Can Participants in a PRP Paradigm Temporally Interrupt Task 1 in order to Minimize Total Processing Time?

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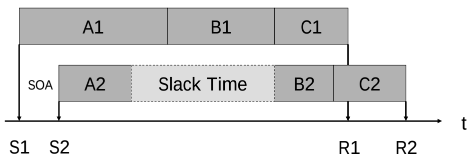
Introduction

The standard account of the PRP effect assumes that Task 1 is centrally processed before Task 2 (Normal Processing Order). This processing order may be suboptimal, however, when the processing demand for Task 1 is much larger than for Task 2. Specifically, according to an optimization account of the PRP effect (Miller, Ulrich, & Rolke, 2006), participants try to minimize their total processing time T=RT1+RT2. When Task 1 is more difficult than Task 2, T will tend to be minimized if participants temporally interrupt processing of Task 1, switch to Task 2, and complete it before switching back to Task 1 (Reversed Processing Order). Such a switching strategy may reduce T especially at short values of SOA. The present experiments tested this prediction of the optimization account. In these experiments, Task 1 was especially time-consuming (mental rotation) whereas Task 2 (left-ear vs. right-ear tone discrimination) could be performed relatively quickly. If the optimization account is valid, then

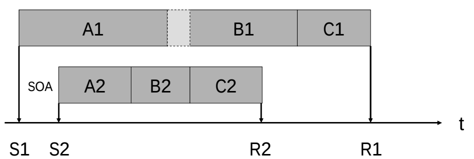
1. *R2 should often occur before R1 at short SOAs, and*
2. *RT1 should decrease as SOA is lengthened.*

Normal Processing Order: When task 1 is difficult and SOA is short, there is a relatively long slack duration. Thus, total processing time T=RT1+RT2 is relatively long.



RT1=860 ms, RT2=920 ms, T=860+920=<u>1780</u> ms

Reversed Processing Order: Processing Task 2 first at the bottleneck stage produces less slack. Thus T=RT1+RT2 is shorter than under normal processing order.



RT1=940 ms, RT2=540 ms, T=940+540=<u>1480</u> ms

Experiment 1 (variable SOAs)

Method

N=32 participants. S1 was the letter F, G, J, P, Q or R. Each letter appeared in its normal or mirror-image form, rotated 90˚ clockwise or 90˚ anti-clockwise. Participants responded with the middle finger of the right hand when the letter was mirror-imaged, and with the index finger of the right hand when it was normal. This assignment was reversed for the other half of participants. S2 was a tone presented to the right or to the left ear. The response to the tone task was given with the left hand, using the middle and index fingers. The assignment of tone-task stimuli to the fingers/keys was swapped half-way through the experiment for this task. SOA (100, 200, 400, 800 or 1600 ms) varied randomly from trial to trial. Response order was classified as normal when R1 preceded R2 by at least 100 ms, as reversed when R2 preceded R1 by at least 100 ms, and as grouped when R1 and R2 were produced within 100 ms of each other.

Results and Discussion

As expected, the processing demand for Task 1 was much larger than for Task 2 as indicated by mean RT1 (915 ms) and RT2 (475 ms) at the longest SOA. Consistent with the predictions of the optimization account, mean RT1 and also the percentage of response reversals decreased significantly as SOA increased. However, the percentage of response reversals was rather small, indicating that participants do not usually interrupt Task 1 processing to minimize the total processing time.

In this experiment, the SOA varied from trial to trial. Since the actual SOA is unpredictable, it may be difficult to make online-adjustments in order to minimize T=RT1+RT2. It could be possible, however, that participants would better minimize T when they can validly predict the SOA. In such a case the more efficient processing order could be prepared before S1 is delivered. Experiment 2 tested this offline-adjustment hypothesis.

Experiment 2 (blocked SOAs)

SOA length was kept constant within a block of trials but varied from block to block. Because SOA length was now predictable, use of the more efficient processing order should be facilitated.

Method

Except for blocked SOAs, this experiment was identical to Experiment 1. A fresh sample of N=32 participants was recruited.

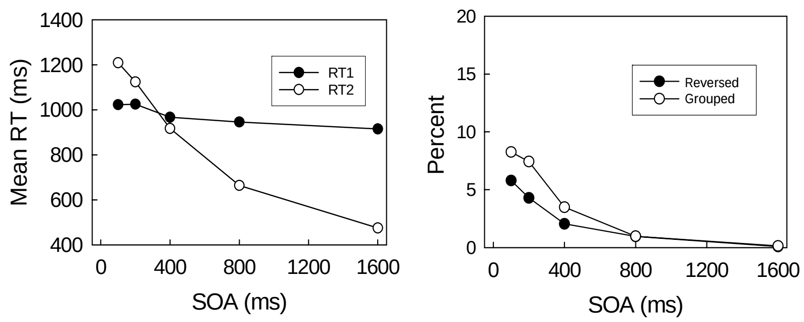
Results and Discussion

The pattern of results was similar to that of Experiment 1. More response reversals occurred at short SOAs, however, suggesting a tendency to minimize T=RT1+RT2. Nevertheless, the outcome of this experiment demonstrates that participants normally prefer the S1-S2 processing order even when full advance information about the actual SOA is provided. The offline-adjustment hypothesis holds only partially.

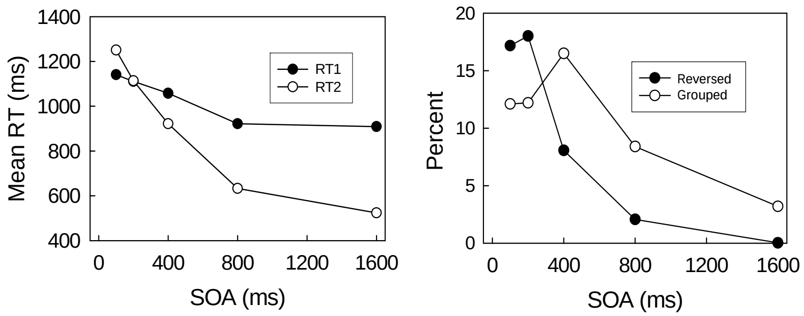
Conclusion

The results of the two experiments show that participants do sometimes interrupt Task 1 processing to minimize T=RT1+RT2. This contradicts the common notion (Pashler, 1994) that the two tasks are always executed at a central level on a first-come, first-serve principle.

Experiment 1: Reaction Time and Percentage of Grouped and Reversed Responses



Experiment 2: Reaction Time and Percentage of Grouped and Reversed Responses



References

Miller, J., Ulrich, R., & Rolke, B. (in press). Parallel and serial processing in dual-tasking: An optimization account. *Cognitive Psychology.*

Pashler H. (1994). Dual-task interference in simple tasks: data and theory. *Psychological Bulletin*, *116*, 220-244.