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Hypercorrection of high confidence errors: Prior testing both enhances delayed performance and blocks the return of the errors

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ABSTRACT

How people correct their mistakes and sustain those corrections over time is a problem of central interest to education. It might be thought that the erroneous beliefs that people hold with high confidence would be especially difficult to correct. Interestingly, people correct these high confidence errors more easily than low confidence errors, a phenomenon known as the 'hypercorrection effect'. Unfortunately, though, with a delay in testing there is a tendency for some of these high confidence errors to reemerge – a finding with serious consequences for education. This study investigated the effect of intervening a test immediately after corrective feedback on preventing the return of the errors. It also investigated processing differences between prevention-focused and promotion-focused people. The most educationally important new finding was that testing immediately after corrective feedback not only greatly enhanced memory for the correct answers but also blocked the return of the errors.

Although it is often asserted that the propensity to commit errors is a fundamental characteristic of being human, correcting those same errors can be seen as one of the primary tasks of education. Whether, as an educator, one should encourage students to express their errors has been a topic of recent debate. A number of research findings indicate that generating errors – as long as corrective feedback is provided (see Butler & Roediger, 2008; Finn & Metcalfe, 2010; Kang, McDermott, & Roediger, 2007; Lhyle & Kulhavy, 1987; McDaniel & Fisher, 1991; Metcalfe, Kornell, & Finn, 2009; Pashler, Cepeda, Wixted, & Rohrer, 2005) – may help rather than hinder learning (Grimaldi & Karpicke, 2012; Hays, Kornell, & Bjork, 2013; Huelser & Metcalfe, 2012; Kornell, Hays, & Bjork, 2009; Richland, Kornell & Kao, 2009; Slamecka & Fevreiski, 1983). However, in the studies that have demonstrated that making errors helps later memory for the correct answer, the 'errors' that have been produced have nearly always been mere guesses rather than genuine errors that the person believes to be correct. In contrast, the present paper investigates a paradigm in which the errors that people make are genuine, but fallacious, responses to questions of fact. Our focus will be on error correction when people strongly believe that the error that they produced was the correct answer, in contrast to mere guesses or responses about which they expressed low confidence.

It may seem intuitive, and a number of theories of memory support the idea (Barnes & Underwood, 1959; Murdock, 1974; Raaijmakers & Shiffrin, 1981), that the errors that an individual strongly believes are correct should be resistant to correction. For example, classic interference theory proposed that when a cue or question A, is associated with a response B, and then the individual is asked to learn a new response, C, to that original cue, the two responses, B and C compete with one another. The stronger the first response (B), the more difficult it should be to supplant it with a new response (C). Although this logic has usually been applied to experimentally learned responses, and not to the educational issue of correcting erroneous prior knowledge, nevertheless the application to error correction seems appropriate. Despite the plausibility of the conjecture that strong prior (but erroneous) responses should make updating difficult, experimental investigations in which a person is asked a factual question, gives an answer along with his or her confidence in the correctness of the answer, is provided with corrective feedback, and then is retested for the correct answer, have shown that high confidence errors are particularly *easy* to correct, a phenomenon known as the *hypercorrection effect* (Butterfield & Metcalfe, 2001).

This effect has been demonstrated many times with immediate testing (Butler, Karpicke, & Roediger, 2008; Butler & Roediger, 2008; Eich, Stern & Metcalfe, 2013; Fazio & Marsh, 2009a, 2010; Kulhavy &

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Stock, 1989; Metcalfe, Butterfield, Habeck, & Stern, 2012; Metcalfe & Finn, 2012a; Sitzman, Rhodes, & Tauber, 2014). Both children and college-aged adults hypercorrect (Metcalfe & Finn, 2012b), although there is some evidence that older adults may hypercorrect less than college-aged participants do (Eich et al., 2013). Hypercorrection occurs with different types of materials (e.g., Fazio & Marsh, 2010, though see Sitzman & Rhodes, 2010) but has most frequently been studied with general information questions. It also appears to occur with delayed testing, although only two studies involving a delay have, so far, been published (Butterfield & Mangels, 2003; Butler, Fazio, & Marsh, 2011). One of these studies also showed that there is a *tendency for the errors to return at a delay* (Butler et al., 2011) – a phenomenon of central concern educationally and in the present article. We will investigate a potential method to prevent this return of the errors.

Two explanations of the hypercorrection effect have garnered empirical support. The first explanation is that when individuals receive feedback that indicates that the answer they have just given with considerable confidence is wrong, they rally their attentional resources – perhaps because they were surprised, embarrassed or upset at having made the mistake – and devote those resources to efforts to impress into memory the correct answer. When they are wrong but with less confidence, they are less concerned and their attentional response to the feedback is less intense.

Several studies provide support for this explanation. Butterfield and Metcalfe (2006) used a simultaneous tone detection task while people were answering and receiving feedback to high and low confidence errors. Failure to detect a soft tone while the feedback was being presented was taken as indicating that the individual's attention was focused on processing the feedback rather than listening for the tone. People missed the tone presented with the feedback more frequently when they had made a high rather than a low confidence error. An experiment by Butterfield and Mangels (2003) indicates a similar conclusion. They conducted an event related potential study of the hypercorrection effect. Time locking to the onset of the corrective feedback, they found an exaggerated p3 voltage deflection during feedback to high as compared to low confidence errors – again suggesting increased attention to the high confident error corrections. And, finally, Fazio and Marsh (2010) showed that people remembered not only the answer but the background on which the answer was presented, again suggesting that they paid more attention to the entire subsequent event, when they had made a high confidence rather than a low confidence error.

The second, non-mutually exclusive explanation that has been extensively explored with regard to the hypercorrection effect is semantic in nature. People are more familiar with the questions related to errors that are committed with high than with low confidence, as well as to the answers associated with those questions (Butterfield & Mangels, 2003; Butterfield & Metcalfe, 2006). Metcalfe and Finn (2012a) conducted a latent semantic analysis (LSA, Landauer & Dumais, 1997) of the relatedness of the errors to the correct answers, both for high and for low confidence errors. This analysis revealed a tighter associative relation between the target and high confidence errors than between the target and low confidence errors. Furthermore, both children and adults claim, upon being given the correct responses, that they 'knew the answers all along' (Metcalfe & Finn, 2012a,b) more for high than for low confidence errors. This is not purely a hindsight bias (Fischhoff, 1975; Hawkins & Hastie, 1990). Metcalfe and Finn (2012a) showed that if before being given the corrective feedback people are asked to make a second guess, or to choose the correct answer in a multiple choice test that does not include their mistake, or they are given successive clues about the answer, they are more likely to produce the answer, to correctly select the answer, and they need fewer clues, for high confidence errors as compared to low confidence errors. These data indicate that they did, in fact, know (all along) something more about the answers to high than to low confidence errors.

It seems likely that while both of these factors are interactive (see Sitzman et al., 2014) and contribute to hypercorrection, the attentional factor might be more short lived than the semantic structure factor. Furthermore, people's semantic structure might be subject – over long delays – to a regression toward its pre-corrective feedback state. Such a regression to the pre-experimental state of semantic memory – a state which included the erroneous response as correct – could presage the return of the high confidence errors over time. This phenomenon was observed by Butler et al. (2011) and is the prime concern of the present article. While these researchers showed that the hypercorrection of high confidence errors persisted at a delay of over a week, they also demonstrated that there was a tendency for some of the original high confidence errors to re-emerge. They suggested that these errors might *not* reemerge if an intervening test were imposed, citing an unpublished study by Fazio and Marsh (2009b) that failed to show evidence for the return of the errors at a delay. However, the failure to find a return of errors, in isolation, is a null effect that could have resulted from myriad causes. While potentially of great educational interest, then, whether testing immediately following corrective feedback might be sufficient to prevent the return of the errors is currently unknown. In the present experiment, we directly test this conjecture in a well controlled within-participants design.

There is a third potential explanation – the recursive reminding hypothesis – that has not previously been applied to the hypercorrection effect but that also deserves attention. Wahlheim and Jacoby (2013, and see Jacoby & Wahlheim, 2013) have proposed that, rather than proactive inhibition (as would be expected by interference theory, as discussed above), proactive *facilitation* will occur if (a) the participant notices at the time of presentation of C that there is a change from the earlier B response, and if (b) they later 'bring to mind' (Jacoby, Wahlheim, & Yonelinas, 2013, p. 638) the B item at time of test for C (and see, Hintzman, 2004). If, however, participants do not bring item B to mind at time of test, its earlier occurrence in the context of A results in proactive interference. In the hypercorrection context, B is the original error, which, in the experimental procedure that follows is corrected the moment it is committed. It is very unlikely that participants fail to notice the change from the error to the correction at time of presentation of the correct answer, given that there is no time delay between the generation of the erroneous response and the presentation of the correction. It is not currently known, however, whether people bring to mind their original high confidence errors more than their low confidence errors when they are tested. But it seems likely. It is also unknown, in the context of factual error correction, whether bringing to mind the original errors helps, rather than hurts (or leaves unaffected) memory for the corrections. These are empirical questions. In the experiment that follows, to investigate whether the original errors come to mind, and whether doing so helps or hurts, we asked people to produce two answers to each question at time of post feedback recall and to indicate which of the two is correct. The recursive reminding hypothesis, to explain the hypercorrection effect, would predict that (a) the original errors should show up more for high than for low confidence errors, and that (b) the probability of error correction, that is of producing the correct 'C' responses and knowing that they are correct, should be higher when the original errors come to mind than when they do not.

This paper also investigates the possibility that there might be individual differences in error correction dependent upon what Higgins (1997), and colleagues, refer to as "regulatory focus." According to regulatory focus theory (Higgins, 1997; see Molden & Miele, 2008, for a review), people who are primarily *promotion-focused*, tend to eagerly seek opportunities for gain that will move them closer to their goals. As a consequence, they are willing to take