Reference: Meiran, N., Chorev, Z., & Sapir, A. (2000) Component processes in task switching. *Cognitive Psychology, 41,* 211-253.
Reviewer: Dan Belenky email: dmb83@pitt.edu

Introduction: What is the big idea?

Task Switching (rapidly changing between two stimuli) has been used to examine issues of executive control. This study unpacks the processes underlying task switching to see how executive it really is.

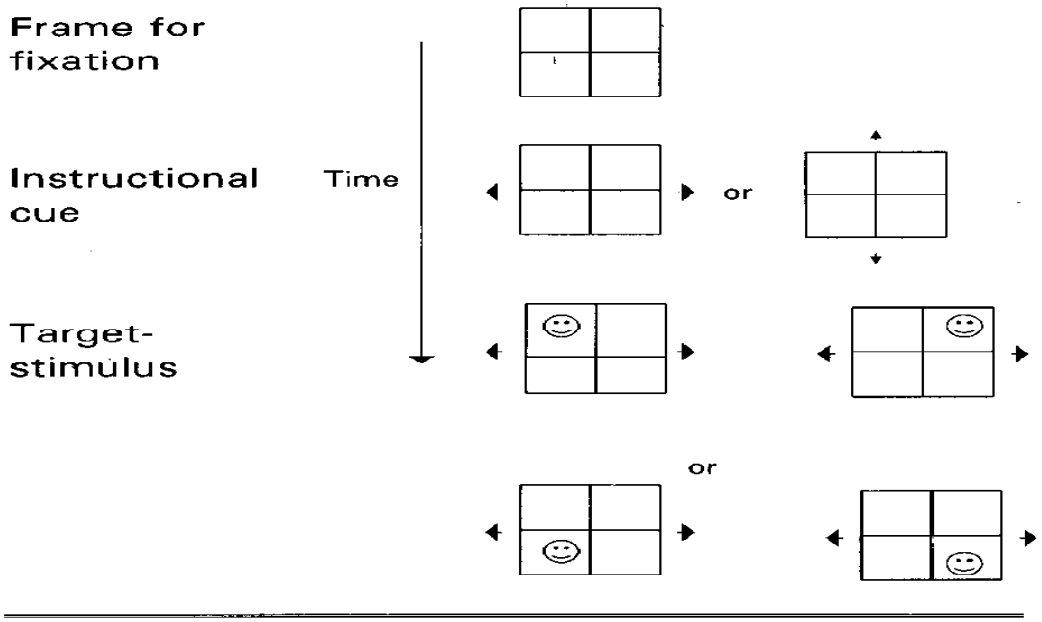
Issues:

- Past research points to a task switching cost. Potential explanations are:
  - Preparatory Reconfiguration
    - Goal activation: updating contents of declarative memory for new task demands
    - Rule activation: Recalling procedural memory for the task at hand
  - Task Set Inertia
    - Switch cost comes from proactive interference from other mappings for similar stimuli.
- Allport et al. (1994) found that increasing the time between response in trial A to trial B reduces task-switching cost. According to those authors, this was due to passive dissipation of previous task information, not really active preparatory reconfiguration. However, their experiment did not really tease those two apart.

- This study uses a cueing paradigm to separate out effects of preparatory reconfiguration from task set inertia dissipation.

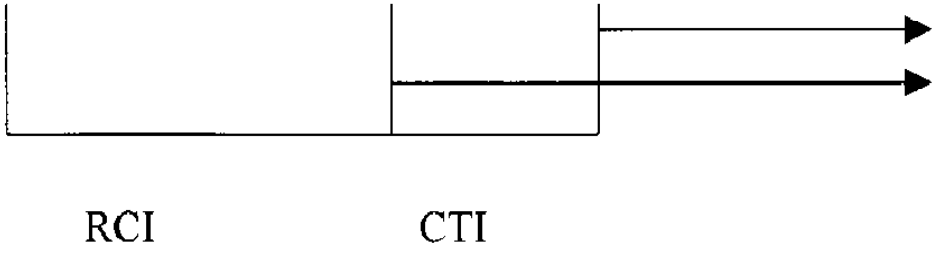
Paradigm: IVs

- Two types of tasks – up/down judgment or left/right judgment.
- Random ordering of tasks produces switch condition (i.e. trial A is different than trial B) and no-switch condition (trial A is same as trial B)
- Trial procedure as in figure below; empty grid, instructional cue, then target is presented so subject can respond.

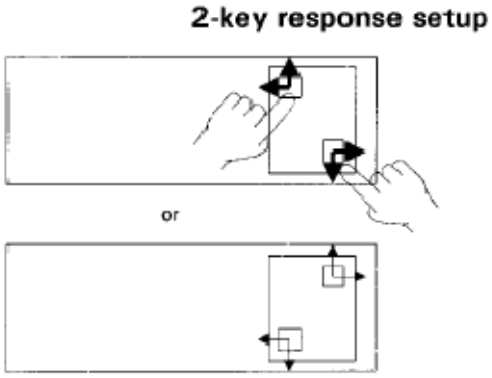


- Cue-Target Interval – time from presentation of cue to presentation of target. Can be short (100-250 ms) or long (over 1500ms).
- Response-Target Interval – time between response of trial A and instructional cue of trial B (can be conceptualized as "response-cue interval," since it is time from previous trial's response to current trial's cue). This interval is passive, since a person cannot really be preparing for the next trial, since they have yet to be given the cue as to which task it will be.

Response in Trial N-1	Cue in Trial N	Target in Trial N	Response in Trial N



- Congruency – whether the correct key was the same as in the previous trial. This reflects which finger is used to press the response key. Since each target could be in two positions, (for example, if "left" could be in "left-up" or "left-down" position), you could answer different tasks using the same finger.



Methods:

- Subjects tested individually, with feedback. They received 20 warm-up trials.
- First block of trials and trials after too long of a response (over 3000ms) were excluded from analysis.

Experiment 1:

- 2 between-subject manipulations: Blocked RCI or Randomized RCI, and Probability of task-switch led to 3 groups
    - Group 1: Blocked RCIs.
    - Group 2: Random RCIs.
    - Group 3: Higher Probability of task repetition
- If group 1 and 2 differ on short trials, this would suggest strategic differences in preparation account for task-switch differences.
- If group 1 and 3 differ on long trials, then this would mean that the effect is nonstrategic, as a person's strategy would be to keep the last set active. A difference at long RCIs indicates a passive set dissipation.
- Within-subject manipulations: RCIs (132, 232, 432, 1032, or 3032 ms), Congruency (congruent or incongruent) and Task Switch (switch or no-switch). There were two experimental sessions.

Results and Discussion:

- Support found for set-dissipation:
    - Task-Switching cost decreased as RCI increased.
    - RT in the no-switch trials was greater when RCI was bigger, indicating dissipation of previous trial set.

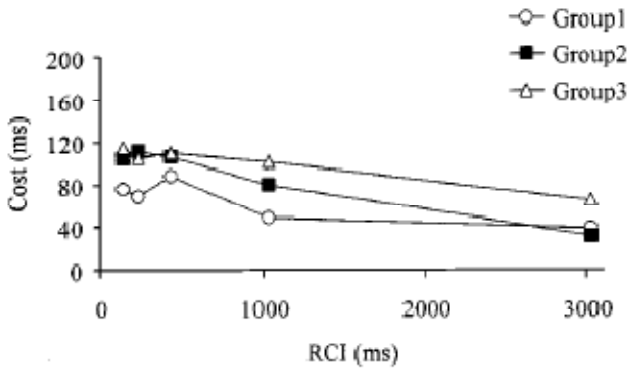
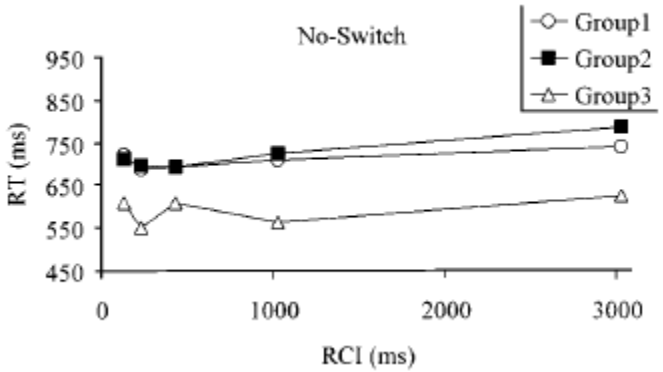


FIG. 3. Task-switching cost (Switch RT − No-Switch RT, in milliseconds) as a function of RCI (ms) and Group in Experiment 1. RCI, Response–Cue Interval. Group 1: Blocked RCI; Group 2: Random RCI; Group 3: Blocked RCI, no-switch more likely than switch.

- Support for passive, non-strategic processes:
  - Blocking of RCI did not change rate of switch cost reduction. (group 1 vs 2)
  - Reduction in switch cost not affected by promoting a strategy of keeping last task set active (Groups 1,2 vs. 3)



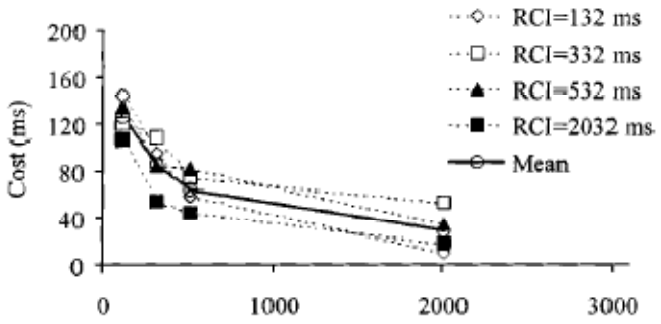
- Task repetition does reduce RT, as predicted by "micro-practice" models.
- Switching is harder for incongruent conditions than congruent.

Experiment 2:

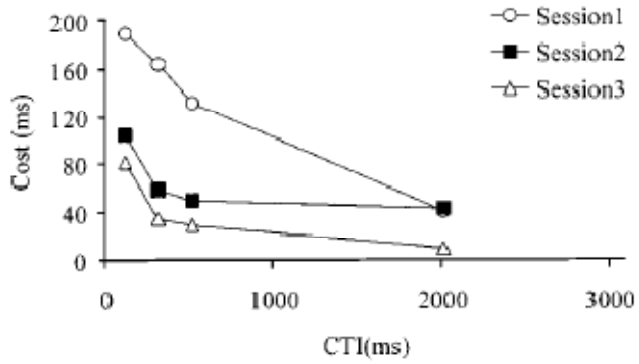
- CTI was short and constant in experiment 1, so participants may not prepare themselves fully. Because they were only partially preparing, the results may have reflected smaller task switching cost than would otherwise be seen.
- Experiment 2 manipulated RCI, like in 1st study (but only 4 types; 132, 332,532, or 2032). The key difference is that this experiment also varied CTI randomly (116, 316, 516 or 2016 ms).

Results and Discussion:

- Increased CTI, up to 500ms, reduces cost of task switching greatly. That is, the longer one has to prepare after being told which task to complete, the faster the RT after presentation of target.



- Increasing RTI past 332ms also reduced switch costs.
    - Congruency facilitated RT in no-switch, but increased RT for switch trials (i.e. higher task-switch cost associated with using similar response)
- Practice reduced switching costs in fast CTIs, but not in long CTIs (i.e. second session better than first session).



How did these findings do in explaining the two potential explanations for task-switch costs?

- RCIs past 532 ms had very little effect in switching costs(about 1.8ms per 100ms of increase RCI). So studies with RCI constant and slow (i.e. over 1000ms) will make set dissipation effect almost totally independent of preparation.
- If the cost reduction rate differs from the previously observed "1.8ms per 100ms RCI," this would indicate preparatory reconfiguration.

o The first 2 studies showed that preparation was involved in reducing task-switch costs. However, there is no evidence for a unique process of preparatory reconfiguration.

o Reconfiguration applies for switch conditions; however, a more general preparation is involved equally for switch conditions as well as no-switch conditions. The next experiment explored this.

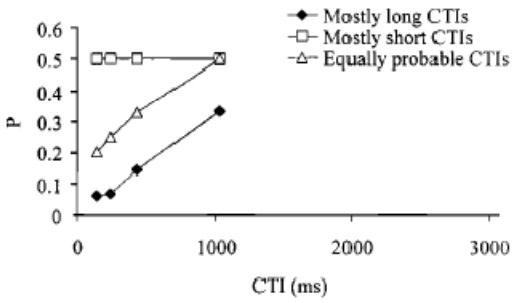
Experiment 3 Overview:

- Reconfiguration was tested as separate from general preparation.

- Reconfiguration depends on prediction of target onset time and having enough time to reconfigure before the target appears.
- Results of experiment 2 supported a competition hypothesis (when target onset becomes more probable because more time has elapsed, more resources may go to maintaining readiness, rather than reconfiguring for a new task). An increase in CTI implied a decrease in resources for reconfiguring, and the mid-level CTIs had a sharper reduction in RT than the longer CTIs.

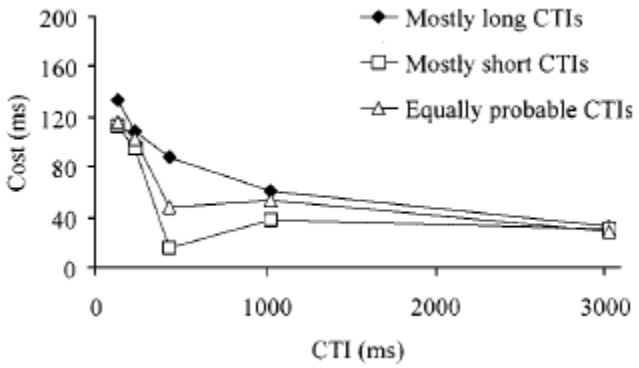
Experiment 3 Predictions and Methods:

- 3 Conditions: Mostly short CTIs, equally probable CTIs, and mostly long CTIs.
- Participants should use this probabilistic information to predict onset of target.
    - Preparatory reconfiguration and predicting target onset hypotheses:
        - Dependence hypothesis states there would be no cost reduction when most CTIs are short, because prediction at these short time intervals is impossible. There can be no prediction, so there can be no preparatory reconfiguration.
        - Resource competition hypothesis predicts that sharpest cost reduction will be found in the early CTIs for the equally probable and long CTI conditions. This is because at short CTIs, more resources as available, as it is unlikely that resources are going towards prediction yet.



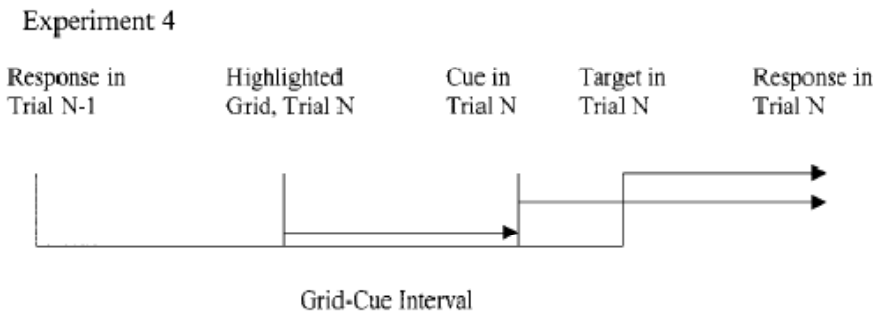
Results:

- RT was not affected when CTI exceeded 432ms. So predicting target onset is not an important factor when CTIs have equal probabilities to be short, medium or long.
- Switch cost was reduced even for the short CTIs, which were not getting very much new information from time elapsing, providing evidence AGAINST the dependence hypothesis.
- Because short CTIs had such a sharp reduction, even in groups where prediction was impossible, there was no evidence for the resource competition hypothesis either.
- Therefore, *prediction does not seem to influence preparatory reconfiguration.*



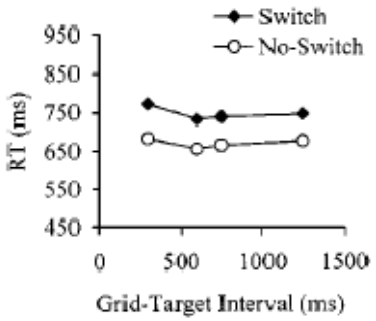
Experiment 4:

- What about phasic alertness? Phasic alertness refers to momentary increase in responsiveness, which has its maximal affects around 500ms after cue.
- Phasic alertness was induced by a sharp change in task-irrelevant objects on the screen (i.e. a grid).
- If reconfiguration is separate, than switch and no-switch trials should be equally affected by phasic alertness:
- Cue-target interval – phasic alertness + preparatory reconfiguration
- Grid-target interval – phasic alertness only



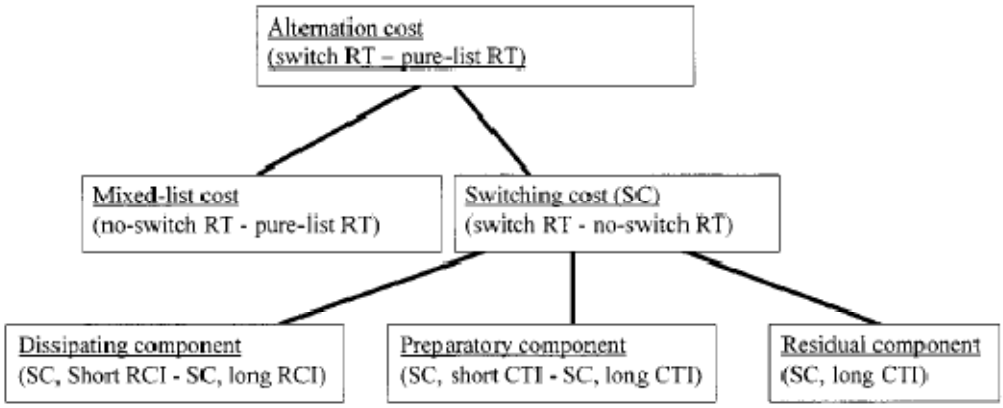
Results:

- Grid-target interval increase led to quicker RT, but did not play a role in task-switching costs.
- The effect of phasic alertness was indeed about 500ms after presentation of grid.
- Longer CTIs again reduced switching cost (as in previous experiments), but did not interact with phasic alertness.
- So, phasic alertness is a separate process than preparatory reconfiguration.



General Discussion:

- Both preparatory reconfiguration and passive set dissipation are present in task-switching:
    - Prolonging the RCI resulted in cost reduction, which supports the set dissipation hypothesis.
    - Prolonging the CTI resulted in switch-cost reduction, beyond the set dissipation effect, which supports the preparatory reconfiguration hypothesis.
- Preparatory reconfiguration is not just phasic altertness, prediction of target onset, or general preparation:
    - Reconfiguration is not dependant on target onset prediction, and reduces switching cost beyond phasic alertness.
- This leads to the proposal of the component processes hypothesis, reflecting the underlying processes:



Each component reflects a specific aspect of processing in a task-switch paradigm:

- Alternation cost reflects the difference between switch conditions and pure list.
- Mixed-list cost reflects the difference between no-switch conditions and pure list.

- Switching cost reflects the difference between switch conditions and no-switch (the general "task-switch" paradigm. Within the switch cost, there are different components:
    - Preparatory:
        - Reconfiguration
        - Phasic Alertness
        - Prediction
    - Dissipating:
        - Task set dissipation (passive)
    - Residual:
        - Motivation to prepare
        - Intrinsic limits
        - Practice effects

Conclusion:

- Task-switching cost is not due to one process, nor is it a measure of executive control:
    - Passive dissipation does not involve cognitive control
    - Preparatory component is an executive control success, but the residual component comes from failure or lack of motivation of control systems.
- Relationships between components and executive control are hard to untangle.

Take home Message:

- Preparation is not one process, and the underlying components may be operating independently.