Reviewer's report

Title: Are women better than men at multitasking?

Version: 2 Date: 26 April 2013

Reviewer: Anna Law

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The manuscript presented two experiments investigating gender differences in multitasking. Experiment 1 used a task-switching paradigm and found that men showed greater task 'mixing' costs across a block of trials. In Experiment 2, the authors used a different methodology, where participants had 3 varied paper-and-pencil tasks to complete within 8 minutes. They found an advantage for women on one of these tasks ('Key Search' from the BADS test battery, which is thought to measure planning and strategy).

The manuscript is clearly and succinctly written; I had no trouble understanding what the authors did and why. They argue that gender differences in multitasking need to be investigated because there is such a strong lay opinion that women are more skilled than men in this regard, and because it is a neglected area of scientific study. I completely agree, and think that this work has the potential to make a useful contribution. However, I think the manuscript needs some more work before I could make a decision about publication, for the reasons detailed below.

Major Compulsory Revisions

1) I am sure that the authors will want to argue this point with me, but a question that I would raise is whether these two studies necessarily belong together in the same paper. The cognitive demands of the two types of situation are very different. Task-switching (Experiment 1) involves rapid alternation between two very similar tasks, and crucially, these switches are demanded by the stimuli and not made at the participant's own discretion. Experiment 2 involves what I would call multitasking (and see Burgess, 2000), where the participant must allocate their time between a number of varied sub-tasks, applying their own strategy rather than responding to switch-cues. One would expect the latter situation to draw on a much wider range of cognitive functions than the former. (Please see Logie et al. (2011) and Adler and Benbunan-Fich (2012) for further discussion of the definition of multitasking).

2) Experiment 2 uses an approach to study multitasking that has been used in many studies previously, but the paper makes no reference to what has gone before and could do more to put the experiment in context of the literature. As far as I am aware this type of paradigm was first used by Shallice and Burgess (1991) when they developed the Six Elements Test. Later variants have tried to devise a way in which overall strategy or co-ordination can be measured. For example, one can make certain items within each sub-task have a higher value.
In the Strategy Application Test of Levine and colleagues (1998, 2000), some items were shorter/easier than others allowing participants to complete more of them within the time limit. In the Greenwich test (Burgess et al., 2000) or the Multitasking Test (Law et al., 2004), some items were coloured red and were worth extra ‘points’. One can then measure the effectiveness of overall multitasking strategy in terms of the proportion of ‘high-value’ items that were completed across all sub-tasks. In the current Experiment 2, the only data available is the score (and RT) on each sub-task separately, and women were found to be significantly better on one particular sub-task. I think if the authors want to claim that this is because it was completed within the context of a multitasking situation, then they have to be able to show that there is no gender difference when the sub-tasks are presented individually. I do note the point about test norms, but I am afraid I remain unconvinced. At least, I think the reader of the current paper would want to know how the sample used by Evans et al. in developing the test compares to the current sample.

3) Related to the previous point, Table 1 shows that men performed better on the Arithmetic sub-task. It is does not reach statistical significance, but has an effect size of 0.32, which is actually a larger effect size for a gender difference than the one that the authors found in Experiment 1 (0.27). Therefore, I think we must be cautious about saying that women have an advantage at multitasking per se, it may simply be that men and women diverted different amounts of effort into different sub-tasks. Is it possible that female participants, feeling under stereotype threat because of the presentation of an arithmetic task, felt more motivated to make a good job of the other tasks? The order in which the participants chose to tackle the sub-tasks might be informative here. Did men and women tend to choose a different task to work on first?

4) As may be apparent, my knowledge of the literature on task-switching is much less than my knowledge of the literature on multitasking. With that caveat, I see no problem with Experiment 1. One potential way forward with this paper might be just to publish that experiment at the moment and do a bit more work on the methodology of Experiment 2, although this of course would be a judgement for the Editor. But in either case, I think the authors have to address in the Discussion why they have found a gender difference that has not shown up in decades of prior research on task switching. Is it simply due to the impressive sample size in this study, and the fact they were looking for one? Or is it because they have looked at mixing costs whereas most papers only focus on switch costs? Why does the gender difference show up only for mixing costs? The General Discussion is fairly brief and should be expanded to discuss these issues in greater depth, to relate the current findings more fully to the existing literatures on task-switching and multitasking, and acknowledge some of the limitations of the methodologies.

Minor Essential Revisions

1) Background, third paragraph. I think it is a bit of an overstatement to say that ‘the brain areas necessary for multitasking in healthy people are well understood’ (page 2). The Burgess et al. (2000) paper referenced here did produce a model
of neuroanatomical correlates of multitasking, based on a sample of brain-damaged individuals, but there has not been any corroboration of this to my knowledge. Of course, it again depends what you mean by multitasking.

2) Results, second paragraph. I think there is an error in this sentence? ‘We carried out four ANOVAs, two each for task-mixing and one for task-switching costs, and for both RT and error rates’ (page 5).

3) Results, third and fourth paragraphs. For completeness, please report the statistics for all main effects and interactions. Currently main effect of gender and interactions are not reported for switch costs although I assume they were not significant.

4) Experiment 2, Materials, typo in the word ‘impairment’.

5) Experiment 2, Procedure, Would the sentence ‘A scoring system established within BADS marks these place according to set rules such as parallel patterns and corner entry’ by better placed with the text on the Key Search task in the Materials section? Seemed out of place here.

Discretionary Revisions

1) I would be interested to know more about the response times in Table 2. Presumably the descriptives are total number of seconds spent working on each sub-task. But did all participants work on the three sub-tasks in sequence until each was finished, or did they swap back and forth between them? Was 8 minutes enough time to finish all of the tasks? Often this type of study uses sub-tasks that cannot be finished within the time frame but has a rule that participants must make some attempt at each one.

2) It is mentioned that there was a phone call half-way through the multitasking test, but no data are presented relating to this – I’d have been interested to see it, even if there was no gender difference. Did people keep working while on the phone? Or did they stop and then return to the same sub-task they had been working on before the interruption? We found that there was a strong tendency for people to do this when interrupted during multitasking, rather than switching sub-tasks on their return (Law et al., 2004).

References


**Level of interest:** An article whose findings are important to those with closely related research interests

**Quality of written English:** Acceptable

**Statistical review:** No, the manuscript does not need to be seen by a statistician.

**Declaration of competing interests:**

I declare that I have no competing interests