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Overcoming screen inferiority in learning and calibration

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ABSTRACT

Metacognitive monitoring that accompanies a learning task reflects self-prediction of achievement at test. Well-calibrated monitoring is important because it is by this subjective assessment that people allocate their learning efforts. Previous studies that compared learning outcomes and calibration of monitoring when learning texts on screen and on paper have found screen inferiority: screen learners performed worse and were more overconfident about their success. However, learning from one's preferred medium was associated with attenuated overconfidence. The present study examined two methods for overcoming screen inferiority in these respects. First, practicing the study-test task allowed overcoming screen inferiority, but only among those who preferred reading from screens. Second, in-depth processing was encouraged by having participants generate keywords at a delay, before monitoring their knowledge and taking the test. This method eliminated screen inferiority even for the first-studied texts, but after practicing it, screen inferiority was re-exposed among those who preferred studying on paper. This study makes a practical contribution to educational practice by suggesting directions for overcoming screen inferiority. From a broader perspective, the study demonstrates that experience with the task and in-depth processing can attenuate overconfidence and that the effectiveness of learning-enhancing methods depends on the study context and learners' preferences.

1. Introduction

Theories of self-regulated learning suggest that spontaneous subjective assessment of knowledge, or metacognitive monitoring, plays an important role in learning regulation (Nelson & Narens, 1990), in addition to the conscious use of learning strategies and assessment of their effectiveness (see Winne & Hadwin, 1998; Greene & Azevedo, 2007, for reviews). Indeed, empirical studies dealing with memorization and reading comprehension tasks have shown an association between monitoring output and decisions regarding allocation of study time (Metcalfe & Finn, 2008; Thiede, Anderson, & Therriault, 2003). However, studies dealing with reading comprehension tasks have found that the accuracy of the relevant metacognitive judgments – metacomprehension judgment or prediction of performance at test – tends to be particularly poor (Dunlosky & Lipko, 2007; Thiede, Griffin, Wiley, & Redford, 2009).

It is well established that metacognitive monitoring is not always reliable, and that this is because learners base their judgments on heuristic cues (Koriat, 1997; see Bjork, Dunloksy, & Kornell, 2013; Metcalfe, 1998; Dunlosky & Tauber, 2013, for reviews). Although this theory was originally developed in the context of memorization tasks, a body of research has suggested that such cues are similarly used to judge comprehension. Cues found to take part in metacomprehension judgments include domain familiarity and interest in the topic (Glenberg & Epstein, 1987; Maki & Serra, 1992), accessibility of information in memory (Baker & Dunlosky, 2006), text concreteness (Ackerman & Leiser, in press), ease of processing the text (Dunlosky & Rawson, 2005; Maki, Foley, Kajer, Thompson, & Willert, 1990; Rawson & Dunlosky, 2002), and global characteristics of texts such as length or difficulty (Weaver & Bryant, 1995). According to this literature, the accuracy of metacomprehension judgments is affected by the predictive validity of these and other cues used in the metacomprehension process.

Previous studies which examined factors that affect metacomprehension accuracy dealt, in the main, with characteristics of the learners (e.g., Griffin, Wiley, & Thiede, 2008), the particulars of the tasks (e.g., Thiede et al., 2003), or characteristics of the text's contents or design (e.g., Ackerman, Leiser, & Shpigelman, 2013; Rawson & Dunlosky, 2002). The present study broadens this inquiry in line with theories highlighting that learners' beliefs regarding the effectiveness of computer-supported learning environments modulate the ways in which these learning environments are used, the goals people set for their learning, and the expected outcomes (e.g., Antonietti & Colombo, 2008). Examinations of these theories often focus on conditions, involving

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both individual differences and design of the learning task, that enable effective utilization of unique features found in computerized learning environments but not on paper, like multimedia and hypertext (e.g., Antonietti, Colombo, & Lozotsev, 2008; Azevedo, 2005; Veenman, Prins, & Elshout, 2002).

We took into account individual differences in beliefs regarding the effectiveness of learning on screen versus on paper, by extending a line of research analyzing reading comprehension that can be performed comparably on both media (Ackerman & Goldsmith, 2011; Ackerman & Lauterman, 2012). In particular, it was found that peoples' medium preference affect their metacognitive processes when learning from texts (Ackerman & Lauterman, 2012). From a theoretical perspective, this approach enables a focus on how the medium through which learning takes place affects self-regulated learning by ruling out differences resulting from population, content, and design-based characteristics. From a practical perspective, learning from continuous texts is widespread in computerized environments, and in many cases these environments offer no special features that are not found on paper. For instance, digital media provide an assortment of on-demand textual information for developing professional competence, like providing access to user reference books or academic papers. Students face computerized reading comprehension tasks in their studies, and higher education candidates face them in online screening exams (e.g., the Graduate Management Admission Test, the GMAT). Thus, it is important to consider the ways self-regulated learning is affected by the medium on which one learns.

Several studies have found screen inferiority in subjective and objective learning measures, as detailed below. In the present study, we aimed to offer methods for overcoming screen inferiority, while considering the study medium, screen versus paper, and participants' medium preference as factors in this improvement.

1.1. The effect of the study medium on text learning

There is growing evidence for cognitive and behavioral differences associated with learning from texts presented on screen and on paper. For example, students scored lower in reading comprehension tests after reading a text presented on screen compared with paper (Mangen, Walgermo, & Brønnick, 2013). Liu (2005) found in a self-report study that when reading on screen, people tend to engage more in browsing and scanning, one-time reading, and non-linear reading, with less sustained attention and less time spent reading in depth. Such findings suggest that people perceive reading from a screen as appropriate for a superficial kind of reading. Indeed, Morineau, Blanche, Tobin, and Guéguen (2005) found that the mere presence of an e-book near a learner hindered recall of information, while the presence of the paper book facilitated it. They suggested that the medium on which a text is presented provides a contextual cue for the retrieval process. It is possible that because of this perception, fewer cognitive resources are mobilized for the comprehension and metacomprehension processes when learning from a screen.

Only a few studies have examined the effects of the reading medium on metacomprehension processes. Ackerman and Goldsmith (2011) compared metacognitive monitoring and control during on-screen and paper learning when both groups of participants faced identical tasks. They measured participants' calibration bias–a measure of over- or underconfidence-by calculating the gap between the participants' mean Predictions of Performance (POPs) and test scores. On-screen learners (OSLs) showed more pronounced overconfidence than on-paper learners (OPLs). In accordance with their biased monitoring, OSLs studied the texts for a somewhat shorter time and achieved lower test scores than OPLs. Considering the increasing prevalence of on-screen learning, it is worth looking into methods for overcoming the screen inferiority found with respect to both performance and calibration bias.

Overall, people tend to prefer reading texts in depth from print rather than from computerized environments (Buzzetto-More, Sweat-Guy, & Elobaid, 2007; Jamali, Nicholas, & Rowlands, 2009; Spencer, 2006; Woody, Daniel, & Baker, 2010). Indeed, the screen inferiority found by Ackerman and Goldsmith (2011) was obtained from students who strongly preferred print over computerized learning. Using students who had only a moderate preference for print, Ackerman and Lauterman (2012) found similar screen inferiority only under mild time pressure. On the one hand, this finding suggests that these students could overcome screen inferiority when they did not have the additional burden of adhering to a time limit. On the other hand, this finding also suggests that screen inferiority remains potent even among learners who have a more positive attitude towards this study medium. Interestingly, Ackerman and Lauterman (2012) found that the best calibration was achieved in both media by those who studied on their preferred medium. Thus, learners' preference seems to be an additional important factor in the accuracy of knowledge monitoring and in the effectiveness of learning regulation according to task demands even for learning from continuous texts.

1.2. Metacomprehension improvement

Metacomprehension research combines reading comprehension theories with metacognition theories. Kintsch (1998) proposed a model of representation levels to explain the processes involved in reading comprehension. According to this model, readers construct meaning from a text at three levels: surface level – the information conveyed by words and signs; the relationships between words that comprise sentences; and at the highest level, the extraction of meaning not conveyed directly by the words and their relationships, a process that Kintsch calls inference or situational representation. It can be derived from this theory that when high-order comprehension is tested, POP should be more accurate when it relies on cues related to high-level representation of the text.

Indeed, two kinds of manipulations aimed at improving high-level representation have been shown to enhance participants' monitoring accuracy. The first of these is practice with the task and test. Hacker, Bol, Horgan, and Rakow (2000) found, in a natural classroom setting, better calibration of POPs as students gained more test practice during the course. Attenuation of overconfidence with practice, and even underconfidence, were found in memorization tasks (e.g., Koriat, Sheffer, & Ma'ayan, 2002). The present study examined whether overconfidence would also be reduced when participants practiced text learning and subsequent test-taking over one session.

The second approach shown to improve monitoring accuracy involves encouraging learners to engage in in-depth processing of the studied text. For example, asking participants to generate keywords or to write a summary of the text after a delay consistently improved monitoring accuracy (Anderson & Thiede, 2008; Fukaya, 2013; Thiede, Dunlosky, Griffin, & Wiley, 2005). In another study, improvement was achieved by instilling test expectancy directed to the level of processing required by the test (Thiede, Wiley, & Griffin, 2011). These methods for enhancing depth of processing proved effective for improving resolution – that is, the extent to which metacognitive judgments discriminate between better- and lesser-known items. Thiede and his colleagues did not examine calibration bias. The present study examined whether such in-depth processing methods are also effective for attenuating overconfidence.

Notably, many of the studies that have found improvements in monitoring accuracy were conducted in computerized