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Working memory theory remains stuck: Reply to Hanley and Young

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Thanks to Rick Hanley for discussing the original research conducted with patient
ELD with me.

Working memory theory remains stuck: Reply to Hanley and Young

Hanley and Young (in press) criticize my representation of ELD's case (Morey, 2018) and my skepticism about whether proposing a specialized visual short-term memory (STM) store is necessary. They provide welcome detail supplementing their original reports (Hanley, Pearson, & Young, 1990; Hanley, Young, & Pearson, 1991). However, I argued from many sources of evidence (Morey, 2018) that hypothesis testing about visual STM has not confirmed the assumptions guiding interpretation of evidence from neurological patients. I still doubt whether ELD's case compels belief in a visual-spatial STM store, and think that retaining this idea likely impedes progress toward understanding working memory (WM).

Though ELD could recognize familiar visual materials, her memory was impaired for novel faces and spatial layouts (Hanley et al., 1990). Hanley and Young (in press) describe how Baddeley hypothesized that ELD's visuospatial sketchpad, which may be used to temporarily represent novel visual information, might have been damaged. Indeed, when tested on a spatial STM task, ELD showed impairments (Hanley et al., 1991). Hanley et al. concluded that ELD could not learn novel visual-spatial materials because they could not be adequately represented in damaged visual STM.

I argued that ELD's unimpaired memory for arbitrary instances of familiar objects was relevant for assessing whether a visual STM store was impaired (Morey, 2018), and Hanley and Young's (in press) logic confirms this. According to Hanley and Young, ELD only recognized visual detail associated with familiar objects because she could activate these representations in long-term memory. But consider their stimuli more closely, and this explanation seems unsatisfying. ELD certainly

had not previously stored these precise instances of familiar objects in long-term memory. She viewed them in novel positions and nonetheless managed to distinguish exact matches from similar lures. Hanley and Young do not specify how activating the concept of, e.g., binoculars, provoked encoding of the novel visual details needed to distinguish a specific set of binoculars arranged in a particular manner from other similar instances. If encoding these novel visual details does not likewise involve temporary representation, then it remains unknown how ELD remembered these: simply saying she used long-term memory does not suffice.

To conclude that ELD's pattern reflects selectively impaired visual STM, we must assume that visual STM exclusively encodes novel features: this is possibly an important distinction worth pursuing. However, if this was what we learned from ELD's case, it has not really influenced how the visuospatial sketchpad is described (e.g., Logie, 2011 does not mention novelty) or measured (e.g., see stimuli of Logie et al., 2010). Closed sets of familiar shapes and colors, which are certainly *not* novel, are commonly used to measure visual STM. Hanley and Young (in press) suggest the crucial point is that ELD only showed intact memory for familiar materials across delays of many minutes, rather than milliseconds, implying that their task primarily measured long-term memory. But as they never reported ELD's memory for instances of familiar visual materials across briefer delays, we simply do not know whether she could temporarily represent novel arrangements of familiar elements or not. The spatial sequence and the Brooks matrices tasks reported by Hanley et al. (1991) differ from recognition tasks in non-trivial ways, and do not necessarily isolate storage processes.

Admittedly, this does not mean that there is definitely no such thing as a visuospatial sketchpad. I questioned (Morey, 2018) whether the cases of ELD and comparable neurological patients *compel* belief in a specialized visual STM store, and

I maintain that the case evidence implicating visual or spatial STM remains too ambiguous to restrict WM theory. Though the most salient thing about ELD's impairment appears to be that visual and spatial materials were strongly affected, how retention time affected her memory remains vague, and we furthermore know that she also showed deficits for aural materials. Her deficits may be *consistent* with an impairment to visual-spatial STM, but her case does not rule out some other yet-to-be-investigated possibility. Hanley and Young (in press) argue that until alternative hypotheses are tested, their conclusions about WM structure should stand. But cases like ELD's are unique, so alternative hypotheses may *never* be tested again under identical circumstances. Rather than wait for an opportunity, we must reconsider how we use neurological patient evidence to restrict WM theory in light of the broader range of evidence available.

Hanley and Young (in press) also provide new analyses suggesting that ELD's spatial STM was indeed significantly worse than normal. But performance on Corsi-block tasks do not necessarily isolate short-term storage. Hanley et al. (1991) observed that ELD's memory for the final spatial item in a sequence appeared remarkably poor. Nevertheless, it is unknown whether this pattern reflects impaired representation of recent images or poor ability to manage output interference. The latter would be consistent with explanations that do not implicate visual STM specifically. Data from recall tasks, such as those used to measure verbal STM deficits, are not directly comparable with data from order reconstruction tasks like Corsi-blocks (Ward, Avons, & Melling, 2005). This means that ELD's apparent dissociation between memory for verbal and non-verbal materials might arise from other differences between the tasks.

In summary, Hanley and Young (in press) provide new information and context about ELD's case. But their view of WM theory remains frozen, and they

seem unworried that the same decades-old debates around the existence of specialized stores still churn without resolution. The accumulated literature suggests that visual short-term memories, much more so than verbal short-term memories, are fragile and prone to interference from many sources even in healthy participants (Morey, 2018). Baddeley (Baddeley, 2012; Baddeley & Hitch, in press) aptly likens theory-building to mapping an unknown territory. If our guiding assumptions are correct, exploration should confirm them. We should gradually add new knowledge, not contradictory information. When we hit a stubborn incongruity, we must reconsider the initial assumption. Continuing down the apparent path toward specifying a distinct visual-spatial STM store has not yielded a better, more complete map of this territory. It is time to seriously consider changing direction.

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