hinderer group predicted to finish their essays on average 19.24 hours (*SD* = 24. 614) before the deadline and actually finished 17.173 hours (*SD* = 23.643) before the deadline.

To investigate the relationship between the predicted and actual submission times three time measures were calculated. As each participant had a different

deadline, the difference between predicted submission times and the deadline (hours before/after deadline), the difference between actual submission time and the deadline (hours before/after deadline) and the difference between predicted and actual submission times (prediction bias) were calculated. A repeated-measures 2x2 ANOVA was performed comparing predicted and actual submission times for the helper and hinderer groups. It was found that the predicted and actual submission times did not differ significantly from each other. Furthermore there was no main effect of group (helper vs. hinderer) and no significant interaction (all Fs < 1.563, all ps > .226). Furthermore, it was found that predicted and actual submission times were significantly correlated with each other, which was confirmed by computing their Pearson's Correlation coefficient, $r(21) = .837$, $p < .001$.

The effect of Helper and Hinderer occurrence on Predicted and Actual Submission Times and Control Ratings

In the second session participants were presented with the five helpers or five hinderers (depending on their group) that they had reported in the first session and had to say if these had actually influenced whether they had finished their essay at their predicted time. For each participant the percentage of helper/hinderers that were predicted and had actually occurred was computed. It was analysed whether participants that had pre-empted the possible helpers or hinderers more accurately would be also more accurate in their completion time predictions. Furthermore, of interest was whether these participants would differ in their control ratings from participants that miss-judged what helpers or hinderers would occur. Percentage correctly predicted helpers/hinderers was

not correlated, as analysed using Pearson's correlation, with estimation bias or the total control rating difference (before vs. after the deadline) (all *p*s > .424).

Time Perception Measures and Control Measures

The data was then split into two groups, depending on time estimation bias of the participants (pessimistic vs. optimistic). Of interest was whether participants who had been optimistically biased in their time predictions would have different total control ratings and different average helper/hinderer control ratings as compared to participants who had been pessimistically biased in their time predictions. In this experiment participants were also split into helper and hinderer groups. It was found that time estimation bias had no effect on the total control ratings, as can be seen in Table 22 below, average total control ratings were not different for the optimistic and pessimistic participant groups nor between the helper and hinderer groups nor before or after the deadline. This was confirmed with a 2x2x2 repeated-measures ANOVA that showed no significant main effects or interactions (all *F*s < 2.670, *p*s > .121).

Table 22. *Showing average total control ratings before and after the deadline as a function of time estimation bias (optimistic vs. pessimistic). SD in brackets.*

	Helper Group		Hinderer Group	
	Before	After	Before	After
Pessimistic	83.40 (14.311)	73.60 (26.444)	93.00 (7.211)	93.67 (7.767)
Optimistic	84.40 (25.036)	74.60 (22.865)	71.13 (27.357)	78.88 (20.622)

The effect of time estimation bias on average helper vs. hinderer control ratings was also analysed. As can be seen in Table 23 below, the only effect was that of

helper vs. hinderer group, with participants in the helper group judging their control over helpers higher than participants in the hinderer group judged their control over hinderers. However, there was no effect of time estimation bias on average helper and hinderer control ratings. This was confirmed by a univariate ANOVA looking at the effect of the between-subjects factors time estimation bias (pessimistic vs. optimistic) and group (helper vs. hinderer) on average helper/hinderer control ratings. This analysis showed a significant main effect of helper vs. hinderer group $F(1, 17) = 5.241$, $p = .035$, ${}_p\eta^2 = .236$. The main effect of estimation bias and the interaction were not significant (all Fs < 1.630, all ps > .219).

Table 23. *Showing average total control ratings before and after the deadline as a function of time estimation bias (optimistic vs. pessimistic). SD in brackets.*

	Helpers	Hinderers
Pessimistic	66.12 (20.19)	59.40 (15.373)
Optimistic	77.64 (3.057)	53.98 (13.877)

Predicted and Actual Submission Times and the other collected measures

The relationship between the three time perception measures and the other measures collected in this experiment were investigated using Pearson's correlations, which were performed separately for the participants in the helper and hinderer groups. It was found that in the helper group predicted submission times were significantly positively correlated with reported interest in the topic $r(14) = 576$, $p = .031$. Given that the predicted completion times were converted to hours before/after the deadline, this positive correlation indicates that participants who reported being more interested in the topic of the essay

predicted to finish later. In the hinderer group it was found that the prediction bias measure (actual-expected submission times) was significantly negatively correlated with reported external pressure $r(11) = -682$, $p = .021$. This negative relationship indicates that participants who reported being under more external pressure tended to finish at their predicted time or earlier than they had predicted and participants that reported being under less external pressure tended to finish later than they had predicted. Furthermore, there was a significant positive correlation $r(11) = .692$, $p = .018$, between prediction bias and priority ratings of the essay. This indicates that participants who rated the essays as being high priority finished the essay later than they had predicted and participants who rated the essay as being low priority tended to at their predicted time or earlier. The time measures did not correlate with any of the other measures taken in this experiment.

Time, Control and the Contingency Task's Control Ratings

No relationship between the time estimation measures, the control perception measures and the ratings of control in the contingency task were found; all Pearson's correlations were non-significant (all *p*s > 312.). When splitting the participants into those with an optimistic and those with a pessimistic time estimation bias no significant difference between their control ratings (see Table 24) of the zero contingency task was found as analysed by a independent-sample t-test ($p = .834$).

Table 24. *Showing average contingency task (ΔP = 0) control ratings as a function of time estimation bias.*

ΔP = 0	Contingency Task Control Rating
Pessimistic	32.38 (23.500)
Optimistic	34.92 (28.397)

Helpers and Hinderers and their associated Control Ratings before the deadline

Following the procedure of Experiments 8-10, two experimenters independently classified the reported helpers and hinderers into two main categories, depending on whether they related to the participants themselves (internal) or to external (external) factors. The helpers and hinderers were furthermore classified into five sub-categories (as described in Experiment 8 & 9): internal mental, internal action, external people, external work and external circumstances. The two experimenters agreed on 87.7% of the classifications and where there was a disagreement a consensus was found. The frequencies of these categories can be seen in Table 25 below. It should be noted that there was only one participant in the hinderer group who reported an item relating to the external people category.

Table 25. *Frequencies of reported helpers and hinderers as a function of category (internal mental, internal action, external people, external work, external circumstances).*

		Helpers	**Hinderers**
Internal	Mental	21.43 %	26.97 %
	Action	50.00 %	13.48 %
External	People	5.71 %	1.12%
	Work	5.71 %	33.70 %
	Circumstances	17.14 %	25.84 %

A univariate mixed-model 2x5 ANOVA was carried out investigating the effect helper vs. hinderer (between-subjects) and the five categories (within-subjects) on control ratings. There was a significant main effect of category $F(4, 150) = 19.038$, $p < .001$, ${}_p\eta^2 = .337$, 90%CI [0.223, 0.411]. And furthermore, a significant helper/hinderer x category interaction $F(4, 150) = 3.605$, $p = .008$, ${}_p\eta^2 = .088$, 90%CI [0.014, 0.145].

To investigate this significant interaction further simple main effects analyses were carried out (Bonferroni corrected). There was a significant simple main effect of category on the control ratings of helpers $F(4,150) = 11.291$, $p < .001$, ${}_p\eta^2 = .231$, 90%CI [.123, .306] and also a significant simple main effect of category on the control ratings of hinderers $F(4, 150) = 9.380$, $p < .001$, ${}_p\eta^2 = .200$, 90%CI [.096, .274]. Furthermore, helpers and hinderers control ratings differed significantly only in the self mental category $F(1, 150) = 8.600$, $p = .004$, ${}_p\eta^2 = .054$, 90%CI [.010, .122]. The simple main effect of helper vs. hinderers was not significant in the other categories (all Fs < 4.846, all ps > .029).

Pairwise comparisons (Bonferroni corrected) were analysed to investigate the difference in control ratings for the five categories (see Figure 27). When

comparing the categories for the helper group only, it was found that the two internal categories had significantly higher (all *p*s < .04) control ratings than the three external categories, with control ratings being at least 34.95, 95% CI [6.807, 63.093] scores higher on the control rating scale. No other effects were significant (all *p*s > .9). When investigating the control ratings for the hinderer group it was found that the internal action category had significantly higher control ratings than the internal mental, external work and external circumstances categories (all *p*s < .006). Control ratings in the action category were at least 31.5, 95% CI [5.809, 57.191] higher than in the other three categories. Furthermore, the internal mental category had significantly higher control ratings than the external circumstances category (*p* = .021), with control ratings being 23.27, 95%CI [2.076, 44.482] higher on the rating scale. As there was only one data-point in the external people category no significant effects for this group were found (all *p*s > .9).

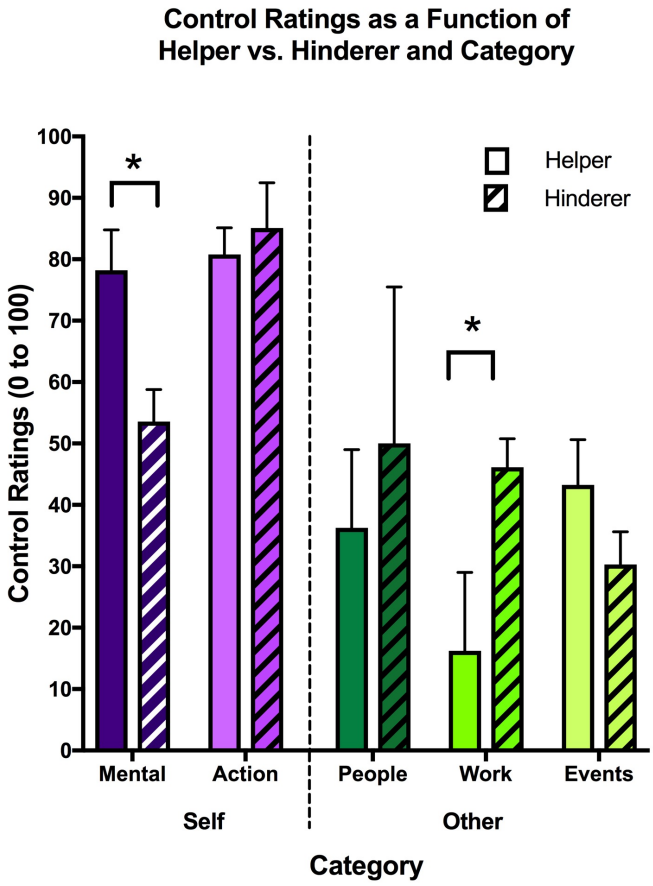

Figure 27. Control ratings (0-100) for the reported helpers and hinderers as a function of helper vs. hinderer group and category (internal-mental, internal-action, external-people, external-work, external-circumstances/events). Error bars = SEM.

Discussion

In the last experiment of this chapter, which looked at completion time predictions of undergraduates for their university essay deadlines, it was found that participants were not significantly optimistically biased in their predictions. It might seem surprising that participants did not display the tendency to underestimate their completion times, given the evidence from Experiments 8 and 9 and previous research which found future task completion time underestimation for academic tasks (Buehler et al., 1994; Newby-Clark et al.,

2000; Buehler & Griffin, 2003; Sanna & Schwarz, 2004; Sanna et al., 2005; Peetz et al., 2010; Buehler et al. 2012; Min & Arkes, 2012; Wiese et al, 2016).

However, it should be noted that most participants in this experiment selected an essay deadline that was on average only approximately 3.9 days after the completion of this questionnaire. Previous research (e.g. Peetz et al., 2010) has suggested that people are less biased when predicting completion times for tasks that have deadlines in the near future.

Furthermore, this experiment was the first in this thesis to introduce a between-subjects design, where half the participants had to report possible facilitating factors and the other half had to report possible impeding factors before making their completion time estimates. Of interest was whether participants who had to report facilitating factors would predict shorter completion times than participants who had to report impeding factors. No such difference was found, which goes against Hypothesis 5. Furthermore, no effect of group on total control ratings was found. However, participants in the helper group rated their average control over helpers higher than participants in the hinderer group rated their average control over hinderers.

When analysing the percentage with which helpers and hinderers that were reported in session 1 actually occurred, no effect of accurately predicting helpers and hinderers on time estimation was found. When splitting the reported helpers and hinderers into the five categories (as in Experiments 8 and 9) and looking at the control ratings associated with each category, it was found that

there was a significant interaction between helper vs. hinderer group and category. In the helper group, the two internal categories had higher control ratings than the three external categories. However, the two internal categories did not differ from each other in their control ratings, nor did the three external categories. In the hinderer group, the internal action category had higher control ratings than the internal mental, external work and external circumstances categories. Furthermore, the internal mental category had higher control ratings than the external circumstances category. The external people category did not differ in its control ratings from any of the other categories. However, as stated in the section above, only one participant in the hinderer group reported an item relating to the external people category, so the result regarding this category should be interpreted with caution. When comparing the control ratings for the five categories between the two groups it was found that in the internal mental category helpers had higher control ratings than hinderers, and that interestingly in the external work category hinderers had higher control ratings than helpers. Investigating the frequency with which helpers and hinderers in the five categories were reported, it was found that half of the helpers belonged to the internal action category, and almost 1/4th belong to the internal mental category. The fewest helpers belonged to the external people and external work (or absence thereof) categories (5% each). In the hinderer group, most of the reported hinderers belonged to the external work (1/3rd), internal mental (1/4th) and external circumstances (1/4th) categories, and that only one person mentioned external people as hinderers.

In this experiment, further individual difference measures were also collected. It was found that in the helper group, participants who declared a higher level of interest in the essay topic predicted finishing the essay later than people who were less interested in the essay topic. In the hinderer group, participants who reported feeling under greater external pressure were more likely to finish on time or earlier than they had predicted, whereas participants who reported feeling under less external pressure were more likely to finish later than they had predicted. Furthermore, participants who rated the essays as high priority finished their essays later than they had predicted, whereas participants who rated their essays as low priority were more likely to finish their essays at or before their predicted time.

This was the first experiment of this thesis, in which participants were presented in session two with the exact deadline they had reported in session one. This eliminated the need to remember the reported deadline. It cannot be excluded from the interpretations of the findings that participants' reported completion times might have been more correlated with their reported deadline because it was presented to them before they had to report their actual completion times. They might therefore have used this presented deadline as an anchor from which they adjusted their reported actual completion times. Following this explanation, participants might not have exactly remembered when they had submitted the essay but might have thought that they were a bit earlier than the deadline and hence reported finishing a few hours before the time that was presented to them as their deadline. Therefore, the absence of time estimation bias in this experiment could be due to either the closeness of the chosen deadlines or the

absence of having to remember the deadline, or an interaction of both factors. Further research would have to vary both these variables independently to investigate the relationship further.

General Discussion: Experiment 8-10

The experiments reported in this chapter confirmed the general tendency of people to underestimate completion times for real-life long-term projects (see Experiments 8 and 9). This bias was not present, however, for tasks with relatively close deadlines (see Experiment 10) for which the deadline was re-displayed when reporting actual completion times. The results of Experiment 8 also suggested that people who were pessimistically biased in their future time estimates tend to report lower control over finishing at their predicted time before the deadline, but that their control ratings increase after the deadline, however this finding was not replicated in the subsequent experiment, going against Hypothesis 2. No such difference was found for people who are optimistically biased in their task completion estimates. Generally, it was found that the individual difference measures of desirability of control and intolerance of uncertainty were not related to the time perception and control perception measures, going against Hypothesis 6.

It was surprising that in Experiment 9 two-thirds of participants did not accurately remember the deadline that they had initially reported. This is an important finding, because previous experiments did not ask participants to re-

state their deadline when reporting their actual completion times, hence it cannot be known if they accurately remembered their deadlines, or if showing them their deadline explicitly would change the completion times they report. Furthermore, it was found that the difference between the deadline reported in session one and the deadline reported in session two had a direct effect on the estimation bias found. Those whose deadline reported in session two was earlier than their original deadline tended to finish their tasks earlier, while those whose deadline was later tended to finish their tasks later. Further research should be conducted to see whether this mental deadline change leads to a change in actual submission times, or whether a change in actual submission times leads to a change in remembered mental deadlines. For example, it could be investigated whether people who are running late shift their mental deadline to a later point in time in order to not "miss" their deadline, and whether people who are running ahead of schedule shift their deadline forward in time in order, perhaps, to free up time for other tasks. It could therefore be the case that this inability to remember the deadline is another factor leading to the planning fallacy. A possible indication of the validity of this suggestion is found in Experiment 10, where participants were directly presented in session 2 with the deadline they had initially reported and estimation bias was eliminated.

When making participants list helpers as opposed to hinderers before making their completion time predictions, it was expected, in light of previous research (Sanna & Schwarz, 2004; Sanna et al., 2005; Min & Arkes, 2012), that their predictions would be more optimistic and hence also more biased. However, no such difference between groups was found (Hypothesis 5).

When looking at the frequencies with which helpers and hinderers of the five different categories were reported across the four different experiments, it can be seen that most helpers belonged to the internal categories, in particular the internal action category, and that the fewest helpers belonged to the external people and especially the (absence of) external work categories. This is with the exception of Experiment 8, in which participants attributed a quarter (before the deadline) to a third (after the deadline) of helpers to other people.

When looking across the four experiments at which hinderers were mentioned most frequently, it can be seen that most hinderers belonged to the internal mental and external circumstances categories. Only a few participants listed their own actions as hinderers. External people were also relatively rarely mentioned as hinderers, with the exception of Experiment 8, in which participants often reported delays in receiving feedback from other people.

With respect to the relationship between helper/hinderer category and their associated control ratings, it is not surprising that helpers are generally rated as more controllable than hinderers. It should be noted that people rate their own actions and own mental states as more controllable than external factors. Importantly, however, their own actions are also rated as more controllable than their own mental states. Contrary to previous suggestions (Buehler & Griffin, 2003; Buehler et al., 2010), people's own mental states were often reported as hinderers of a timely task completion (both before and after the deadline).

To sum up, two of the experiments (Experiment 8 and Experiment 9) in this chapter confirmed the general tendency for people to underestimate their future task completion times in the real-life context. This tendency was not found in Experiment 10, however this could have been due to the fact that the chosen deadlines were closer in time or due to the fact that participants were presented with their stated deadline time before stating their actual completion times. The experiments in this chapter did not confirm the hypothesis that people who feel more in control over their timely task completion would predict shorter task completion times than those who feel less in control (Hypothesis 2). Furthermore, no evidence was found that feeling more in control over facilitating and preventative factors would lead to shorter task completion time predictions (Hypothesis 4).

Chapter 5: General Discussion

This thesis investigated the role of control in future task completion time predictions. A model was proposed, *The Control Model of Future Time Prediction* (see Figure 28), whereby having experienced a controllable task, as opposed to an uncontrollable task, would lead to shortened future task completion time predictions. The model suggests that a match or mismatch between the controllability of the past and future task would determine if the future task completion time predictions would be biased. Specifically, optimism bias, as characteristic of the planning fallacy, is predicted to only occur if the past task has been controllable, leading to shortened future task completion time predictions, and the future task is uncontrollable, leading to objectively longer task completion times.

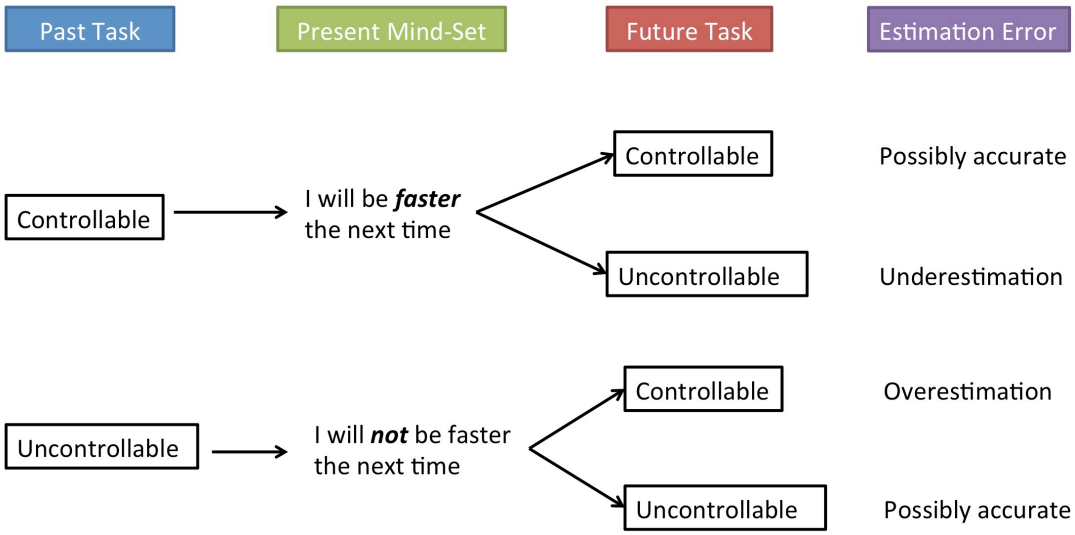

Figure 28: *The Control Model of Future Time Prediction*.

Taking the findings of all the experiments in this thesis together, it is proposed that it is the objective controllability of the task preceding the prediction that influences future task completion time predictions and not the subjective perception of controllability over the preceding or the future task. The model suggests that if people experience a controllable task they will predict shorter future task completion times for a similar task. If people experience an uncontrollable task they will not predict shorter future task completion times for a similar task. It is proposed that this is a type of temporal contraction for future tasks caused by controllability of the past task. However, whether the future task predictions are accurate or (optimistically/pessimistically) biased depends on the next stage of the model, and that is the nature of the future task for which the prediction was made. This second stage of the model was not explicitly tested in the current thesis, as task times of the future tasks were held constant. Theoretically speaking, if a controllable past task is followed by a controllable future task, then it is possible that the shorter task completion predictions are accurate, because the future task might actually take less time. This would mean that the future task completion time predictions might be optimistic, but cannot be considered as optimistically biased. If a controllable past task is followed by an uncontrollable future task, then the shorter task completion time predictions will be an optimistically biased underestimation of the actual future task completion times, as characteristic of the planning fallacy. However, if the past task is uncontrollable, people will not predict shorter future task completion times. So, if the uncontrollable task is followed by a similar task but of a controllable nature their predictions might be an overestimation of the actual task completion times, meaning they are pessimistically biased. Lastly, if an

uncontrollable task is followed by an uncontrollable task then again future task completion times could be relatively accurate estimates of the actual task completion times. According to the newly proposed model, it is the controllability of both the past task and the future task that determines whether task completion time estimates are biased or accurate.

The previous five psychological theories of the planning fallacy described in Chapter 1: the original inside-outside model (Kahneman & Tversky, 1977), the *Extended Inside-Outside Model* (Buehler et al., 2010; Buehler & Griffin, 2015), the *Memory-Bias Account* (Roy et al., 2005), the *Anchoring and Adjustment Account* (Thomas et al., 2003), and the *Self-Learning Account* (König & Thomas, 2015) proposed ways of making predictions more accurate that are often based *only* on the characteristics of past tasks, for example *reference class forecasting* (Kahneman & Tversky, 1977, Kahneman & Lovallo, 1993; Lovallo & Kahneman, 2003) or taking into account one's own previous experiences (Buehler et al., 2010; Buehler & Griffin, 2015). Some additions to these models have included characteristics about future tasks, such as taking into account possible obstacles (Sanna & Schwarz, 2004; Sanna et al., 2005). However, none of these models proposed to contrast the characteristics of the past task with those of the future task, in order to make predictions more accurate. Nor did any of the previous models take the controllability of the past and/or future tasks into account as a possible variable leading to shorter future task completion time estimates. The current model suggests that in order to make more accurate completion time predictions the objective controllability of the past and future tasks has to be taken into account.

Objective Task Control and the Planning Fallacy

This thesis consisted of three experimental chapters that tested the predictions of the above-described model. Chapter 2 tested whether having experienced a controllable task, rather than an uncontrollable task, in the past would lead to shortened future task completion time estimates (Hypothesis 1). The four experiments in this chapter used experimental controllable and uncontrollable tasks and measured participants' subjective perceptions of control and their past and future task completion time estimates. Hypothesis 1 was supported by the findings of Experiment 1 and Experiment 3. Participants in these experiments made shorter future task completion time estimates following a controllable task as compared to an uncontrollable task. Furthermore, when compared to their actual completion times it was found that these estimates represented an underestimation, i.e. were optimistically biased, as is characteristic of the *planning fallacy*. That such underestimations were not found for past completion time estimates, is in line with the inside-outside model of the planning fallacy (Kahneman & Tversky, 1977) and the *Extended Inside-Outside Model* of the planning fallacy proposed by Buehler et al. (2010) and Buehler and Griffin (2015). These accounts propose that the planning fallacy is characterised by a "paradoxical combination of optimism about the future with realism about the past" (Buehler & Griffin, 2015, p. 32). However, the findings of Experiment 1 go against the *Memory-Bias Account* of the planning fallacy (Roy et al., 2005) that would predict underestimation of both past and future task completion time estimates. Furthermore, the findings of Chapter 2 do not provide support for the *Anchoring and Adjustment Account* of the planning fallacy (Thomas et al., 2003), which suggests that underestimation of future task completion times mainly

occurs when a task is preceded by a shorter task, because future task completion time estimates are anchored on previous durations. As task durations were held constant within the experiments of Chapter 2, future task completion time underestimations cannot be attributed to anchoring, but can be ascribed to the experimental manipulation of task controllability.

Possible Underlying Mechanisms

This thesis suggested that task controllability could be seen as a variable contributing to optimism bias for predicting future task completion times, as characteristic of the planning fallacy. However, the mechanism by which control leads to shortened future time predictions is not yet clear and should be the subject of future research. One possible suggestion is that the effect of controllability on future task completion time predictions could be seen as a potentially similar phenomenon to the temporal binding effect found for retrospective time estimation (of relatively short durations). The temporal binding effect is manifested in temporal contractions of cues and outcomes if these are intentionally or causally connected (e.g. Haggard et al., 2002; Buehner, 2012; for a review see Moore & Obhi, 2012). There is good evidence that perception of control is related to time perception. For example, it was shown that the closer together in time events occur the stronger our sense of causality (Michotte, 1963) and control, sometimes called the sense of agency (Shanks, Pearson & Dickinson, 1989). Importantly, recent research established that conversely people's time perception is also influenced by their control over a situation. It was found that people judge actions and outcomes to have been

closer together in time, if they have actively controlled the outcome, i.e. if they were the actor causing the outcome to occur. This phenomenon has been the called *intentional* or *causal temporal binding effect* (Eagleman & Holcombe, 2002; Haggard, Clark & Kalogeras, 2002; Buehner, 2012; for a review see Moore & Obhi, 2012). In the first experiment to report the temporal binding effect, Haggard et al. (2002) compared time judgments for causally linked actions and outcomes with time judgments for the same events occurring without causal linkage. In their experiment they used the Libet clock method, where participants watch a rapidly moving clock hand and have to report the position of this clock hand when certain events occur. They found that in an operant condition, where actions caused a tone to occur 250ms later, those actions and outcomes were bound together in time. This means that participants judged actions to occur later and tones to occur earlier than in the comparison baseline condition, where these events were presented on their own. This finding has been replicated by studies not using the Libet clock-method, but which instead asked participants to estimate the time numerically, a procedure first used in this context by Humphreys and Buehner (2009). The temporal binding effect has been found in different time-scales such as the millisecond (e.g. Ebert & Wegner, 2010; Haggard et al., 2002) and second (Humphreys & Buehner, 2009) range. Furthermore, it has been shown that manipulations of controllability (as used in a contingency procedure) affect the temporal binding (Moore et al., 2009). The previous accounts of temporal binding found temporal contraction of actions and outcomes occurring at each trial of a task, if these actions and outcomes were intentionally or causally related. It could be suggested that these temporal contractions might be summed to produce a temporal contraction over the

whole task, which would lead to shorter task duration estimates. However, none of the investigations into the temporal binding effect have so far have looked at temporal contraction of future time. The reason why this temporal contraction of the whole task only occurs for future task predictions (as in the experiments of the current thesis) and not for estimating the durations of past tasks has to be further explored in future research. One explanation might be that temporal binding of the individual trials is not actually summed for the past, but is only expected to happen in the future. This would mean that after having experienced a controllable task, people are relatively accurate in judging the total duration of all trials for the past task, but they expect that the outcomes will follow their actions faster the next time they do the same task, and this expected speeding up is then summed across all trials when predicting future task durations. Future research should establish whether this is a possible underlying mechanism leading to the planning fallacy for future task completion time predictions. This would also help in addressing the alternative explanation that future time predictions are lengthened for uncontrollable tasks, rather than being shortened for controllable tasks, due to affective reactions to uncontrollable tasks such as frustration and boredom with the task.

Perceived Task Controllability and the Planning Fallacy

It should also be noted that across all the experiments in Chapter 2 and Chapter 3 no relationship between perceived controllability of the past task and future task duration estimates was found, going against Hypothesis 2. This might seem

somewhat surprising as it might be expected that the perception of control would strengthen the effect of actual control on future task completion time predictions. It might be assumed that the explicit perception of control over a task would make people more optimistic about their future task completion times, as has been suggested by literature discussed in Chapter 1 (e.g. Armor & Taylor, 1998; Weinstein, 1980; Sheppherd et al., 2012). However, one limitation of previous investigations, as described in Chapter 1, is that objective control was not manipulated or at least measured for the tasks for which subjective controllability perceptions were measured and therefore it cannot be assessed whether subjective and objective controllability variables were both involved in the previously reported effects.

It could be that the effect of control on future time predictions is of *implicit* nature and that objective past task control itself is the factor that causes future task completion time predictions to be shortened. Therefore, the current results might also be seen as in line with previous findings from the temporal binding literature. A study by Ebert & Wegner (2009) suggested that causal actions could lead to temporal binding even in the absence of an explicit sense of agency (i.e. perception of control). Ebert and Wegner (2009) performed experiments in which temporal binding was investigated with an experimental task in which actions produced outcomes with different consistency (consistent or inconsistent with the action). They found that temporal binding (seen as an implicit effect of causality) was not always correlated with explicitly perceived control (agency) over the task. Following the suggestions from this research it is proposed here that temporal contraction of future task completion time

predictions, caused by the controllability of a task, can also be dissociated from subjective perceptions of control over the past task. This means that controllability would *directly* bias time prediction without necessarily a mediating effect of subjective controllability perceptions of the past task.

One limitation of the current paradigm was that controllability (contingency) was not varied on a continuum within one experiment, but was used dichotomously. Within each experiment there was one controllable condition (positive contingency) and one uncontrollable condition (zero contingency). Future research could vary contingency (i.e. controllability) in a continuous way and assess where the threshold for the effect of controllability on future task completion time predictions lies. This would also aid the investigation into the relationship between the subjective perception of control and the actual controllability of the task. It could be that it was because of the dichotomous nature of the current paradigm that the subjective perceptions of control did not seem to be related to the estimation of future task completion times.

Future research into the link between subjective perceptions of task control and the planning fallacy should also take into account if other variables might play a role in determining people's subjective perceptions of task control. For example, participants might objectively have the opportunity to control a task, however their perception of control might diverge from the objectively calculated control because of their perceptions of the task or their own abilities. As has been discussed in Chapter 1 in relation to the *illusion of control*, perceptions of control can vary based on personality and mood variables, and therefore diverge from

the objective task controllability. Even though the current investigations did not find a relationship between individual-difference variables and perceptions of control, a possible relationship cannot be excluded, as the current results could be due to sample characteristics, e.g. generally low depression scores, as discussed in Chapter 2. Furthermore, perceptions of control could also be influenced by participants' preconceptions of the task (e.g. task difficulty) or their own skills. It has been suggested that "people also appear to be sensitive to their skills and circumstances when making predications. […] People's performance predictions appear to reflect an appreciation of their own capabilities, and not simply fanciful projections of what might be accomplished." (Armor & Taylor, 2002, p. 338). An investigation into the underpinnings of the perception of task controllability and how this might affect future task completion time predictions is something that should be explored in future research.

Individual-Differences and the Planning Fallacy

Lastly, Chapter 2 also investigated how individual-difference variables would affect future task completion time estimates. It was expected that people suffering from depression would be less prone to the controllability of a past task shortening their future task completion time estimates (Hypothesis 3). It was furthermore expected that people with high desire for control would be more prone to the controllability of a past task shortening their future task completion time estimates (Hypothesis 6). Experiment 2 and Experiment 3, which investigated the relationship between depression and future time

estimates found no effect of depression on future time estimates. It could be suggested that this was due to the sample of participants in both experiments having particularly low depression scores. Further research would therefore be needed to disconfirm the hypothesis. Therefore, it is proposed that future studies could replicate the experimental methods employed in Experiment 3 with a clinically depressed sample and compare them with a non-depressed control group. Experiment 4 investigated the relationship between desire for control and future time estimates, and also found no relationship between this individual-difference variable and future time estimates. This is surprising given that previous research found a relationship between desire for control and future task completion time underestimation (Halkjelsvik et al., 2012). However, it should be noted that in Experiment 4 no general tendency to underestimate future task completion times was found, which could be due to the fact that the tasks were shorter than in the previous experiments. It has previously been suggested that shorter experimental tasks are not as likely to be underestimated as longer experimental tasks (e.g. Roy et al., 2008; Buehler et al., 2010; Buehler & Griffin, 2015). However, the lack of task completion time underestimations in this experiment could also be due to the small number of action-outcome pairings and low number of trials in the task. A further difference in Halkjelsvik et al.'s (2012) study was that participants were given an incentive for speedy task completion, which was not the case in the current experiments. It should also be noted that previous research (e.g. Buehler & Griffin, 2003) found no relationship between other individual-difference variables that might have been expected to be related to the planning fallacy such as dispositional optimism and dispositional procrastination.

Anchoring and the Planning Fallacy

The three experiments in Chapter 3 explored an alternative hypothesis to the one proposed in *The Control Model of Future Time Prediction*. These experiments were done to exclude this alternative hypothesis and strengthen the case for the newly proposed model. This alternative hypothesis was that people anchor their predictions of future task completion times on the duration of previously experienced controllable tasks but not on the duration of previously experienced uncontrollable tasks (Hypothesis 7). This idea built on the *Anchoring and Adjustment Account* of the planning fallacy (Thomas et al., 2003), which proposed that people would anchor their future time predictions on previous task durations. Buehler and Griffin (2018) suggested that people would anchor their future task completion time predictions on previous *salient* tasks. Hypothesis 7 was an extension of this thinking, suggesting that controllability of a task is the salient feature that would determine which previous task duration is used as an anchor. In the three experiments in this chapter participants were presented with short and long tasks of a controllable or uncontrollable nature. Generally participants predicted that their future task completion times would be shorter than the long task and longer than the short task, but also predicted that they would be shorter than the average of the two task durations. Experiment 5 showed a trend in the direction supporting Hypothesis 8. However, this trend was not replicated by Experiment 6 or Experiment 7. Experiment 6 presented participants with two tasks, both of which were controllable, but one of which was more controllable than the other. It did not seem like the *relative difference* in controllability made the more controllable task act as an anchor for future task duration predictions. Experiment 7 presented participants with an

uncontrollable and a *highly* controllable task, which was expected to make the controllable task even more salient in order to facilitate anchoring. However, no anchoring effect was observed. From the findings of this chapter it is suggested that it is not anchoring on the duration of the controllable task that makes people prone to future task completion time underestimations. However, given that participants did also not base their future task completion time predictions on an accurate average of the two previously experienced durations, it cannot be confirmed that they performed a form of spontaneous *reference class forecasting* in order to arrive at their predictions. Furthermore, as participants did not anchor their predictions on the last (or first) experienced task duration, no support was found for the *Anchoring and Adjustment Account* (Thomas et al., 2003).

The Planning Fallacy for Real-Life Tasks

The three experiments in Chapter 4 investigated how perceptions of controllability would influence future task duration estimates for real-life tasks. It was predicted that participants who felt more in control over a timely task completion would predict faster task completion times than those who felt less in control (Hypothesis 2). Furthermore, it was predicted that participants who felt more in control over possible facilitating and especially over possible impeding factors would show a greater tendency to predict shorter task completion times (Hypothesis 4). The results of the three experiments in this chapter did not find support for these hypotheses. Participants in Experiment 8 and Experiment 9 did display a tendency to underestimate their task completion

times, as is characteristic of the planning fallacy (Kahneman & Tversky, 1977; Buehler et al., 1994; Buehler et al., 2010; Buehler and Griffin, 2015). However, this underestimation bias was not related to their subjective perception of control over timely task completion. Experiment 10 found no general tendency for future completion time underestimations. However, this could be attributed to the fact that participants chose deadlines that were relatively close (only a few days away). Previous studies have shown that people are more accurate in predicting their task completion times for closer deadlines than for deadlines further in the future (Peetz et al., 2010). Furthermore, re-displaying the deadline before participants reported their actual submission times might have biased or anchored participants' reporting of their actual submission times.

Two individual-difference measures were collected in the experiments of Chapter 4. The first was the desirability of control and the second was the intolerance of uncertainty. It was predicted (Hypothesis 6) that people with higher desire for control and lower tolerance for uncertainty would be more prone to underestimating their task completion times. However, no relationship between the individual-difference measures and future time predictions was found. The results of this chapter support the findings of Chapter 2 and Chapter 3 that subjective perception of higher controllability over a task might not cause future task completion time underestimation. However, further research is needed to investigate the relationship between perceived controllability and the planning fallacy for real-life tasks.

Future Directions

As has been explained in the sections above the experiments of this thesis tested the first half of the newly proposed *Control Model of Future Time Prediction*. The experiments in Chapter 2 lent support to Hypothesis 1, which predicted that the controllability of past tasks would influence future task completion time predictions, especially controllable past tasks leading to shortened future task completion time predictions. Future research should vary the controllability of the tasks in a continuous fashion to establish the threshold for this effect of controllability on future task completion time predictions. Importantly, future research should furthermore test the second half of the proposed model by also varying the durations of the past and future tasks. However, an investigation of the full model would need a new type of paradigm, which would allow for both the controllability and the task durations to vary. This would bring the added complication of assessing the interplay between the two variables, controllability and duration, on the planning fallacy effect. Therefore, careful consideration is needed when designing this type of new paradigm for the investigation of the whole model. Furthermore, the relationship between objective control over a task and the subjective task controllability perception should be further explored, especially investigating how their interplay might affect the planning fallacy. If successful, this could be very impactful for understanding the planning fallacy phenomenon as observed for many tasks and projects.

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Appendices

Appendix A: Experimental Instructions and Questions

General Participant Instructions: Experiment 1-7

In this experiment you will work for a company called *Fruity Juice Inc.*

This company has just received orders for different fruit juices and has to fill bottles with different juices.

Your task is to operate the different filling machines for the juice types. Each juice type has its own filling machine.

The bottle filling machines are very easy to operate: to fill the individual bottles, you press a button using the space bar on the keyboard.

However, previous workers have reported that there might be problems with the bottle filling machines.

Sometimes the filling machines don't turn on as intended and sometimes they turn on when no one is operating the buttons.

In order to see how much control you have over the filling process you should press the button only on half the occasions and observe what happens.

Your two tasks are thus:

1. Filling bottles

2. Investigating to what extent you can control the filling process.

The bottle filling process works like this:

1. You will see a cross (+) on the screen indicating that a new empty bottle is under the filling machine's tap.
2. You will see a button, which you can operate by pressing the space bar on the keyboard.
3. This button is only activated for 3 seconds, meaning that you have 3 seconds to decide if you want to press the button or not.
4. You should press the button on half the occasions.

5. The bottle will come out of the filling machine either successfully filled with juice or empty.

This is what the experiment looks like… (sample trial)

Once you have successfully filled the amount of bottles needed for that particular batch the filling machine will stop automatically.

You will then be asked some questions about your experience in the production of that particular juice type. This will refer to the whole production process of that particular batch – not just the second part. These questions will include judgements about how much control you had over the filling of the bottles.

When you have completed the production of bottles for all orders the experiment will stop automatically.

IF YOU HAVE ANY QUESTIONS, PLEASE ASK THE EXPERIMENTER NOW! ☺

Additional Instructions: Experiment 1

QUESTIONS YOU WILL BE ASKED:

About halfway through the production process for every juice batch, you will be asked to make a judgement about how much control you had over the filling of the juice bottles.

You should report your perception of control on a scale from 0 to 100.

0 = NO Control
100 = TOTAL Control

When you have made that judgement, you will return to the SAME filling machine and continue production of that juice type batch.

Changed Instructions: Experiment 2 & Experiment 3

Once you have successfully filled the amount of bottles needed for that particular batch, the filling machine will stop automatically.

You will then be asked two questions about your experience in the production of that particular juice type.

CONTROL JUDGEMENT
You will be asked to make a judgement about how much control you had over the filling of the juice bottles.
You should report your rating of control on a scale from 0 to 100.
0 = NO Control
100 = TOTAL Control

TIME JUDGEMENT
You will be asked to make a judgement about the time it takes you to complete some aspects of the task.

Changed Instructions: Experiment 4

Once you have successfully filled the amount of bottles needed for that particular crate, the filling machine will stop automatically.

You will then be asked two questions about your experience in the production of that particular juice type.

CONTROL JUDGEMENT

You will be asked to make a judgement about how much control you had over the filling of the all the juice bottles of that particular juice type.

You should report your rating of control on a scale from -100 to +100.

TIME JUDGEMENT

You will be asked to make a judgement about the time it takes you to complete some aspects of the task.

Changed Instructions: Experiment 5 – Experiment 7

Before you start you will be asked to make a judgement about how much control you think you will have over the filling of the juice bottles.

You should report your rating of control on a scale from -100 to +100.

When you have completed the production of bottles for all juice types the experiment will stop automatically.

You will then be asked two further questions – which you will need to read very carefully.

Experimental Questions

Experiment 1-3

How much CONTROL did you feel you had over the filling of the bottles?
Enter a number from 0 to 100 (0 = NO control - 100 = TOTAL control)

How much TIME do you feel it will take you to produce the NEXT batch of fruit juice?
Type in number of minutes and seconds.

Additional Questions: Experiment 1

Control after 16 trials
You are now HALFWAY through the production of this fruit juice batch.
How much CONTROL did you feel you had over the filling of the bottles?
Enter a number from 0 to 100 (0 = NO control - 100 = TOTAL control)

Past Time Estimation after 32 trials
How much TIME do you feel it took you to produce THIS batch of fruit juice?
Type in number of minutes and seconds.

Experiment 4

How much CONTROL do you think you will have over the filling of the bottles?
Enter a number from -100 to +100
-100 = TOTAL prevention, 0 = NO control, +100 = TOTAL control

How much CONTROL did you feel you had over the filling of ALL the bottles of this juice type?
Enter a number from -100 to +100
-100 = TOTAL prevention, 0 = NO control, +100 = TOTAL control

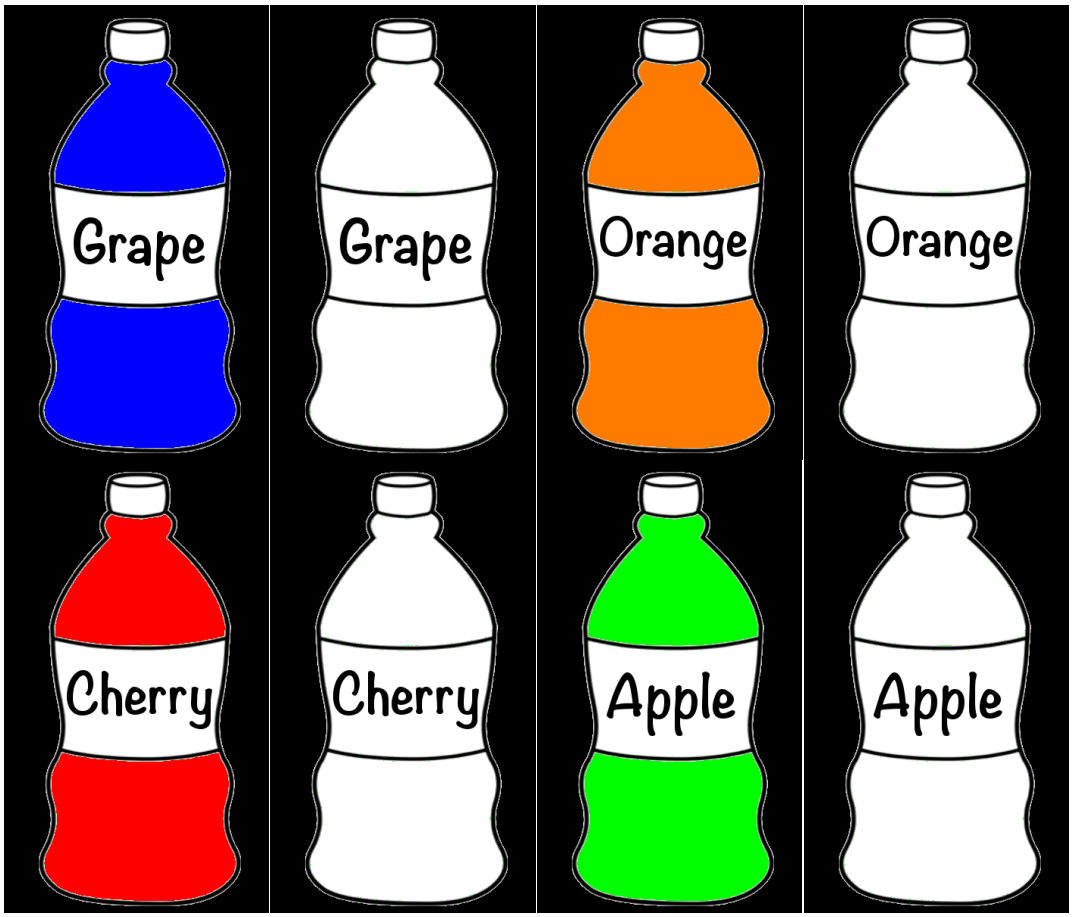
How much TIME do you feel it will take you to produce the NEXT crate of the SAME juice type?
Type in number of minutes and seconds.

Experiment 5-7

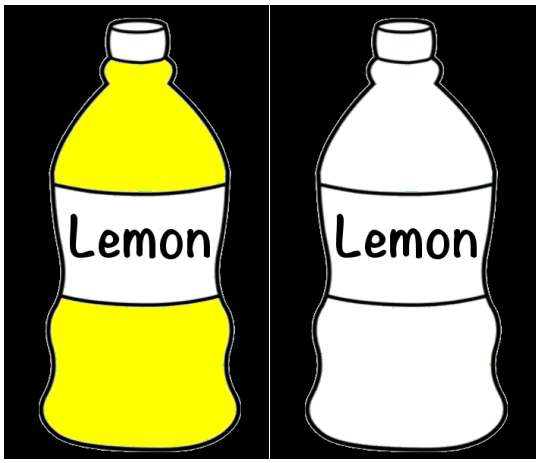
How much CONTROL did you feel you had over the filling of ALL the bottles so far?

How much TIME do you feel it will take you to produce all of the bottles for the NEXT type of fruit juice?

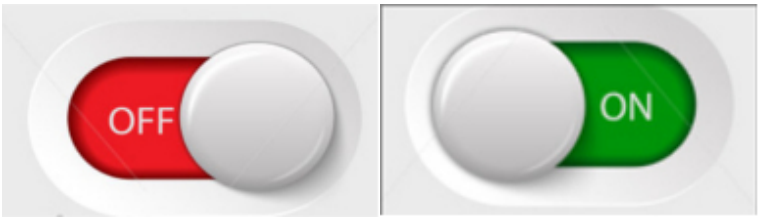
Appendix B: Experimental Stimuli



Stimuli used during experimental instructions



Buttons shown during experimental trials



Appendix C: Questionnaires Experiment 8-10

Experiment 8

Questionnaire Session One – Before Task Completion

1. Time
We would like you to think about your upcoming deadline for submitting your BA Research Project. The deadline is Monday 11th March at 12 o'clock.

When do you predict to hand in your Research Project?

Please choose a DAY and a TIME

Choose the DAY you predict to submit your BA Research Project: *

Choose the TIME (on the above stated day) you predict to submit your BA Research Project (24h format):

2. Control

Thinking about the submission deadline of your Research Project, how much CONTROL do you feel you have over submitting it at your predicted time?

Rate your Control on a scale from 0-100:
From 0 = No Control to 100 = Total Control

3. Helpers

1.
Thinking about all the things that might HELP you to submit your Research Project at your predicted time.

Please list the 5 MOST IMPORTANT things that might HELP you to submit your Research Project at your predicted time.
Please be as specific as possible, avoiding generalities.

2.
Please also rate the amount of CONTROL you predict having over these 5 things that might HELP you to submit at your predicted time.
Rate your Control on a scale from 0-100: from 0 = No Control to 100 = Total Control

4. Hinderers

1.
Thinking about all the things that might HINDER you to submit your Research Project at your predicted time.

Please list the 5 MOST IMPORTANT things that might HINDER you to submit your Research Project at your predicted time.

Please be as specific as possible, avoiding generalities.

2.
Please also rate the amount of CONTROL you predict having over these 5 things that might HINDER you to submit at your predicted time.

Rate your Control on a scale from 0-100: from 0 = No Control to 100 = Total Control

5. Comments

This is your opportunity to tell us anything else about your deadline, e.g. if you have an extension, extra-time etc.

Questionnaire Session Two – After Task Completion

1. Time

We would like you to think about your past deadline for submitting your BA Research Project.

When DID you hand in your Research Project?

Please choose a DAY and a TIME
Choose the DAY you submitted your BA Research Project:

Choose the TIME (on the above stated day) you submitted your BA Research Project (24h format):

2. Control

Thinking about the submission deadline of your Research Project, how much CONTROL do you feel you had over submitting it at your predicted time?

Rate your Control on a scale from 0-100:
From 0 = No Control to 100 = Total Control

3. Helpers

1.
Thinking about all the things that HELPED you to submit your Research Project at your predicted time.

Please list the 5 MOST IMPORTANT things that HELPED you to submit your Research Project at your predicted time.

Please be as specific as possible, avoiding generalities.

2.
Please also rate the amount of CONTROL you felt you had over these 5 things that HELPED you to submit at your predicted time.

Rate your Control on a scale from 0-100: from 0 = No Control to 100 = Total Control

4. Hinderers

1.
Thinking about all the things that HINDERED you to submit your Research Project at your predicted time.

Please list the 5 MOST IMPORTANT things that HINDERED you to submit your Research Project at your predicted time.

Please be as specific as possible, avoiding generalities.

2.
Please also rate the amount of CONTROL you felt you had over these 5 things that HINDERED you to submit at your predicted time.

Rate your Control on a scale from 0-100: from 0 = No Control to 100 = Total Control

5. Comments

This is your opportunity to tell us anything else about your deadline, e.g. if submitted later than 24th March or if you received an extension.

Experiment 9

Questionnaire Session One – Before Task Completion

1. Deadline Type

We would like you to think about a DEADLINE that you have upcoming in the next 2 weeks.

This can be an academic or a non-academic deadline. And it can be externally- or self-imposed.

Please select only ONE deadline and tell us below what this deadline is about.

Please write your answer(s) here:

Deadline Type - what is your deadline for?
What do you need to do for this deadline?

Is your deadline an academic deadline or not?
Is your deadline externally or self-imposed?

2. Deadline

When is your deadline?
Please select a Date and Time!

3. Time
What Date and Time do you expect to FINISH the task for which you have the deadline?

4. Control
Thinking about the deadline, how much CONTROL do you feel you have over finishing the task at your predicted time?

Rate your Control on a scale from 0-100:

From 0 = No Control to 100 = Total Control

5. Helpers
1.
Thinking about all the things that might HELP you to finish the task at your predicted time.

Please list the 5 MOST IMPORTANT things that might HELP you to finish the task at your predicted time.
Please be as specific as possible, avoiding generalities.

2.
Please also rate the amount of CONTROL you predict having over these 5 things that might HELP you to finish the task at your predicted time.

Rate your Control on a scale from 0-100: from 0 = No Control to 100 = Total Control

6. Hinderers

1.
Thinking about all the things that might HINDER you to finish the task at your predicted time.

Please list the 5 MOST IMPORTANT things that might HINDER you to finish the task at your predicted time.

Please be as specific as possible, avoiding generalities.

2.
Please also rate the amount of CONTROL you predict having over these 5 things that might HINDER you to finish the task at your predicted time.

Rate your Control on a scale from 0-100: from 0 = No Control to 100 = Total Control

7. Comments

This is your opportunity to tell us anything else about your deadline or your task that you think is important.

Questionnaire Session Two – After Task Completion

1. Deadline Type

Please enter the original deadline task that you selected in Session One (a few weeks ago) of this online study.

Deadline Type - what was your deadline for?
What did you need to do for this deadline?

2. Deadline
When was your original deadline (that you selected in Session One)?
Please select a Date and Time!
Has your deadline changed since you selected it in Session One?
If your Deadline has changed since Session One, please indicate the NEW DATE & TIME of your deadline.
If your deadline has changed since Session One, please indicate why and provide some comments.

3. Time
Have you finished the task for your deadline yet?
If you have finished the task for your deadline:
What Date and Time DID YOU FINISH the task for which you had the deadline?

4. Deadline Control

Thinking about the deadline, how much CONTROL do you feel you had over finishing the task at your predicted time?

Rate your Control on a scale from 0-100:

From 0 = No Control to 100 = Total Control

5. Helpers

1.
Thinking about all the things that HELPED you to finish the task at your predicted time.

Please list the 5 MOST IMPORTANT things that HELPED you to finish the task at your predicted time.

Please be as specific as possible, avoiding generalities.

2.
Please also rate the amount of CONTROL you had over these 5 things that HELPED you to finish the task at your predicted time.

Rate your Control on a scale from 0-100: from 0 = No Control to 100 = Total Control

6. Hinderers
1.
Thinking about all the things that HINDERED you to finish the task at your predicted time.

Please list the 5 MOST IMPORTANT things that HINDERED you to finish the task at your predicted time.

Please be as specific as possible, avoiding generalities.

2.
Please also rate the amount of CONTROL you had over these 5 things that HINDERED you to finish the task at your predicted time.

Rate your Control on a scale from 0-100: from 0 = No Control to 100 = Total Control

7. Comments

This is your opportunity to tell us anything else about your deadline or your task that you think is important.

(e.g. if you still haven't finished the task for your deadline, and when you expect to finish it)

Experiment 10

Questionnaire Session One – Before Task Completion

1. Essay Deadline

We would like you to think about an upcoming Essay Deadline that you have within the next two weeks.

Please choose an Essay submission where the deadline is already set and you also have a fixed time at which you will have to submit the Essay to your tutor.

Please enter the Date and Time of your Essay submission deadline.

2. Control

Thinking about when you would like to submit the Essay, how much CONTROL do you feel you have over submitting the Essay by your desired time?

Rate your Control on a scale from:
0 = No Control to 100 = Total Control

3. Helpers (Group 1)
Thinking about all the things that might HELP you to submit the Essay by your desired time.

Please list the 5 MOST IMPORTANT things that might HELP you to submit the Essay by your desired time.

Please be as specific as possible, avoiding generalities.

Please also rate the amount of CONTROL you predict having over these 5 things that might HELP you to submit the Essay by your desired time.

Rate your Control from 0 = No Control to 100 = Total Control

4. Hinderers (Group 2)
Thinking about all the things that might HINDER you to submit the Essay by your desired time.

Please list the 5 MOST IMPORTANT things that might HINDER you to submit the Essay by your desired time.
Please be as specific as possible, avoiding generalities.

Please also rate the amount of CONTROL you predict having over these 5 things that might HINDER you to submit the Essay by your desired time.
Rate your Control from 0 = No Control to 100 = Total Control

5. Predicted Submission Date & Time
When do you predict to submit your Essay?
Please choose a DAY and a TIME.

If you predict to submit at midnight, please enter 23:59.

6. Comments
Please tell us anything about your Essay Deadline that you think might be important and has not already been covered in the previous sections.

Questionnaire Session Two – After Task Completion

1. Deadline
In the First Part of this study you indicated that your Essay Deadline would be:
On:
At:

Did this Essay Deadline change?
If your Essay Deadline did change please indicate your NEW Deadline below.

2. Time
Have you submitted your Essay yet?
If you have submitted your Essay,
What Date and Time DID YOU SUBMIT?

3. Control
Thinking about the deadline, how much CONTROL do you feel you had over submitting the Essay at your predicted time?
Rate your Control from 0 = No Control to 100 = Total Control

4. Helpers (Group 1)
In the First Part of this study a few weeks ago we asked you to list 5 Helpers that you expected would help you submit the Essay at your predicted time.
Furthermore, we asked you to rate your control over these Helpers.

Now we would like to know if these things indeed helped you to submit the Essay at your predicted time.

The first Helper you listed was:
Did this indeed help you to submit at your predicted time?

The second Helper you listed was:
Did this indeed help you to submit at your predicted time?

The third Helper you listed was:
Did this indeed help you to submit at your predicted time?

The fourth Helper you listed was:
Did this indeed help you to submit at your predicted time?

The fifth Helper you listed was:
Did this indeed help you to submit at your predicted time?

5. Hinderers (Group 2)

In the First Part of this study a few weeks ago we asked you to list 5 Hinderers that you expected would hinder you to submit the Essay at your predicted time. Furthermore, we asked you to rate your control over these Hinderers.

Now we would like to know if these things indeed hindered you to submit the Essay at your predicted time.

The first Hinderer you listed was:
Did this indeed hinder you to submit at your predicted time?

The second Hinderer you listed was:
Did this indeed hinder you to submit at your predicted time?

The third Hinderer you listed was:
Did this indeed hinder you to submit at your predicted time?

The fourth Hinderer you listed was:
Did this indeed hinder you to submit at your predicted time?

The fifth Hinderer you listed was:
Did this indeed hinder you to submit at your predicted time?

6. Comments
Please tell us anything about your Essay Deadline that you think might be important and has not already been covered in the previous sections.

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I would like to thank my parents, Marilena Parvu and Johannes Just, for their continuous love and support and for teaching me the value of intellectual curiosity from an early age. I especially thank my mother who was always there for me and helped me with her words of guidance and wisdom. I learned from her that the hard times in life should not be considered as problems, but seen as puzzles that one is given to solve in order to achieve a better future. And I thank my father for instilling in me his passion for storytelling and seeing the funny side of life.

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