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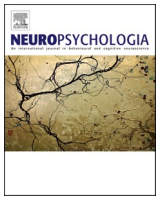

Can signal detection theory explain everyday amnesia (high confident misses)?

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ABSTRACT

Levi et al. (2021) critique the concept of everyday amnesia (high confident misses) by arguing that these are simply due to criterion shifts within a signal detection framework. We agree that signal detection figures can be drawn to conceptualize the results, but we argue such efforts merely provide a re-description of the phenomenon without explaining it. For that, one would need a process theory. Signal detection theory represents an elegant framework for conceiving of issues in decision making, but not for explaining mechanisms underlying them. A signal detection figure can be created for any possible recognition memory result; any pair of hit rates and false alarm rates (and hence miss rates and correct rejection rates) is amenable to such a depiction. If we were to cast the issue we raised in terms of signal detection theory, we might ask: Why do some subjects place their most liberal criterion in such a way that they miss, with high confidence, items that they recently studied? Signal detection theory provides no answer.

Roediger and Tekin (2020) described what they thought was an interesting phenomenon in recognition memory.

In re-examining three sets of previously reported recognition memory data in which confidence ratings had been taken, they discovered that for the (usually neglected) response category of misses, 15–20% were made with high confidence. Thus, for faces and words that had just processed 5–10 minutes previously, subjects averred that they were absolutely sure they had not been presented in the experiment. Because all the subjects in these experiments were highly intelligent college students, the fact that they could show such rapid and complete forgetting only a few minutes after study – with powerful copy cues as retrieval cues – seemed like an interesting phenomenon. Evincing perhaps too much enthusiasm, we called the phenomenon everyday amnesia. That is merely a description, of course, not a theoretical statement, and we made no claims to the contrary. We provided it as something of an interesting puzzle.

Levi et al. (2021) argue that high confidence misses do not reflect any sort of amnesia; rather, they simply reflect that some items will fall to the left of a decision criterion within standard signal detection theory (SDT) and that this criterion moves around as a function of conditions and subjects. Nothing could be more predictable, and maybe even downright boring, than misses made with high confidence. In short, there is really nothing unusual to see in high confidence misses and we can all go back to our normal research without pausing to wonder about them. End of story.

For the first author, reading Levi et al.'s (2021) paper brought on a sense of déjà vu. In 1995, Roediger and McDermott reported high levels of false recall and high confidence false recognition in a word-list paradigm, and they thought the phenomena were interesting as cases of false memory that arose immediately after a list was presented. Just a few years later, Miller and Wolford (1999) examined this false memory paradigm within the context of SDT, and they reached the conclusion "that most of the false memories could be ascribed to criterion shifts" (p. 398). So, to quote Yogi Berra, "It's like déjà vu all over again." This time we claim that high confidence misses are interesting, not high confidence false alarms, but in either case proponents of SDT say that the phenomena are easily explained. We will return to the argument later.

But first, let's assume for a moment that SDT does explain (or even "predict", as Levi et al. say) the phenomenon of high confident misses or everyday amnesia. If this is so, we believe the authors are being too modest. After all, then SDT could be said to explain much more important phenomena, without ever referring to either psychological or neural processes. The three panels in Levi et al.'s (2021) paper shows three versions of criterion placement for anterograde "everyday

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amnesia" or high confidence misses. The red part of the figures conceptualizes high confident misses; again, the figure is said to explain them. But why stop there? Why not explain dense anterograde amnesia with SDT? We can simply draw the signal detection model that corresponds to anterograde amnesia, thereby "explaining" it.

In Fig. 1A, we see an SDT explanation for dense bilateral medial temporal lobe amnesia in which patients cannot report recent memories, and their recognition memory performance scarcely exceeds chance (see E.P.'s data in Hamann and Squire, 1997). Why? According to Fig. 1A, the explanation is that the distribution of memory signals generated by targets and foils overlap almost completely. As a result, the hit rate will approximately equal the false alarm rate ($d' \approx 0$). If Fig. 1A provides an explanation, then, with SDT, one need not even refer to the brain to "explain" amnesia.

Fig. 1B shows how SDT can explain another phenomenon that has puzzled researchers since it was discovered, viz., hyperthymesia or highly superior autobiographical memory (HSAM; see Parker et al., 2006; McGaugh and LePort, 2014). Now we must assume that the distributions of memory signals associated with events that happened vs. those that did not happen are quite distinct, with little overlap. HSAM subjects are quite accurate in their recall, and according to Levi et al. (2021), SDT explains recall as well as recognition (but see Roediger and Payne, 1985). The HSAM subjects' decision criterion is placed between the distributions, resulting in a high hit rate and low false alarm rate ($d' \approx 4$). Some incorrect autobiographical memories slip through, but on the whole, these people are remarkably accurate in recounting and, presumably, recognizing experiences of their lives. Interestingly, when they are put through standard laboratory memory tasks, their performance falls within the normal range (LePort et al., 2012; Patihis et al., 2013). They only excel in remembering autobiographical events, which seems to be further evidence for two types of event memory (McDermott et al., 2009; Roediger and McDermott, 2013). We could draw yet another SDT model intermediate between the two models depicted in Fig. 1 (e.g., ($d' \approx 2$) that would "explain" the second type of event memory in HSAM subjects, as it does in normal subjects.

Will the scientific world accept the SDT-based explanations of anterograde amnesia and hyperthymesia proposed here? We suspect not. SDT provides a useful conceptualization of the underlying memory signals and the decision criteria, not a theoretical explanation in terms of psychological constructs or neural processes of why they are depicted as they are. Likewise, we do not find the SDT interpretation of everyday amnesia to be an explanation, for the same reasons. SDT casts matters in a formal framework, but one that lacks the mechanistic underpinnings (psychological or neural) that would provide an explanation.

Signal detection theory represents a magnificent formal framework for conceptualizing decisions, in particular binary decisions (Wixted, 2020). It has been extraordinarily useful in many realms of decision making for conceptualizing how analyses should proceed in terms of ROC curves and CAC plots (Mickes, 2015). Yet it is not an explanation of the behavioral data. In the case of recognition memory, a signal detection model can be created to conceptualize any pair of hit rates and false alarm rates (and thus miss and correct rejection rates). To do so, the criteria might need to be shifted, and/or the distributions might be shifted, and/or a third distribution might need to be introduced (e.g., Roediger and DeSoto, 2015; Wixted and Stretch, 2000). Regardless, an SDT model can be created for virtually any recognition memory finding, but it cannot reasonably be argued that it therefore also explains them. Instead, it *translates* the finding into a useful theoretical conceptualization.

Levi et al. (2021) argue that "The absence of such errors [high confidence misses or false alarms] would undeniably provide a refutation of SDT …" (108114, MS), but of course that is not so. SDT can easily interpret the absence high-confidence misses (e.g., the absence of a rating of 1 on a standard 1-to-6 confidence scale), as shown in Fig. 2 here. If the leftmost criterion were shifted far enough to the left, then the fact that no misses were made with high confidence would occur in an experiment involving a limited number of target trials (as is true in every recognition memory experiment). If no high-confidence misses were observed in a given experiment, a figure like that shown in Fig. 2 would provide the signal detection interpretation. However, that figure would not therefore explain the absence of everyday amnesia.

Returning to the case of Roediger and McDermott's (1995) results that Miller and Wolford (1999) said were explained by a one-item criterion shift, the latter article received several critical replies (Roediger and McDermott, 1999; Wickens and Hirshman, 2000; Wixted and Stretch, 2000). Then Gallo et al. (2001) provided a test of the criterion shift explanation and found it wanting. A decade later Miller et al. (2011) replied. A few other authors chimed in on the debate. However, most of the action for researchers using the DRM paradigm was to ask

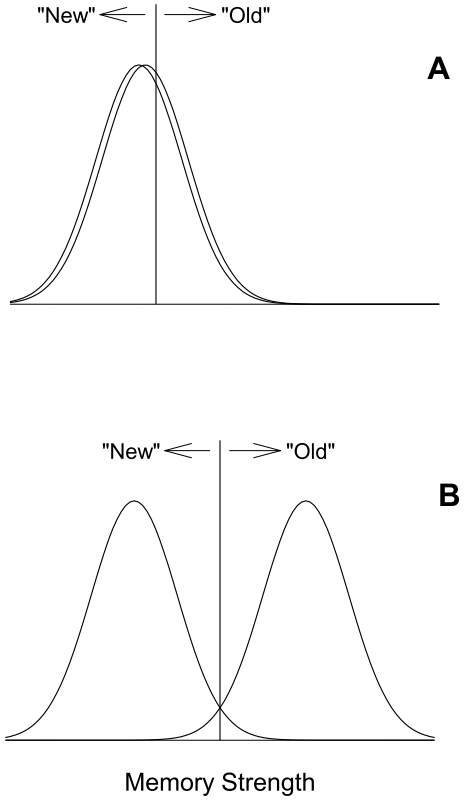

Fig. 1. Fig. 1A provides a conceptualization of dense bilateral anterograde amnesia in terms of SDT. Fig. 1B provides a similar conceptualization of hyperthymesia. See text for details.

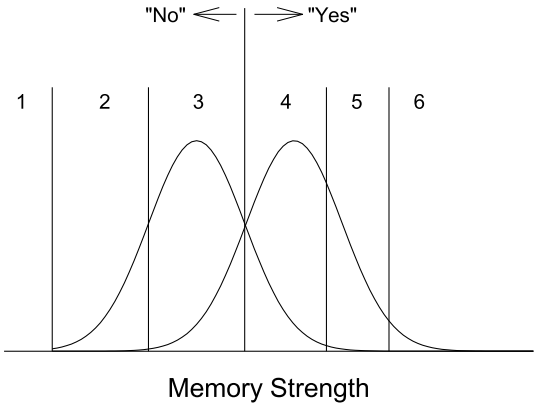

Fig. 2. Provides a depiction of a signal detection model with no high confident misses.

interesting questions about possible causes in terms of process theories, to seek individual differences in the illusion, and to examine extensions into other arenas (see Gallo, 2006, 2010). The SDT debate was a side-show, and the phenomenon of high confidence false memories was not explained away by SDT in the eyes of most researchers. We do not yet know how to explain everyday amnesia even though we do know how to depict it in terms of SDT. Thus, we expect the same dynamic will play out here. Researchers will likely focus on explaining the phenomenon, not ignoring it merely because it can be formalized within SDT.

In sum, SDT provides a fine re-description of the results reported by Roediger and Tekin (2020), but it does not explain them. Levi et al. (2021) argue that "SDT conceives both misses and FAs [false alarms] as epiphenomenal …" (p. 3, MS). We disagree. We find false alarms (or false memories) and misses, especially those made with high confidence, as interesting psychological phenomena that require mechanistic explanations.

References

Gallo, D.A., 2006. Associative Illusions of Memory: False Memory and Research in DRM and Related Tasks. Psychology Press, New York.

Gallo, D.A., 2010. False memories and fantastic beliefs: 15 years of the DRM illusion. Mem. Cognit. 38, 833–848.

Gallo, D.A., Roediger, H.L., McDermott, K.B., 2001. Associative false recognition occurs without strategic criterion shifts. Psychon. Bull. Rev. 8, 579–586.

Hamann, S.B., Squire, L.R., 1997. Intact perceptual memory in absence of conscious memory. Behav. Neurosci. 111 (4), 850–854.

LePort, A.K., Mattfeld, A.T., Dickinson-Anson, H., Fallon, J.H., Stark, C.E., Kruggel, F., et al., 2012. Behavioral and neuroanatomical investigation of highly superior autobiographical memory (HSAM). Neurobiol. Learn. Mem. 98 (1), 78–92.

Levi, A., Mickes, L., Goshen-Gottstein, Y., 2021. The New Hypothesis of Everyday Amnesia: an Effect of Criterion Placement, Not Memory. Neuropsychologia.

McDermott, K.B., Szpunar, K.K., Christ, S.E., 2009. Laboratory-based and autobiographical retrieval tasks differ substantially in their neural substrates. Neuropsychologia 47 (11), 2290–2298.

McGaugh, J.L., LePort, A., 2014. Remembrance of all things past. Sci. Am. 310 (2), 40–45.

Mickes, L., 2015. Receiver operating characteristic analysis and confidence–accuracy characteristic analysis in investigations of system variables and estimator variables that affect eyewitness memory. J. Appl. Res. Memory Cognit. 4 (2), 93–102.

Miller, M.B., Guerin, S.A., Wolford, G.L., 2011. The strategic nature of false recognition in the DRM paradigm. J. Exp. Psychol. Learn. Mem. Cognit. 37 (5), 1228–1235.

Miller, M.B., Wolford, G.L., 1999. Theoretical commentary: the role of criterion shift in false memory. Psychol. Rev. 106 (2), 398–405.

Parker, E.S., Cahill, L., McGaugh, J.L., 2006. A case of unusual autobiographical remembering. Neurocase 12 (1), 35–49.

Patihis, L., Frenda, S.J., LePort, A.K., Petersen, N., Nichols, R.M., Stark, C.E., et al., 2013. False memories in highly superior autobiographical memory individuals. Proc. Natl. Acad. Sci. Unit. States Am. 110 (52), 20947–20952.

Roediger, H.L., DeSoto, K.A., 2015. Understanding the relation between confidence and accuracy in reports from memory. In: Lindsay, D.S., Kelley, C.M., Yonelinas, A.P., Roediger, H.L. (Eds.), Remembering: Attributions, Processes, and Control in Human Memory: Papers in Honor of Larry L. Jacoby. Psychology Press, New York, pp. 347–367.

Roediger, H.L., Payne, D.G., 1985. Recall criterion does not affect recall level or hypermnesia: a puzzle for generate/recognize theories. Mem. Cognit. 13, 1–7.

Roediger, H.L., McDermott, K.B., 1995. Creating false memories: remembering words not presented in lists. J. Exp. Psychol. Learn. Mem. Cognit. 21 (4), 803–814.

Roediger III, H.L., McDermott, K.B., 1999. False alarms and false memories. Psychol. Rev. 106 (2), 406–410.

Roediger, H.L., McDermott, K.B., 2013. Two types of event memory. Proc. Natl. Acad. Sci. Unit. States Am. 110, 20856–20857.

Roediger, H.L., Tekin, E., 2020. Recognition memory: tulving's contributions and some new findings. Neuropsychologia 139, 107350.

Wickens, T.D., Hirshman, E., 2000. False memories and statistical design theory: comment on miller and Wolford (1999) and roediger and McDermott (1999). Psychol. Rev. 107 (2), 377–383.

Wixted, J.T., 2020. The forgotten history of signal detection theory. J. Exp. Psychol. Learn. Mem. Cognit. 46 (2), 201–233.

Wixted, J.T., Stretch, V., 2000. The case against a criterion-shift account of false memory. Psychol. Rev. 107 (2), 368–376.