Journal of Experimental Psychology:
Learning, Memory, and Cognition
2017, Vol. 43, No. 6, 1001–1003

0278-7393/17/$12.00 http://dx.doi.org/10.1037/xlm0000362

COMMENTARY

How Memory Is Tested Influences What Is Measured: Reply to Wyble and Chen (2017)

Khena M. Swallow
Cornell University

Yuhong V. Jiang and Deborah H. Tan
University of Minnesota Twin Cities

In this response to Wyble and Chen's (2017) commentary on attribute amnesia, we hope to achieve several goals. First, we clarify how our view diverges from that described by Wyble and Chen. We argue that because the surprise memory test is disruptive, it is an insensitive tool for measuring the persistence of recently attended target attributes in memory. Second, we identify points of agreement between our view and that of Wyble and Chen. Like them, we believe that the strength of a mental representation is a critical factor in determining whether the representation persists long enough to be used in a surprise recognition task. We also agree that consolidation is one means of strengthening this representation. Finally, we suggest questions that should be addressed to clarify the factors that determine whether attended information can be reported in a surprise memory test.

Keywords: attribute amnesia, attention, short-term memory, interference

The recent discovery of attribute amnesia (Chen & Wyble, 2015) offers a new opportunity to understand many aspects of visual cognition. In attribute amnesia, participants are asked to search a display of a few items for a target. The target is distinguished from distractors by a single attribute, such as its identity (or other attributes). For example, participants may search for an even digit among odd digits. As is common in visual search tasks, participants are asked to report a different attribute of the target, such as its location, before continuing on to the next trial. What is novel about attribute amnesia, however, is that the identity of the target, the very attribute that participants used to identify it, appears to be rapidly forgotten: On a surprise memory test, participants are much less likely to correctly report the target's identity than if the memory test was expected (Chen & Wyble, 2015, 2016). Thus, attribute amnesia is a deficit in reporting an attribute of an object that was processed only a short time ago.

The finding that people are unable to explicitly report recently attended visual attributes joins a long line of findings suggesting that intuitions about visual cognition based on phenomenological experience are often misguided (e.g., change blindness, inattentional blindness; Chabris & Simons, 2011; Rensink, O'Regan, & Clark, 1997). However, as with earlier demonstrations, it is important to investigate whether deficits in explicit measures of memory and attention are apparent when more sensitive measures are used. For example, an important advance in change blindness research was made when Hollingworth and Henderson (2002) found that change blindness is reduced for objects that participants fixated both before and after the change. Similarly, priming measures reveal that some information about unattended items is retained, even when explicit memory for those items is at chance levels (DeSchepper & Treisman, 1996).

It is with measurement sensitivity in mind that we conducted the experiments reported in Jiang, Shupe, Swallow, and Tan (2016). We raised two concerns about the sensitivity of the original paradigm for assessing attribute memory. First, the use of a surprise memory test to assess attribute memory introduces new task demands that could interfere with memory for that attribute. The unexpected display and question included novel instructions, novel response mappings, and of course, surprise. Second, even without the complications surrounding a surprise memory test, explicit recognition tests are often insensitive to the presence of weaker, or implicit, memory representations (Schacter & Graf, 1986).

To address these concerns, we asked whether priming measures would reveal memory for the attributes that were used to define targets. Using Chen and Wyble's (2015) task in which participants localized a target digit defined by its parity, we showed that participants performed at chance on the surprise memory trial in identifying the target digit. However, priming measures indicated that the target's identity persisted in memory longer than the surprise memory test might have suggested: Participants were more accurate and faster when the current trial's target was the same as the preceding trial's target. This intertrial priming demonstrated that a representation of the target's identity persisted beyond the end of the trial, long enough to influence performance

Khena M. Swallow, Department of Psychology, Cornell University; Yuhong V. Jiang and Deborah H. Tan, Department of Psychology, University of Minnesota Twin Cities.

Correspondence concerning this article should be addressed to Khena M. Swallow, Department of Psychology, Cornell University, 211 Uris Hall, Ithaca, NY 14850. E-mail: kms424@cornell.edu

on the next one. The target's location memory evidenced similar results. Participants showed strong intertrial priming for the target's location. Though their memory for the target's location was above chance on the surprise test, it was significantly lower on the surprise trial than on postsurprise trials. Based on these findings, we concluded that "a failure to accurately report an attribute on the surprise trials does not imply that the information is completely absent from memory" (Jiang et al., 2016, p. 1336).

In their commentary, Wyble and Chen (2017) discussed these findings in the context of their more recent work on attribute amnesia. While acknowledging that priming is a useful tool to assess attribute memory, Wyble and Chen suggested that the surprise memory test is not necessarily inferior. They reported that surprise test response times were similar in experiments where they found attribute amnesia (Chen & Wyble, 2016, Experiment 3a) and in experiments where they did not (Chen & Wyble, 2016, Experiment 3c). Thus, participants were capable of accurately responding to the surprise memory test, and the amount of time that it took them to do so was a poor indicator of whether they were able to report the attribute. However, the data came from a single trial for each participant, raising concerns about the power to detect a difference if it truly exists. Moreover, a lack of a reaction time difference across experiments is not strong evidence against the claim that the surprise memory test was disruptive. The surprise memory test could disrupt attribute memory through time-independent processes (i.e., interference) as well as time-dependent processes (i.e., decay, cf. Lewandowsky, Oberauer, & Brown, 2009; Ricker, Vergauwe, Hinrichs, Blume, & Cowan, 2015). Because the surprise memory test presents a new situation, requires the participant to establish a new task set, and increases cognitive load, it is likely to increase interference in working memory (Liefooghe, Barrouillet, Vandierendonck, & Camos, 2008; Makovski, Shim, & Jiang, 2006; Makovski, Sussman, & Jiang, 2008; Sligte et al., 2008). Interference can occur during time periods that are shorter than the observed surprise memory test response times (Lewandowsky et al., 2009; Ricker et al., 2015).

How then, should attribute amnesia be assessed? In their commentary, Wyble and Chen (2017) proposed that attribute amnesia is indexed by poorer performance on the surprise trial relative to the postsurprise trials, rather than by chance performance on the surprise memory test. They pointed out that in postsurprise trials participants expect to have to report the attribute, but have no such expectation in surprise trials. Although this is certainly true, it is nevertheless the case that, unlike postsurprise trials, the surprise memory test requires participants to learn and adjust to the new task demands. Thus, comparing performance on the surprise and postsurprise trials confounds the expectation to report the attribute with the effects of encountering those new task demands. What is measured is the nature of the representations that survive the memory test, and the conditions under which they are likely to do so. Consistent with this claim, we reported in Jiang et al. (2016) that the surprise memory procedure disrupts memory for both the attribute that participants expected to report and the attribute that defined the target. We suggested that the disruption is reduced on postsurprise trials, in part, because the same instructions, response mappings, and task demands are no longer novel or surprising. Contrasting performance on the surprise and postsurprise trials underestimates participants' memory for the target-defining attribute by including the effects of surprise, task set reconfiguration, and any number of unknown processes, regardless of how long it takes. Usage of this procedure may yield insights into when and what type of mental representation survives the surprise test. However, it cannot address the inherent gap between what the surprise memory test procedure measures and what existed in memory before the disruption set in.

Though the surprise test procedure is imperfect, it is a valuable tool for understanding the conditions under which memory will be robust enough to survive the procedure. Jiang et al.'s (2016) study was not designed to address this issue. Our explanation for the finding that "identity memory was less robust than location memory" was that "location continued to be relevant for the task but identity was no longer relevant" (Jiang et al., 2016, p. 1336). This statement describes the conditions under which we might expect memory for an attribute to survive the surprise memory test. It does not speculate about the mechanisms that might make that possible. Therefore, we consider the recent work of Chen and Wyble as advancing, rather than contradicting, our views about attribute amnesia. We agree that experimental manipulations that strengthen a memory representation should increase the likelihood that the representation persists despite significant interference. We further agree that mechanisms that strengthen these representations are more likely to be evoked when the task requires it (Makovski et al., 2008; Maxcey-Richard & Hollingworth, 2012; Sligte, Scholte, & Lamme, 2008). Chen and Wyble's recent work on attribute amnesia has provided valuable insight into the conditions under which attribute memory can be strengthened. This work shows that having to maintain a target attribute over a delay increases its chance of survival in the surprise test (Chen & Wyble, 2016). This could be attributable to consolidation. Without additional data, however, Jiang et al. (2016) allow that other factors may also play a role. These factors could include attention to the information in working memory, the binding of features to objects, depth of processing, how the representation is used, and associating the stimuli to oneself.

One issue of debate raised in Wyble and Chen's (2017) commentary is the nature of memory for the recently attended target attribute. Two possibilities have been raised: (a) the mental representation of the target's identity was initially robust and then reverted to a weak state once identity became irrelevant, and (b) the representation was never in a robust format (e.g., the representation was weakly encoded, never consolidated, or the features were not bound to items in working memory). It may be tempting to conclude that our original study supported the first possibility. For example, one might consider the priming data as evidence that participants had robust representations of the target's identity, and the surprise memory data as evidence that this representation was weakened. However, our data do not warrant such an interpretation. Jiang et al. (2016) did not assess the robustness of a target attribute's mental representation at two different time points: when the identity was relevant and after it became irrelevant. We left this issue open, proposing only that identity memory may have been less robust than location memory because it was no longer relevant, among other possible reasons.

We see several directions for future research on attribute amnesia. First, it is important to refine the methods that are used to assess mental representations of a recently attended attribute while minimizing disruptions from the memory test itself. Second, empirical research should continue tackling questions that examine factors which increase the robustness of attribute memory, both in

the surprise test procedure and in less disruptive measures. For example, what does the requirement to maintain an attribute over a delay do? Does it change how the attribute was initially perceived, how much attention the attribute received during encoding, or the format of the representation that is maintained in working memory? Finally, at the theoretical level, Chen and Wyble's work on attribute amnesia along with their surprise test procedure opens new opportunities for understanding the role of expectation in visual cognition. So far the surprise procedure has been used in studies of attention (e.g., in inattentional blindness), yet clear differences exist between not expecting and not attending. The former taps into task set and the latter is more closely linked to selective processing. Distinguishing lack of attention from lack of expectation is an important theoretical step for guiding future cognitive and neuroscience research on visual cognition.

References

Chabris, C., & Simons, D. (2011). *The invisible gorilla: How our intuitions deceive us* (Reprint ed.). New York, NY: Harmony.

Chen, H., & Wyble, B. (2015). Amnesia for object attributes: Failure to report attended information that had just reached conscious awareness. *Psychological Science, 26,* 203–210. http://dx.doi.org/10.1177/0956797614560648

Chen, H., & Wyble, B. (2016). Attribute amnesia reflects a lack of memory consolidation for attended information. *Journal of Experimental Psychology: Human Perception and Performance, 42,* 225–234. http://dx.doi.org/10.1037/xhp0000133

DeSchepper, B., & Treisman, A. (1996). Visual memory for novel shapes: Implicit coding without attention. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 22,* 27–47. http://dx.doi.org/10.1037/0278-7393.22.1.27

Hollingworth, A., & Henderson, J. M. (2002). Accurate visual memory for previously attended objects in natural scenes. *Journal of Experimental Psychology: Human Perception and Performance, 28,* 113–136. http://dx.doi.org/10.1037/0096-1523.28.1.113

Jiang, Y. V., Shupe, J. M., Swallow, K. M., & Tan, D. H. (2016). Memory for recently accessed visual attributes. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 42,* 1331–1337. http://dx.doi.org/10.1037/xlm0000231

Lewandowsky, S., Oberauer, K., & Brown, G. D. A. (2009). No temporal decay in verbal short-term memory. *Trends in Cognitive Sciences, 13,* 120–126. http://dx.doi.org/10.1016/j.tics.2008.12.003

Liefooghe, B., Barrouillet, P., Vandierendonck, A., & Camos, V. (2008). Working memory costs of task switching. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 34,* 478–494. http://dx.doi.org/10.1037/0278-7393.34.3.478

Makovski, T., Shim, W. M., & Jiang, Y. V. (2006). Interference from filled delays on visual change detection. *Journal of Vision, 6,* 1459–1470. http://dx.doi.org/10.1167/6.12.11

Makovski, T., Sussman, R., & Jiang, Y. V. (2008). Orienting attention in visual working memory reduces interference from memory probes. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 34,* 369–380. http://dx.doi.org/10.1037/0278-7393.34.2.369

Maxcey-Richard, A. M., & Hollingworth, A. (2012). The strategic retention of task-relevant objects in visual working memory. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 39,* 760–772. http://dx.doi.org/10.1037/a0029496

Rensink, R. A., O'Regan, J. K., & Clark, J. J. (1997). To see or not to see: The need for attention to perceive changes in scenes. *Psychological Science, 8,* 368–373. http://dx.doi.org/10.1111/j.1467-9280.1997.tb00427.x

Ricker, T. J., Vergauwe, E., Hinrichs, G. A., Blume, C. L., & Cowan, N. (2015). No recovery of memory when cognitive load is decreased. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 41,* 872–880. http://dx.doi.org/10.1037/xlm0000084

Schacter, D. L., & Graf, P. (1986). Preserved learning in amnesic patients: Perspectives from research on direct priming. *Journal of Clinical and Experimental Neuropsychology, 8,* 727–743. http://dx.doi.org/10.1080/01688638608405192

Sligte, I. G., Scholte, H. S., & Lamme, V. A. F. (2008). Are there multiple visual short-term memory stores? *PLoS ONE, 3,* e1699. http://dx.doi.org/10.1371/journal.pone.0001699

Wyble, B., & Chen, H. (2017). Memory consolidation of attended information is optional: Comment on Jiang et al. (2016). *Journal of Experimental Psychology: Learning, Memory, and Cognition, 43,* 997–1000. http://dx.doi.org/10.1037/xlm0000333

Received August 29, 2016
Accepted October 12, 2016 ■