Cognitive flexibility and epistemic validation in learning from multiple texts

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Abstract

Advanced learning in ill-structured domains is frequently based on multiple documents that contain conflicting information and opposing perspectives on the same or related issues (such as multiple texts belonging to a scientific controversy). In such cases, cognitive flexibility can be defined as the ability to develop a justified point of view by adopting some arguments and rejecting others on rational grounds. I will suggest that learners can achieve this goal only if they actively and strategically validate incoming text information against previously acquired knowledge and beliefs (epistemic validation) (statement 1). Up to now, the cognitive processes underlying epistemic validation have not been addressed by the major theories in the fields of text comprehension and learning from text. I will introduce a simple process model according to which epistemic validation rests on two types of cognitive processes, (automatic) epistemic monitoring and (strategic) epistemic elaboration (statement 2). Epistemic monitoring means that learners regularly and efficiently monitor incoming text information for internal consistency and plausibility. In many cases, learners tend to refute new information that conflicts with their prior knowledge or information acquired earlier. Alternatively, learners who are motivated and able to do so may engage in an effortful and strategic epistemic elaboration of arguments that are initially evaluated as implausible. Finally, I will propose that learners' epistemological beliefs serve as declarative metacognition that is crucial for engagement in epistemic elaboration. As such, epistemological beliefs determine whether learners achieve cognitive flexibility in learning with multiple texts (statement 3).

Cognitive flexibility and epistemic validation in learning from multiple texts

The concept of cognitive flexibility has been introduced by Spiro and coworkers as an important objective for advanced learning in ill-structured domains (Spiro, Feltovich, Coulson, & Anderson, 1988). Advanced learners are those who already possess some knowledge about the content domain they are studying. Accordingly, advanced learning is more likely to be found in secondary education, in academic settings, or professional training than in elementary education. A content domain is ill-structured if it meets two criteria: (1) a great deal of complexity, i.e. a large number of concepts and relations between these concepts, and (2) irregular and inconsistent information. For advanced learning in such a domain, the instructional objective of cognitive flexibility may be defined as the ability to spontaneously restructure one's knowledge in response to changing cognitive demands posed by the learning material (Spiro & Jehng, 1990).

Cognitive flexibility is a relevant objective also for learning with multiple texts, a field that has started to attract research in educational psychology only a decade or so ago (Perfetti, Britt, & Rouet, 1999; Rouet, 2006; Rouet, Britt, Mason, & Perfetti, 1996). In learning with multiple texts, learners study several texts (rather than just one textbook chapter) that represent divergent perspectives on the same issue. More often than not, learning with multiple texts is a case of advanced learning in an ill-structured domain. Imagine, for example, a student who has already acquired some basic knowledge in an area of science, e.g., climatology. This student might use the internet to find out more about a current topic such as the causes global warming. In the course of her studies, she might encounter a scientific article claiming that global warming is attributable to the fact that human activities have increased emissions of greenhouse gases. At some later point, she might read another text that discusses an increase in solar activity as a major cause of global warming. Still later, the student might study another document that criticizes current climate models as being too unreliable to be used for predicting global warming at all. Thus, the student is likely to be confronted with different theoretical viewpoints and inconsistent evidence. In order to learn successfully, she needs to process various types of conflicting information, to assess the credibility and plausibility of this information, and to integrate it into a coherent and adequate point of view.

The scenario just described is typical for advanced learning in all areas of science. More often than not, advanced learning in science is based on multiple texts representing different positions in a scientific controversy, empirical studies with results that seem to contradict one another, or documents that present divergent interpretations of empirical findings and methods. In all of these cases, cognitive flexibility can be defined further as the ability to

develop a justified point of view by adopting some arguments and rejecting others on rational grounds.

In the following sections, I will argue and present some preliminary empirical evidence for three theoretical propositions. First, I will suggest that the goal of cognitive flexibility requires learners to actively validate incoming text information against previously acquired knowledge and beliefs (epistemic validation). Second, I will sketch a model of the cognitive processes underlying epistemic validation. In particular, I will argue for the proposition that epistemic validation rests on two types of cognitive processes, i.e. (automatic) epistemic monitoring and (strategic) epistemic elaboration. While epistemic monitoring is a regular part of comprehending the information presented in multiple documents, epistemic elaboration is optional and (meta-)cognitively more demanding. Importantly, learners can be expected to achieve cognitive flexibility only if they engage in epistemic elaboration. Among other things, learners' epistemological beliefs, i.e. their beliefs about the nature of knowledge and knowing (Hofer & Pintrich, 1997) are a major determinant of whether they engage in epistemic elaboration or not. My third theoretical proposition will be that epistemological beliefs serve as a kind of declarative metacognitive knowledge that guides learners' strategic use of epistemic elaboration. In this way, epistemological beliefs can have an indirect but profound influence on cognitive flexibility in learning from multiple texts.

1. Cognitive flexibility requires active validation of information

Learners studying multiple texts with conflicting arguments will be unable to achieve an adequate understanding of the content domain by merely processing the presented information in a receptive manner. Rather, they need to actively judge whether the information communicated by the various texts is true or plausible. In other words, learners need to evaluate the knowledge claims raised by the various documents with respect to validity criteria such as (propositional) truth, logical consistency, or argument quality. This kind of judgments may be termed *epistemic validation* (Richter, 2003). In providing these judgments, learners use their background knowledge and what they have already learned from previously studied texts as epistemic background for validating incoming text information.

Epistemic validation processes are largely ignored by the dominating theoretical approaches to text comprehension and learning from text. To be sure, all major theories in these fields acknowledge the relevance of prior knowledge for improving the quality of learning processes and outcomes. However, they restrict the functions of prior knowledge to setting constraints on the interpretation of text information (e.g., the Construction-Integration

model, Kintsch, 1988, 1998), to an interpretative framework or scaffold for integrating new text information (e.g., schema theory, Anderson, 1985), or to a knowledge-base for inferences and other cognitive activities by which learners enrich the information given (e.g., constructivism/constructionism, Bruner, 1973; Graesser, Singer, & Trabasso, 1994). Their huge theoretical differences notwithstanding, all of these theories presuppose a supplemental relationship of text information and prior knowledge. The Construction-Integration model is a case in point. Because of its text-driven, bottom-up character, the model can handle conflicting information only by assigning negative links in the construction phase. In the integration phase, conflicts between propositions in the network are resolved mainly by strengthening some nodes and suppressing others. In this way, a stable situation model can be constructed even in the face of conflicting information. However, this is done simply by capitalizing on some information while ignoring other information. Thus, a text-driven model such as the Construction-Integration model may be able to describe how one-sided, impoverished representations originate when learners encounter conflicting information (Otero & Kintsch, 1992). However, it cannot explain how learners can make sense of multiple documents with conflicting information.

Accumulating facts and enriching or scaffolding them with prior knowledge are successful strategies only for learning materials that are fully plausible and consistent. In contrast, if multiple texts present conflicting information or information that is inconsistent with prior knowledge such a strategy is doomed to failure. In that case, learners can only arrive at a coherent representation of the content of these texts by actively using prior knowledge and previously acquired information to evaluate the plausibility of what a particular text tries to make them believe. This activity involves comparing competing claims raised by different texts and checking the quality of arguments in order to come up with an informed and justified point of view (cp. Perfetti, Britt, & Georgi, 1995). In a nutshell, successful learning with multiple texts requires cognitive flexibility. Cognitive flexibility, in turn, requires epistemic validation.

2. Epistemic validation rests on epistemic monitoring and epistemic elaboration processes

How can the cognitive processes underlying epistemic validation in learning with multiple texts be described? I suggest that epistemic validation rests on two types of processes that may be termed epistemic monitoring and epistemic elaboration. The distinction between epistemic monitoring and epistemic elaboration maps onto the long-standing distinction of routine and efficient memory-based vs. slow and resource-demanding explanation-based

processes in text-comprehension research (Graesser et al., 1994; McKoon & Ratcliff, 1992). In this section, I will outline the nature of epistemic monitoring and epistemic elaboration and review empirical evidence that supports the assumption of these processes. I will then explain how cognitive flexibility in learning with multiple texts depends on the interplay of epistemic monitoring and epistemic elaboration.

2.1 Epistemic monitoring: Routine and efficient detection of inconsistencies

Epistemic monitoring processes routinely check for the consistency of prior knowledge and incoming text information. Provided that learners possess relevant prior knowledge that is active in working memory or can easily be made available by passive memory-based processes, epistemic monitoring processes are carried out routinely and efficiently, i.e. they pose little demands on cognitive resources and are not dependent on processing goals (Richter, Schroeder, & Wöhrmann, 2009). In most cases, learners use their current situation model, i.e. the referential representation of the content domain they have build up already during learning, for monitoring the plausibility of new information (Johnson-Laird, 1983; Zwaan & Radvansky, 1998). In the scenario introduced above, the student of climatology who just read a document arguing that global warming is caused by human activities is likely to have integrated some of these arguments into her situation model of global warming. When the student is studying another text arguing for solar activity as the main cause of global warming, the previously acquired arguments are activated from long-term memory (cued by concepts common to both texts such as *causes of global warming*) and the inconsistency is detected by epistemic monitoring. Due to the memory-based and routine character of epistemic monitoring, all of this happens fast, with little cognitive effort, and regardless of the students' reading goal.

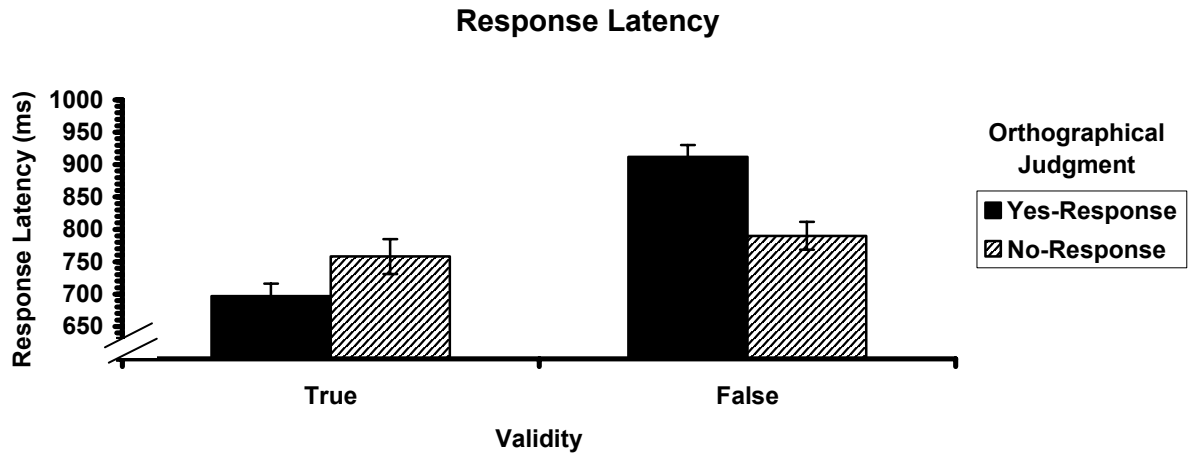
Evidence for routine and efficient epistemic monitoring processes comes from a large body of psycholinguistic research showing that inconsistencies between incoming information and currently active or easily accessible knowledge are detected quite regularly. Recent research from our work group provides direct evidence for the existence of these processes (Richter et al., 2009). In one experiment, words were presented rapidly (300 ms or 600 ms) one by one on a computer screen. At some words, the presentation stopped and participants were asked to judge whether the word was spelled correctly or not. Sequences of words formed simple assertions that were either true (e.g., *Fire trucks are red*) or false (e.g., *Soft soap is edible*). In trials in which the target word was the last word of an assertion, response latencies and error rates of the orthographical judgments were increased when the task required an affirmative response (i.e., the last word was spelled correctly) but the assertion

was false. Response latencies and error rates were also increased when the task required a negative response (i.e., the last word was spelled incorrectly) but the assertion was true (Figure 1). Thus, there was a Stroop-like effect suggesting that individuals routinely and unintentionally monitor the validity of information. This effect may be called epistemic Stroop effect.

In addition, experiments by Singer, Halldorson, Lear, and Andrusiak (1992) provide indirect evidence for the assumption that comprehenders routinely monitor the plausibility of implicit background assumptions (enthymemes) of causally related sentences. Inconsistent causal sequences such as *Dorothy poured the bucket of water on the bonfire - The fire grew hotter*, facilitated responses to questions such as *Does water extinguish fire?* compared to temporal sequences that were used as controls. Similarly, there is evidence from reading-time and event-related potential studies that comprehenders monitor the logical consistency (Lea, 1995; Lea, Mulligan, & Walton, 2005) and situational plausibility of texts (Ferretti, Singer, & Patterson, 2008; Singer, 2006) even if they do not follow an intentional validation strategy. In most cases, comprehension of sentences with inconsistent and implausible information was slowed down.

All of the studies mentioned in the last paragraph establish one important precondition for epistemic monitoring in text comprehension: Prior knowledge or previously encountered information relevant for detecting the inconsistency must either be currently active in working memory or it must be reinstated routinely and with little cognitive effort by textual cues. The passive memory-based processes involved here can be modeled computationally with the resonance-like activation mechanism implemented in the Landscape Model (Tzeng, van den Broek, Kendeou, & Lee, 2005; van den Broek, Risden, Fletcher, & Thurlow, 1996). In this context, resonance means that concepts activated during reading by incoming text information will activate other concepts associated with it by means of spread-of-activation (McKoon, Gerrig, & Greene, 1996; O'Brien & Myers, 1999). These concepts can be part of the mental representation of the text content as well as part of prior knowledge stored in long-term memory.

a)



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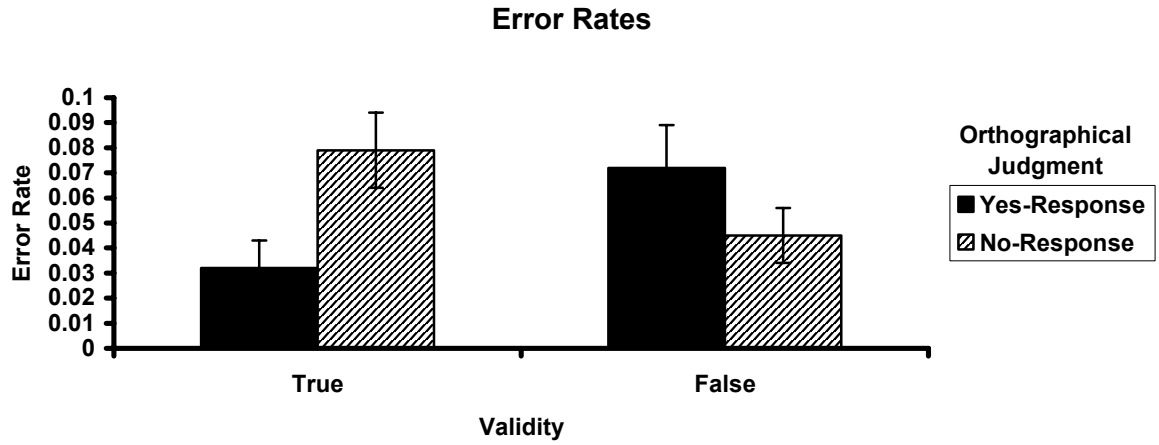

Figure 1. Epistemic Stroop effect: Orthographical judgments concerning the last word of simple assertions take more time (a) and are more error-prone (b) if the required response (yes vs. no) and the validity of assertions (true vs. false) are incongruent. For example, judging whether the last word of the false assertion *Computers have emotions* is spelled correctly takes longer and is more error-prone compared to judging the last word of the true assertion *Cognac contains alcohol*. This pattern is reversed if the last word is spelled incorrectly (e.g., *emohtions* and *alcoholl*), requiring a no-response for the orthographical judgment. (Adapted from Richter et al., 2009, Figure 4; with kind permission from the American Psychological Association).

2.2 Epistemic elaboration: Resolving inconsistencies by strategic and knowledge-based processing

As a result of detecting an inconsistency between previously held beliefs and text information by epistemic monitoring, learners sometimes may initiate *epistemic elaboration processes*. In contrast to epistemic monitoring, epistemic elaboration is based on processes

that are assumed to be slow, resource-demanding, and under the strategic control of the learner (Richter, 2003). For these reasons, learners are likely to engage in these processes only if they are motivated and able to do so. Learners motivated to engage in epistemic elaboration study in order to come up with a justified point of view of how things really are (epistemic learning goal) rather than to accumulate information in an uncritical manner (receptive learning goal). The goal to memorize as much information as possible for later reproduction of this information, for instance, is probably widespread among students preparing for an exam but it may effectively prevent learners from engaging in epistemic elaboration. Learners able to engage in epistemic elaboration should have sufficient cognitive resources (working memory capacity) available and possess relevant prior knowledge. If both the motivational and cognitive conditions are met, learners can use their prior knowledge to elaborate hypothetical truth conditions of an assertion or argument initially found implausible. In other words, epistemic elaboration processes evaluate the circumstances that – were they given – would render the questionable piece of information or argument valid (cp. Johnson-Laird, 1983, p. 249). Ultimately, epistemic elaboration processes may lead to a conscious decision about whether a particular piece of information or argument is accepted as being valid or rejected as being invalid (for a detailed model-based account of these processes, see Johnson-Laird, Girotto, & Legrenzi, 2004).

Epistemic elaboration processes are accompanied by other knowledge-based comprehension processes such as elaborative and bridging inferences that learners use to establish hypothetical truth conditions or to search for evidence that could support some doubtful piece of information. As a consequence, epistemic elaboration can strongly foster learning by supporting learners in the construction of a rich situation model and gaining an informed and point of view on the content domain (Richter, 2003). For example, the student of climatology in the sample scenario might start wondering how the inconsistency can be resolved that she has noticed between the claim of one text that human activities are the main cause of global warming and the claim of the other text that solar activity is the main cause. She might actively search for further information in the texts and her own long-term memory that would support or weaken either position. In the end, she would come up with an informed decision on which position is more plausible to her and, as a by-product, also with a rich situation model of global warming and its causes. However, it is important to keep in mind that all of this can happen only if the student follows the goal to gain an accurate and justified view on the causes of global warming, if her cognitive resources are not absorbed by other

activities, and if she possesses sufficient and relevant prior knowledge that she can use for epistemic elaboration.

Relative to epistemic monitoring, evidence for epistemic elaboration processes is still rather sparse. In experiments by Wiley and Voss (1999) on learning with multiple texts in history, students wrote more coherent and essays with stronger causal links and scored better on inference and analogy tasks when they had received the instruction to write an argumentative essay, compared to the tasks to write a summary or a narrative text (for similar results, see Voss & Wiley, 1997). Given that the task to write an argumentative essay is likely to induce an epistemic learning goal, these results are in line with the idea that strategic (i.e., deliberate) epistemic elaboration foster situation model construction and the development of a justified point of view.

The view advocated here also incorporates the assumption that epistemic elaboration processes are initiated when an inconsistency between text information and prior knowledge is detected. This assumption implies that learners should benefit from texts with implausible information if they are motivated and able to engage in epistemic elaboration. The effect predicted by this somewhat counterintuitive assumption may be termed *reverse validity effect* because it resembles the well-documented reverse coherence effect (i.e., high-knowledge learners often benefit from incoherent texts, McNamara, Kintsch, Songer, & Kintsch, 1996). Richter (2003, Experiment 1) tested one part of this hypothesis in an experiment with university students who read expository texts that contained only valid arguments or a number of invalid arguments (argumentation errors). Participants read these texts either with an epistemic learning goal ("develop your own point of view!") or a receptive learning goal ("memorize facts!") in mind (time on-task was held constant). Participants who read the texts with the epistemic learning goal in mind showed better comprehension on the situation model level for texts with invalid arguments compared to the text with only valid arguments. Situation model strength was assessed by means of responses to multiple-choice inference questions. Participants who read the texts with the epistemic learning goal also produced more arguments to support their stance toward the position of the text. For participants with the receptive learning goal, the pattern of results was reversed. Apparently, inconsistencies of text information and world knowledge evoked by texts with invalid arguments stimulated epistemic elaboration processes if participants were motivated to invest the cognitive effort needed for epistemic elaboration. A recent experiment from our work group focused on the second part of the reverse validity effect, i.e. prior knowledge as a prerequisite for epistemic elaboration (Richter, Schroeder, & Wöhrmann, unpublished data). In this experiment,

university students again learned with texts that presented either only valid arguments or valid arguments mixed with invalid ones. In line with the hypothesis of a reverse validity effect, those participants who possessed a large amount of prior knowledge were able to construct a richer situation model for the texts with invalid arguments compared to the texts with only valid arguments (Figure 2).

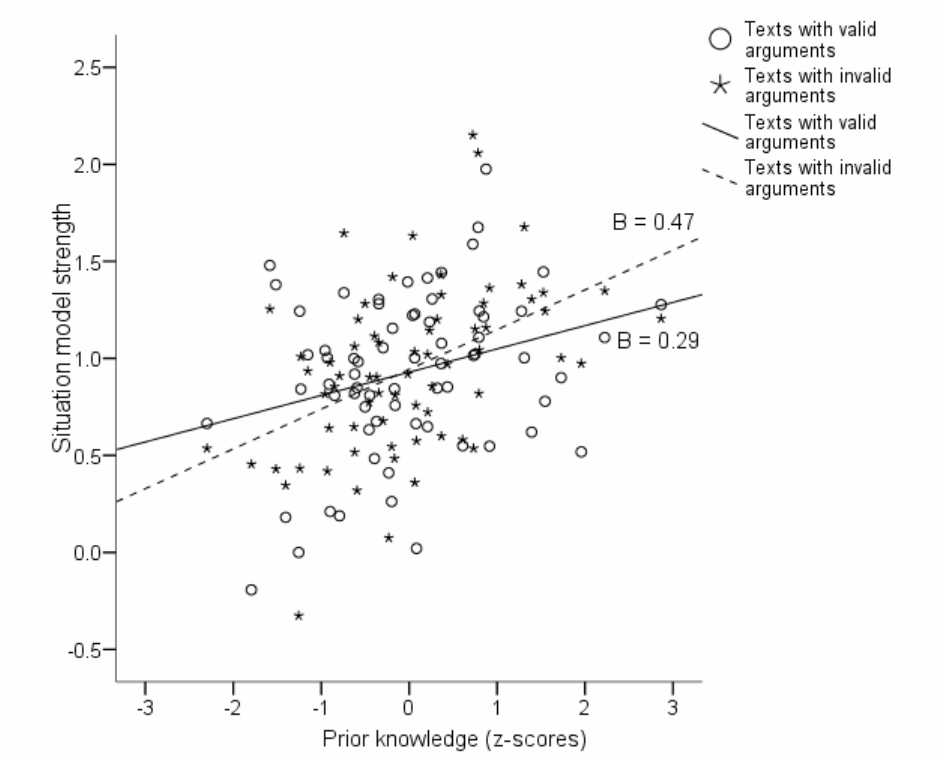

Figure 2. Reverse validity effect: Invalid arguments lead to better comprehension on the level of the situation model if learners possess sufficient prior knowledge to engage in epistemic elaboration. The figures display simple slopes for prior knowledge (with standardized regression coefficients) for texts with valid and invalid arguments. Situation model strength was measured with a variant of the recognition method proposed by Schmalhofer and Glavanov (1986). (Richter, Schroeder, & Wöhrmann, unpublished data).

2.3 Epistemic monitoring, epistemic elaboration and cognitive flexibility

The simple process model outlined in the preceding sections is also applicable to learning with multiple texts that contain conflicting information. The assumptions of two types of cognitive processes, one routine and efficient and the other one strategic and resource-demanding, allows precise predictions as to when learners achieve cognitive flexibility in learning with multiple texts and when they fail to do so. In particular, based on the process model, an assimilative and an elaborative mode of dealing with conflicting information during learning can be distinguished. These will be discussed in turn.

Assimilative epistemic processing

First consider what happens if a learner studying multiple texts lacks the motivation and/or the ability to engage in epistemic elaboration, for example because she follows a learning goal that does not necessitate epistemic elaboration or lacks cognitive resources or relevant background knowledge. In this case, only epistemic monitoring processes are carried out because these processes neither require a specific learning goal nor do they demand a large amount of cognitive resources. As a consequence, incoming information that conflicts with information from previously read texts is likely to be processed in an *assimilative mode*. Learners' use their current situation model as the primary basis for epistemic monitoring. The current situation model, in turn, rests in large parts on the contents of previously read texts. Incoming information that is revealed by epistemic monitoring to be inconsistent with the current situation model is simply rejected and will not be integrated into the situation model. As a result, the situation model will be biased towards the contents of the texts read earlier. In sum, the process model of epistemic validation implies that learners often will not exhibit cognitive flexibility in dealing with conflicting information in multiple texts. Rather, they tend to stick to information they have already learned.

Several branches of research on learning, text comprehension and social information processing suggest that the cognitively inflexible mode of assimilative processing seems to be the default way to deal with conflicting information. For example, numerous studies on conceptual change have shown that it can be quite difficult to change previously acquired knowledge and beliefs (Chinn & Brewer, 1993; Limon & Mason, 2002; Vosniadou, 1994). It seems plausible that these difficulties can partly be explained by assuming that students often rely on epistemic monitoring without engaging in epistemic elaboration. Research on the persistence of discredited or corrected information (continued influence of misinformation effect, Ross, Lepper, & Hubbard, 1975; Johnson & Seifert, 1994) suggests a similar conclusion. Johnson and Seifert (1994) used fictional news reports as text materials that were continuously updated during the experiment. In the course of the updating, some of the information given in earlier reports was corrected by information provided later. Despite being explicitly corrected, the initial information continued to be used by participants in judgment and inference tasks. Interestingly, the research on the continued-influence-of-misinformation effect also sheds light on the conditions under which such effects occur. For example, Johnson and Seifert (1994) found that only pieces of (mis)information central to the causal chain of the reported events were likely to persist whereas representations of less important details were easily altered. In a similar vein, self-generated causal explanations and

knowledge-based inferences seem to amplify the continued-influence-of-misinformation effect (Anderson, Lepper, & Ross, 1980; Ross, Lepper, Strack, & Steinmetz, 1977). Finally, there is evidence that the effects occur only if the initial information is consistent with participants' prior knowledge and beliefs (Lewandowsky, Stritzke, Oberauer, & Morales, 2005). Being part of the causal chain of a story and being elaborated by self-generated explanations or knowledge-based inferences, the initial information is more likely to be integrated into a situation model representation. Once it is part of the situation model, it is immediately available for the epistemic monitoring of incoming information and can be used to detect and reject inconsistent information. Schroeder, Richter, and Hoever (2008) directly tested the hypothesis that epistemic validation and integration of information into a situation model representation are closely related to each other. In their experiment, university students read expository texts that contained implausible sentences. A multinomial models analysis of recognition and plausibility judgments revealed a close- bi-directional relationship of validation and situation model construction: Plausible information was more likely to be integrated into participant's situation model than implausible information. On the other hand, information that was part of the situation model was more likely to be judged as plausible. Thus, once information has passed the epistemic gatekeeper and becomes part of a learner's situation model, it is used for monitoring the validity of incoming information. One consequence of this bi-directional relationship is that learners can hardly achieve cognitive flexibility in learning with multiple texts if epistemic validation does not go beyond epistemic monitoring.

Elaborative epistemic processing

Next consider what happens if a learner is both motivated and able to engage in epistemic elaboration of inconsistencies between multiple texts. In that case, the learner will actively search for arguments and evidence on both sides of the conflicting issue and elaborate hypothetical truth conditions. This mode of processing conflicting information may be termed *elaborative epistemic processing*. Overall, learning with multiple texts benefits from elaborative epistemic processing in several ways. First, by considering both sides of an issue, learners are likely to make well-justified and rational decisions on what view they should adopt themselves. Second, they will know arguments and evidence for and critical arguments against both sides of the issue, which will make it easier to change their mind should they encounter new information. Third, they will also pay more attention to the sources they are studying and encode meta-information about the sources which is relevant for assessing their credibility (e.g., characteristics of the author, text genre, form of

publication, etc.) along with the factual information (sourcing, Britt & Angliskas, 2002). All of these aspects are central to cognitive flexibility in learning with multiple texts.

3. Epistemological beliefs serve as declarative metacognition guiding epistemic elaboration

The assumption that epistemic elaboration processes are under the strategic control of learners brings epistemological beliefs into play. Epistemological beliefs are subjective theories about characteristics, criteria, and justification conditions of knowledge (Schmid & Lutz, 2007). These theories, which can be more or less coherent, complete, and adequate, are the subjective counterpart of objective theories developed in classical epistemology and the philosophy of science, in a similar way as declarative metacognitive knowledge consists of subjective theories about the subject matter of cognitive psychology (e.g., Flavell & Wellman, 1977). In this sense, epistemological beliefs may be regarded as an epistemological (as opposed to cognitive-psychological) kind of metacognitive knowledge (Hofer, 2004; Kitchener, 1983; Mason & Boldrin, 2008). As such, epistemological beliefs are relatively stable learner characteristics that can have a profound influence on the cognitive flexibility that learners can achieve in learning with multiple texts. According to the framework outlined here, epistemological beliefs exert this influence via epistemic elaboration processes.

Generally speaking, a well-developed epistemological position (such as commitment within relativism, Perry, 1970, or reflective judgment, King & Kitchener, 1994) makes it more likely that learners follow an epistemic learning goal which, in turn, is a precondition for epistemic elaboration. A key dimension in most structural models of epistemological beliefs is the perceived certainty of knowledge (Hofer and Pintrich, 1997). Learners who believe that knowledge is certain and never changing are likely to regard expository texts and scientific publications as a source of unquestionable information. Thus, the fundamental insight that knowledge is fallible and changing as a matter of principle is a precondition to engage in epistemic elaboration at all. In support of this general hypothesis, a study by Richter and Schmid (2010, Study 2) found the belief that knowledge is uncertain and changing to enhance the likelihood that university students engaged in epistemic strategies such as actively checking whether knowledge claims are backed up by sound reasons. This effect was mediated by epistemic curiosity and moderated by learners' extrinsic motivation (Figure 3). Epistemic curiosity was measured by items referring to affective or motivational reactions to cognitive conflicts (e.g., *I want to know which theory is correct in the explanation of a certain phenomenon*). Thus, the belief that knowledge is uncertain or changing seems to predispose

learners to be curious to learn how things really are. This motivational state, in turn, can enhance the likelihood and the intensity of epistemic elaboration. On the other hand, this relationship can easily be undermined by extrinsic motivation. If, for example, learners focus on achievement goals (e.g., to score well in an exam) effects of epistemological beliefs on epistemic curiosity and epistemic elaboration seem to be suspended.

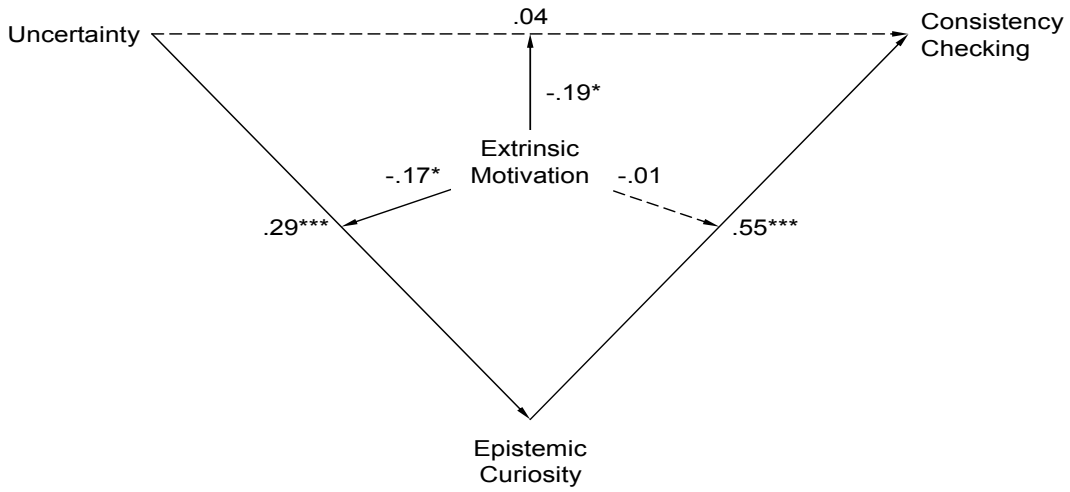

Figure 3. The epistemological belief that knowledge is uncertain and changing fosters the use of epistemic strategies by evoking epistemic curiosity, but this mediator relationship holds only if extrinsic motivation is low (moderated mediation). Arrows pointing at other arrows indicate moderator effects (moderated mediation, standardized coefficients). (Adapted from Richter & Schmid, 2010, Figure 3; with kind permission from Springer Science+Business Media.)

However, the belief that knowledge is uncertain and changing per se may not sufficient to induce an epistemic learning goal. For example, a relativist position which also incorporates this belief would not be compatible with such a goal. For this reason, the framework outlined here implies that a relativist position ("Some people say A, others say B – that is ok for me") will usually go along with superficial understanding because it essentially prevents learners from epistemic validation. This is because learners will strive for making a rational decision on the acceptance or rejection of claims and arguments only if they believe that knowledge is certain and fallible and, at the same time, that there are objective standards of knowledge and the justification of knowledge claims. In other words, the dimension of certainty is likely to interact with the perceived objectivity or need of justification when it

comes to epistemic elaboration. Recent data from our workgroup on the reverse validity effect suggest that this is indeed the case (Richter, Schroeder, & Wöhrmann, unpublished data). We found that only learners who believe that knowledge is subject to change but is nevertheless structured and objective (measured with the dimensions Variability and Texture of the instrument CAEB, Stahl & Bromme, 2007) were able to benefit from a text that contained invalid arguments. In contrast, holding only the belief than knowledge is subject to change or only the belief that knowledge is structured and objective was not sufficient to produce a reverse validity effect.

In sum, there is emerging evidence that epistemological beliefs serve as a special kind of metacognitive knowledge that determines whether and to what extent learners engage in epistemic elaboration or epistemic strategies. According to the framework outlined here, this implies that epistemological beliefs should also have a profound impact on cognitive flexibility in learning with multiple texts, and that this impact should be mediated by epistemic elaboration. Recent research by Pieschl, Stahl, and Bromme (2008) on the role of epistemological beliefs in hypertext learning suggests that there might be some truth to this idea. In their study, university students with more sophisticated epistemological beliefs accessed more complex and deeper-level nodes in a hypertext learning environment on genetic fingerprinting. According to Pieschl et al. (2008), this finding shows that epistemological beliefs serve as standards for calibrating learning processes. This interpretation is of course in line with the model advocated here. However, direct tests of the relationships between epistemological beliefs, epistemic elaboration, and learning with multiple texts are still lacking.

Conclusion

This chapter described a cognitive process model of epistemic validation in the comprehension of multiple texts with conflicting information. The model is based on the distinction of routine, memory-based epistemic monitoring and strategic, resource-dependent epistemic elaboration processes. Several empirical findings such as the epistemic Stroop effect (Richter et al., 2009), plausibility effects on situation model construction (Schroeder et al., 2008), or the reverse validity effect corroborate the assumption that these two types of processes underlie epistemic validation.

What is familiar and what is new about the process model of epistemic validation? Generally speaking, the model proposed here is compatible with current theories of text comprehension and learning from text but it also goes beyond these theories in important respects. By assuming that comprehenders monitor the consistency of incoming information,

the model incorporates a specific type of top-down processes as a regular part of comprehension. On that score, the model outlined here differs from theories such as the Construction-Integration model (Kintsch, 1988,1998) which concentrate on text-driven processes only. By combining memory-based processes (epistemic monitoring) and explanation-based processes (epistemic elaboration), the process model picks up the general – and increasingly popular – idea that both types of processes contribute to text comprehension (van den Broek, 2005).

Finally, when it comes to the comprehension of multiple texts, the process model of epistemic validation coheres well with the theoretical framework proposed by Rouet and co-workers (1996; Perfetti et al., 1999), which may be regarded as the starting point of a systematic study of multiple text comprehension. However, the idea that an adequate comprehension of multiple texts that includes cognitive flexibility requires the active validation of conflicting information adds a novel aspect to the picture. It implies a number of interesting and empirically testable predictions. So far, few of these predictions have been tested so there is a lot of empirical work ahead. It looks like a worthwhile endeavor.

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