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The Impact of Prior Task Experience on Bias in Predictions of Duration

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Abstract

The effect of prior experience on bias in time predictions on two different types of laboratory task was examined in two studies. Experiment 1 revealed that prior experience of performing a substantial part of the same task led to greater time prediction accuracy. However, contrary to the weight of previous research, there was little evidence of the temporal underestimation indicative of the planning fallacy. In fact, temporal underestimation only occurred on a longer duration task when it was preceded by a much shorter task, which was either related (Experiments 1 and 2) or unrelated to it (Experiment 2). In contrast, temporal overestimation prevailed on tasks ranging from about 30 seconds' to four minutes' duration. Contrary to the theory of the planning fallacy, these studies indicate that people do take account of their performance on previous tasks and use such distributional information when predicting task duration. The potential role of the anchoring and adjustment cognitive heuristics in determining temporal misestimation is discussed.

Introduction

The process of predicting task duration has been the subject of considerable research (e.g., Buehler, Griffin & MacDonald, 1997; Koole & Van't Spijker, 2000). In general, such research has produced evidence of temporal underestimation on various laboratory (e.g., Josephs & Hahn, 1995) and real world tasks (e.g., Buehler, Griffin & Ross, 1994). Such research supports the cognitive judgment phenomenon known as the planning fallacy, which is the tendency to underestimate task duration despite being aware that previous similar activities took longer than anticipated (Buehler, Griffin & Ross, 2002).

The planning fallacy was identified by Kahneman and Tversky (1979), who suggest that distinct two types of data are available to people when predicting task duration. Namely, singular information, which is data about the task at hand; and distributional information, which concerns data about previous tasks. An aspect of singular information is the amount of work involved in completing a current task, whereas personal performance on previous similar tasks is an aspect of distributional information.

Kahneman and Tversky (1979) propose that the planning fallacy is a consequence of heuristic information processing whereby singular information becomes the focus of attention at the expense of distributional information, which is overlooked. Hence, temporal underestimation occurs

because the current task is treated as a unique event, which is dissociated from previous similar activities.

Given that the neglect of distributional information has been suggested as a possible cause of the planning fallacy (Kahneman & Tversky, 1979), it is notable that the issue of prior task experience has received little empirical treatment in relation to time estimation. One exception is the work of Thomas, Newstead and Handley (2003; see also Thomas, Handley & Newstead, 2004), which revealed that prior experience of performing (or mentally planning how to complete) certain laboratory tasks led to a reduction in temporal misestimation. However, Thomas et al. (2003) found little evidence of the temporal underestimation indicative of the planning fallacy on short duration (i.e., up to four minutes' duration) laboratory tasks such as the Tower of Hanoi.

In fact, there was evidence of general temporal overestimation on such tasks, with underestimation only occurring on longer tasks when they were preceded by a shorter version of the same task. For example, temporal underestimation prevailed on the five-disk Tower of Hanoi task only when the three-disk version of this task was performed beforehand. The findings of Thomas et al. (2003) indicate that there are certain tasks on which the temporal underestimation indicative of the planning fallacy does not occur and is reversed.

Thomas et al. (2003) suggest that the temporal underestimation they observed may have been a consequence of participants using the anchoring and adjustment cognitive judgmental heuristics (Tversky & Kahneman, 1982). That is, information such as the perceived duration of the first task served as an anchor for time predictions on the second task, which were insufficiently adjusted according to the greater demands of the upcoming task. Such a judgment strategy would be expected to result in temporal underestimation if the perceived duration of a just-completed shorter task served as a basis for time predictions on a current task.

A principal aim of the present research was to further address the issue of prior experience by employing laboratory tasks that are not only less artificial than those employed by Thomas et al. (2003), but are more akin to the ones used in previous research supporting the planning fallacy (e.g., Byram, 1997). That is, tasks that have well-

defined components and must be completed sequentially by following a set of instructions.

The present studies also sought to determine the direction in which time predictions were biased (i.e., under or overestimation) on a laboratory task that takes longer to complete than those used in our earlier work, but is of similar duration to some of the laboratory tasks employed in previous research (e.g., Buehler et al., 1997). Given that the tasks employed by Thomas et al. (2003; 2004) were of shorter duration than the laboratory tasks used in research supporting the planning fallacy (e.g., Josephs & Hahn, 1995), it could be that temporal underestimation is only evident on tasks that take longer than four or five minutes to complete. Consistent with this suggestion, temporal underestimation has been observed on laboratory tasks ranging in duration from about 10 minutes (e.g., Francis-Smythe & Robertson, 1999) to over one hour (Byram, 1997). The issue of task duration was addressed in the present studies by employing tasks that were of similar duration to those used in our previous research alongside one that took longer to complete.

Experiment 1

The issue of task duration was addressed in this study by using three different versions of the same miniature construction kit (i.e., toy castle) manufactured by Playmobil®. One of these tasks (long duration task) took about 11 minutes to complete whilst the others took either four minutes (medium duration task) or 30 seconds to finish (short duration task). The medium and short tasks were sub-component versions of the long duration task, and involved constructing different parts of the same miniature castle. The issue of prior task experience was addressed by varying the order in which the long duration task was performed. That is, whether time prediction bias differed when the long task was performed after, or was preceded by, one of the two shorter tasks.

Method

Participants. Eighty (64 female and 16 male) students at the University of Plymouth participated voluntarily in partial fulfillment of a psychology course requirement. No biological data other than gender was recorded.

Design, Materials and Procedure. A 2 (time: predicted vs. actual duration) x 4 (task experience: long then short task vs. short then long task vs. medium then long task vs. long then medium task) mixed factorial design was used. The time factor was a repeated measure, with participants producing a predicted and actual task completion time. Task experience was manipulated between groups, with participants being randomly assigned to one of the four equal-sized conditions.

Prior to judging task duration, the amount of time that participants were given to view the task components and instruction booklet differed according to the type of task that was about to be performed. Pilot testing revealed that

80 seconds were needed to preview the instruction booklet and the plastic components of the long task. Pilot testing revealed that the instruction booklet and the plastic components of the short and medium tasks could be previewed in 20 and 40 seconds, respectively.

The long duration task involved building a multi-turreted castle with surrounding jetty and battlements by assembling a series of molded plastic components in a pre-specified order. The medium duration sub-component task involved building the castle without the surrounding jetty and battlements. The short duration sub-component task involved building one wall of the castle. A digital stopwatch was used to measure task duration.

Results

Means (and standard deviations) of predicted and actual completion time on the second task are presented in Table 1.

Table 1: Predicted and Actual Duration of the Second Task Per Task Experience Condition (In Seconds).

Time	Task Experience Condition			
	Short-Long Task (n = 20)	Long-Short Task (n = 20)	Medium-Long Task (n = 20)	Long-Medium Task (n = 20)
Predicted	435.00 (181.70)	28.15 (20.12)	550.50 (129.59)	254.25 (109.20)
Actual	556.25 (147.18)	18.55 (18.00)	497.85 (124.14)	178.95 (35.68)

There was considerable variability within the predicted and actual task completion time data, and frequency distributions of these data from each task experience condition were positively skewed. Hence, these data were subjected to a logarithmic transformation before being statistically analyzed.

A 2 (time) x 4 (experience) split-plot analysis of variance (ANOVA) produced a main effect of task experience, $F(3,76) = 637.66$, $MSE = .14$, $p < .001$, with overall time being longest in the medium then long task condition. Pairwise comparisons (Scheffé) revealed significant differences between the means of all conditions ($ps < .05$) except those of the medium then long task and the short then long task conditions ($p > .10$). The main effect on the time factor was not significant ($F < 3$, $p > .10$).

The ANOVA also produced an interaction, $F(3,76) = 6.12$, $MSE = .11$, $p < .01$ (see Figure 1 below). This revealed that temporal overestimation was evident on the medium and short duration tasks, whereas the direction in which time predictions were biased on the long task differed according to the relative duration of the previous task. Specifically, temporal overestimation was evident when the medium task had just been completed, whereas underestimation occurred when the short task was performed initially. Tests for simple effects revealed that predicted and actual time differed significantly on the

medium and short duration tasks ($p < .05$). On the long duration task, the difference between predicted and actual time was significant when the short task ($p < .05$), but not the medium task was performed beforehand ($p > .10$).

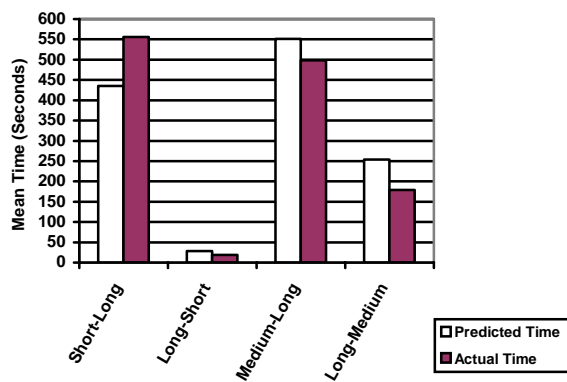


Figure 1: Predicted and actual completion time on the second task per task experience condition

Discussion

Temporal overestimation was evident on the medium and short duration sub-component tasks when they were performed after the long task. Consistent with the work of Thomas et al. (2003; 2004), this finding indicates that the temporal underestimation indicative of the planning fallacy (Kahneman & Tversky, 1979) is not evident (and is reversed) on another type of laboratory task with a duration of less than five minutes.

There was some evidence of temporal underestimation on the long duration task, but only when the short sub-component task had just been completed. The latter finding concurs with the notion that individuals might use the anchoring and adjustment cognitive heuristics when judging the duration of the second of two consecutive tasks (Thomas et al., 2003). That is, information about the previous task serves as an anchor for time predictions, which are insufficiently adjusted according to the relative demands of the current task.

In contrast, temporal overestimation (rather than underestimation) prevailed on the long task when the shorter duration medium sub-component task was performed beforehand. Thus, it seems that an anchoring and adjustment strategy was not used when judging the duration of the second task when a sizeable portion of this task had just been completed.

A possible explanation for these findings is that, due to differences in the extent of prior experience, different kinds of task-related information were used when predicting the duration of the long task. As completion of the medium task involved assembling half of the long task, participants in this experimental condition possessed considerable information about the nature of the long task when predicting its duration.

Given the extent of these individuals' prior task experience, they might have engaged in more thorough information processing when making a second time prediction. For example, they may have calculated the number of large plastic components required to complete the medium task, and appropriately scaled up this figure as a function of the greater number of major components involved in finishing the long duration task.

Using such a judgment strategy could result in temporal overestimation if it involved thinking about factors that delayed the completion of the previous task (e.g., fitting some plastic components together incorrectly). Thus, these participants may have erred on the side of caution because they took account of their previous task performance. In fact, time predictions were more accurate when the long task was preceded by the medium rather than the short task, suggesting that greater prior task experience was used to good effect.

As participants who performed the short task initially constructed only one wall of the Playmobil® castle (i.e., one part of the long task), they possessed little information about how to complete the long task when predicting its duration. In the absence of substantial prior task experience, these individuals may have used heuristic information processing when making a second time prediction. For example, time predictions may have been anchored on the perceived duration of the first task with insufficient upward adjustment for the longer duration of the second task. Thus, due to insufficient prior task experience, these participants may have relied on the anchoring and adjustment cognitive heuristics when judging the duration of the long task.

Whilst this study suggests that time predictions on the longer of two successive tasks might be based on information about the first task, the nature of this task-related information is not known. Given that the present tasks differed in duration, it could be that an anchoring and adjustment judgment strategy involving the perceived duration of the previous task is responsible for temporal underestimation when a longer task follows a shorter one.

In contrast, as the present tasks share the same structure (i.e., they are different versions of the same task), it could be that information about the nature of the first task formed the basis of time predictions on the second task. For example, the number of major plastic components involved in completing the previous task could serve as an anchor for time predictions on the current task. Temporal misestimation would be expected to occur as a consequence of using this kind of judgment strategy if the number of major plastic components differed between the first and second tasks. That is, if time predictions were not sufficiently adjusted from an anchor value to take account of the number of major plastic components needed to complete the second task.

Having found evidence of temporal underestimation on the long duration task when a much shorter version of it had just been completed, Experiment 2 sought to determine the type of information about a just-completed shorter task that

formed the basis of time predictions on the long duration task.

Experiment 2

The issue of the relevance of prior task experience was addressed in this study, where a related or an unrelated shorter duration task was performed before the long Playmobil® task. The related task was the short duration task from Experiment 1, whereas the unrelated task was the three-disk version of the Tower of Hanoi task. Pilot testing revealed that the three-disk task and the short sub-component task were of similar duration ($M_s = 28.59$ and 25.37 seconds, respectively).

Performing the short Playmobil® task initially would provide participants with some information about the nature of the long duration task, whereas no information about the long duration task would be acquired whilst completing the three-disk task.

If time predictions were based on information about the nature of the previous task, then they should be more accurate on the long duration task when the related task was performed beforehand. Conversely, if time predictions were based on information such as the perceived duration of the previous task, then the extent of judgment bias on the long task should not differ according to the relevance of prior experience.

Method

Participants. Fifty-six (42 female and 14 male) students at the University of Plymouth participated voluntarily. Forty-three individuals participated in partial fulfillment of psychology course requirement whilst the remainder were paid £2.50 each. No biographical information other than gender was recorded.

Design, Materials and Procedure. The long duration Playmobil® task, and a wooden Tower of Hanoi task apparatus containing three different-sized disks were used. A digital stopwatch was used to measure task duration.

There were two equal-sized groups of participants who performed either the three-disk task or the short sub-component task before the long duration Playmobil® task. The amount of time that participants were given to preview the plastic Playmobil® task components and instruction booklet differed according to the type of task that was about to be completed.

On the three-disk and short duration sub-component tasks, participants were given 20 seconds to preview the instructions and task apparatus or plastic components. Participants previewed the plastic components and instruction booklet of the long duration task for 80 seconds.

Results

Means (and standard deviations) of predicted and actual completion time on the long task are presented in Table 2.

Table 2: Predicted and Actual Duration of the Long Task Per Prior Experience Condition (In Seconds).

Time	Prior Experience Condition	
	3-disk Task First (n = 28)	Short Task First (n = 28)
Predicted	412.50 (137.99)	432.86 (177.66)
Actual	614.04 (125.32)	599.07 (140.91)

For the same reasons that were specified in Experiment 1, the predicted and actual completion time data were subjected to a logarithmic transformation before being statistically analyzed. A 2 (time) x 2 (task experience) split-plot ANOVA produced a main effect of time, $F(1,54) = 61.81$, $MSE = .07$, $p < .001$, with completion times exceeding predictions ($M_s = 606.56$ and 422.68 seconds, respectively). This finding indicates that temporal underestimation was evident on the long duration task. The main effect of prior experience and the interaction were not significant ($F_s < 1$, $p_s > .10$). The absence of a significant interaction suggests that the extent of temporal underestimation on the long duration task did not differ according to the type of shorter task that was performed beforehand.

Discussion

Consistent with the results of Experiment 1, temporal underestimation was evident on the long duration Playmobil® task when the short sub-component task was performed beforehand. Temporal underestimation also prevailed on the long task when it was preceded by an unrelated task that was of much shorter duration (i.e., the three-disk Tower of Hanoi task).

The presence of temporal underestimation on the long task is consistent with Thomas et al.'s (2003) suggestion that the anchoring and adjustment cognitive heuristics are used when judging the duration of the second of two successive tasks. However, as the extent of underestimation did not differ significantly according to the relevance of prior experience, it seems that information about the nature of the previous task was not used as a basis for time predictions on the long duration task. Instead, some other kind of task-related information presumably served as a basis for time predictions on this task.

A possible candidate source of such information is the perceived duration of the previous task. That is, individuals judged how long the first task took to complete, and used this figure as a basis for their second time prediction. Indeed, at the end of the first experimental trial, several participants commented that the just-completed task had taken them less time to finish than they predicted. Whilst

such evidence is purely anecdotal, it indicates an awareness of temporal misestimation on both of the short tasks, and suggests that several individuals estimated the duration of the first task retrospectively.

An anchoring and adjustment judgment strategy involving the perceived duration of the previous task should result in time prediction bias when successive tasks differ in duration. That is, temporal misestimation is a consequence of failing to increase or decrease the current prediction according to the longer or shorter duration of the upcoming task (Thomas et al., 2003). Such insufficient adjustment from an anchor value (i.e., the perceived duration of the previous task) would lead to temporal underestimation if the current task took longer to complete than the previous one.

General Discussion

The present studies provide further insight into the role of prior experience in the process of predicting task duration. In Experiment 1, we found that, relative to building just one wall of the Playmobil® castle initially, constructing half of the castle on the first trial resulted in greater time prediction accuracy on the long duration task. This finding is consistent with previous research, which has found that prior experience attenuates bias in temporal (e.g., Josephs & Hahn, 1995) and non-temporal judgments (e.g., Smith & Kida, 1991) of task performance.

More importantly, this finding suggests that performance on previous similar activities is not only considered when judging task duration, but can also be used to good effect (i.e., to improve time prediction accuracy). Given that distributional information seems to be a key component of the planning fallacy, the role of prior task experience in mediating temporal misestimation is in need of further study. That is, further insight into how such distributional information can be used effectively will enhance our understanding of the planning fallacy phenomenon.

Whilst it has been shown that possessing considerable prior task experience reduces temporal misestimation (Experiment 1), the present research also indicates that the use of such distributional information does not always improve judgment accuracy. In both studies, there was evidence of temporal underestimation on the long Playmobil® task when it was preceded by a much shorter duration sub-component task. However, the extent of this temporal underestimation was similar when either the short sub-component task or an unrelated short duration task was performed initially (Experiment 2).

Consistent with our previous work (Thomas et al., 2003; 2004), this finding indicates that information about a just-completed similar task is considered when predicting task duration, but can lead to judgment bias. If, as we propose, an anchoring and adjustment strategy involving the perceived duration of a previous shorter task forms the basis of time predictions on a longer task, then an alternative interpretation of the planning fallacy suggests itself. That is, temporal underestimation is a consequence of time predictions being based on the shorter duration of a previous

task, but being insufficiently scaled up according to the greater demands of the current task.

Whilst it is for future research to determine whether the present findings generalize to more everyday kinds of task, the use of the anchoring and adjustment cognitive heuristics could explain the prevalence of the planning fallacy on many large scale projects. That is, individuals who undertake such projects will typically have experience of performing similar but less complex tasks (Kidd, 1970). Moreover, as large scale (e.g., construction) projects tend to be performed infrequently, judgments of their duration can only really be based on the shorter duration of previous less complex tasks. If time predictions are anchored on the duration of previous smaller scale tasks, then temporal underestimation would be expected to occur.

In both studies, there was some evidence of the temporal underestimation indicative of the planning fallacy on the long duration Playmobil® task. This finding suggests that temporal underestimation might only be evident on laboratory tasks that are of longer duration than those employed in our earlier research. However, temporal underestimation was not evident on the long duration task when the medium sub-component task was performed initially (Experiment 1).

It was suggested that temporal overestimation on the long duration task was due to participants taking account of factors that delayed the completion of the medium task (e.g., incorrectly fitting some plastic components together) and incorporating such information into their second time prediction. Although further research is required to test the validity of this claim, it has been shown that thinking about such information can reduce bias in non-temporal judgments of task performance (e.g., Koriart, Lichtenstein & Fischhoff, 1980).

Given the present findings, it could be that, when prior experience is substantial, people incorporate potential impediments to optimal task completion into their temporal judgments on subsequent tasks. This kind of judgment strategy might lead to temporal overestimation, and also to greater time prediction accuracy. Support for the latter suggestion comes from Experiment 2, where time predictions on the long duration task were less biased when participants possessed more extensive prior task experience. That is, when the medium rather than short duration sub-component task was performed beforehand.

The existence of temporal overestimation on the short and medium duration sub-component tasks (Experiment 1) highlights the directional nature of time prediction bias. A possible explanation for the presence of temporal overestimation on tasks with a duration of up to four minutes is that people tend to judge task duration in whole minutes rather than seconds, or by using longer temporal units such as 5 or 10 minutes (Fraisse, 1984).

Given the duration of the two shorter tasks used in Experiment 1, temporal overestimation should prevail if participants used temporal units such as five minutes when judging their completion times on the medium sub-

component task. Likewise, giving a time prediction of two or three minutes would be expected to result in temporal overestimation on the short sub-component task. Thus, the reversal of the temporal underestimation indicative of the planning fallacy on the two shorter Playmobil® tasks could be a consequence of the type of time unit used to judge task duration.

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