

Need for cognitive closure may impede the effectiveness of epistemic belief instruction

Tom Rosman^a, Anne-Kathrin Mayer^a, Johannes Peter^a, and Günter Krampen^{ab}

^a *Leibniz Institute for Psychology Information (ZPID), Universitaetsring 15, D-54296 Trier, Germany*

^b *University of Trier, Universitaetsring 15, D-54296 Trier, Germany*

This is an Accepted Manuscript (peer-reviewed version) of an article published by Elsevier in *Learning and Individual Differences* on 31 May 2016.

Recommended citation: Rosman, T., Mayer, A.-K., Peter, J., & Krampen, G. (2016). Need for cognitive closure may impede the effectiveness of epistemic belief instruction. *Learning and Individual Differences*, 49, 406–413. doi: 10.1016/j.lindif.2016.05.017.

Acknowledgements: Research was funded by the German Joint Initiative for Research and Innovation with a grant acquired in the Leibniz Competition 2013 (grant number SAW-2013-ZPID-1 195). We thank Dipl.-Psych. Sandra Waeldin from the ZPID – Leibniz Institute for Psychology Information for carrying out both the epistemic change and the learning strategy interventions.

Abstract

The present article examines the effects of need for cognitive closure on epistemic belief instruction efficacy. Individual differences in need for closure were assumed to interfere with the mechanisms postulated in Bendixen's (2002) process model of epistemic change and thus impede intervention effectiveness. A short-term epistemic belief intervention drawing on both the presentation of diverging (i.e., controversial) information and on constructivist teaching approaches (i.e., moderated discussion) was developed. Instruction primarily aimed at reducing absolute and multiplicitic beliefs in psychology freshmen. In a pretest-posttest field-experimental study, 83 psychology freshmen were randomly assigned to the intervention group or one of two control groups (learning strategies instruction group or untreated control group). As expected, epistemic belief intervention reduced both absolute and multiplicitic beliefs. With regard to multiplicitic beliefs, high need for closure significantly reduced instruction efficacy. Our findings thus highlight the crucial importance of considering individual differences in epistemic belief instruction.

Keywords: Epistemic beliefs; Absolutism; Multiplicism; Need for cognitive closure; Instruction;

Introduction

The present article investigates need for cognitive closure as a moderator of epistemic belief intervention effectiveness. Epistemic beliefs are defined as individual conceptions about the nature of knowledge and the process of knowing (Hofer, 2000; 2001). Research emphasizes that individual differences in epistemic beliefs are linked to information processing (Kardash & Howell, 2000), text comprehension (Bråten, Strømsø, & Ferguson, 2016), learning (Cano, 2005; Rosman, Peter, Mayer, & Krampen, submitted), and academic achievement (Schommer, 1993). For example, students viewing scientific knowledge as “dynamic, interrelated, and more constructed rather than ‘found’” (Porsch & Bromme, 2011, p. 807) will likely put more emphasis on the breadth and depth of learning contents than students conceiving knowledge as an accumulation of absolute truths.

Even though there is a small literature base on how to promote more advanced beliefs (e.g., Muis & Duffy, 2013; Kienhues, Bromme, & Stahl, 2008), studies on individual factors that moderate epistemic belief instruction effectiveness are very rare¹. Nevertheless, Kienhues, Ferguson, and Stahl (2016) point out that individual differences might influence how people benefit from epistemic belief interventions. This should especially apply to variables which are likely to influence motivation for epistemic change (Kienhues et al., 2016), and might explain why many instructions seem to work out well for some individuals but not for others (Maggioni, Alexander, & van Sledright, 2004; Kienhues et al., 2008). Need for cognitive closure – defined as an individual’s desire for “an answer on a given topic, any answer, ... compared to confusion and ambiguity” (Kruglanski, 1990, p. 337) – is particularly

¹ As pointed out by an anonymous reviewer, one notable exception is a study by Ferguson and Bråten (2013) who investigated changes in epistemic beliefs (induced by confrontations with conflicting texts) as a function of individual topic knowledge.

promising in this regard because it can easily be manipulated at the group-level, thus entailing important implications for classroom practice and epistemic belief instruction.

1 Background

Two main approaches can be identified in the epistemic beliefs literature. In the *dimensional approach*, epistemic thinking is conceptualized as a set of largely independent beliefs about, for example, the sources or justification of knowledge (Barzilai & Weinstock, 2015). The dimensional approach primarily uses quantitative measurements (i.e., Likert-type questionnaires). For example, agreement to statements like “Ideas in science sometimes change.” is deemed to reflect more advanced beliefs (Conley, Pintrich, Vekiri, & Harrison, 2004). The *developmental approach* conceives the development of epistemic beliefs as a sequence of three successive stages characterized by different, partly opposing conceptions of knowledge and knowing (Kuhn, 1991; Kuhn & Weinstock, 2002): *Absolutists* tend to view knowledge as an accumulation of certain and absolute “facts”: An ultimate truth exists and experts can ultimately get to it. In contrast, *multiplicists* view scientific knowledge as inherently subjective, up to the point where they interpret all viewpoints on a topic as equally legitimate “opinions” (so-called *radical subjectivity*). Finally, individuals who reach the stage of *evaluativism* realize themselves to be part of the process of knowledge and knowing, and acknowledge that different positions might require weighting of evidence and evaluations of truthfulness (Hofer & Pintrich, 1997). Qualitative measurements (e.g., interviews) are more prominent in developmental approaches. These nevertheless may be enriched by quantitative measures. For example, Barzilai and Weinstock (2015) stress, with regard to developmental approaches, “a need to complement such methods with quantitative measures that enable assessment among larger and more diverse samples and in varied research settings” (p. 142).

In line with this, the present article draws on a quantitative approach to investigate changes in epistemic beliefs using Kuhn's (1991) developmental model.

1.1 Epistemic beliefs in psychology

Knowledge in psychology is ill-defined (e.g., concepts are loosely structured and theories are inconsistent; Muis, Bendixen, & Haerle, 2006) and educational practices frequently emphasize the presence of multiple explanations for a phenomenon (Palmer & Marra, 2008). Moreover, differences in epistemic beliefs between various disciplines have been shown (e.g., higher multiplicism in psychology; Green & Hood, 2013; Muis, Trevors, Duffy, Ranellucci, & Foy, 2015). In line with this, the Theory of Integrated Domains in Epistemology (TIDE) suggests that domain-specific beliefs are shaped by students' instructional environment, which is why psychology freshmen might become even more multiplicistic during their first semesters. Believing that psychology solely reflects an accumulation of opinions, they might even develop a radically subjectivist (Hofer & Pintrich, 1997) stance towards psychological knowledge. Students with such *highly generalized* (i.e., generalized onto psychology in general and not attending to context) multiplicistic beliefs no longer see meaning in striving to understand and weigh different positions. This is in line with Hofer's (2001) concern that multiplicism might thwart students' intellectual commitment, which might also lead to rote learning, feelings of confusion, and decreased study satisfaction.

Support for a view that multiplicism impedes learning comes from research on multiple text comprehension (e.g., Bråten, Strømsø, & Samuelstuen, 2008; Bråten, Ferguson, Strømsø, and Anmarkrud, 2013). For example, after assessing students' epistemic beliefs, Bråten et al. (2013) had their participants read multiple documents on a controversial scientific issue (sun exposure and health) and subsequently answer three short essay-questions deemed to indicate students' understanding of the respective issue. When controlling for prior

topic knowledge, they found a view of knowledge as inherently subjective (personal justification of knowledge) to negatively predict multiple-documents comprehension. In line with this, Elby and Hammer (2001) assume learners to be more persistent in trying to understand counter-intuitive learning content when they view the content as certain (in contrast to tentative). In light of these arguments, we see highly generalized multiplicistic beliefs as a grave obstacle for learning and achievement in psychology.

A contextually adaptive view of knowledge and knowing, on the other hand, might very well be helpful for learning. Students who recognize that depending on the issue in question, knowledge might be (un)certain to different degrees (i.e., who are better at coordinating objective and subjective conceptions of knowledge; Kuhn & Weinstock, 2002), might, for example, put a stronger focus on the argumentative or methodological quality of psychological studies, thus entailing deeper processing and ultimately better learning. Therefore, we see evaluativism as the most sophisticated² form of epistemic beliefs, whereas – at least in psychology – absolutism and multiplicism might be more unsophisticated.

1.2 Epistemic change and epistemic belief instruction

The *Process Model for Personal Epistemology Development* (Bendixen, 2002) specifies three central mechanisms for epistemic change: First, individuals have to recognize a dissonance between existing beliefs and new experiences (i.e., they have to question their existing beliefs). This mechanism is called *epistemic doubt*. In a next step, so-called *epistemic*

² While it is beyond the scope of this paper, we agree with Bromme, Kienhues, and Porsch's (2010) suggestion that a certain amount of domain-specific knowledge is required for evaluativistic judgments, and that relying on an expert (a component of absolutism) might be more functional for laypersons. We thus acknowledge that the "sophisticatedness" of epistemic beliefs strongly depends on context and that our distinction might be oversimplified.

volition, which implies the intention to devote sustained effort to changing one's beliefs (Ferguson, Bråten, & Strømsø, 2012), comes into play. The third mechanism focuses on so-called *resolution strategies* (e.g., reflection and social interaction) to solve the dissonance (Kienhues et al., 2008). Using think-aloud protocols, Ferguson and colleagues (2012) found evidence for the model's components, in particular for epistemic doubt and resolution strategies.

Consistent with a view of epistemic doubt as a catalyst for epistemic change, many (shorter) interventions aim at increasing students' awareness for the existence of differing positions towards issues, mainly through presenting diverging information in text form (e.g., Gill, Ashton, & Algina, 2004; Kienhues et al., 2008). According to Kienhues and colleagues (2016), diverging information refers "to all types of information that present different, apparently conflicting, viewpoints to the information consumer" (p. 3). Since multiple viewpoints on an issue are presented, diverging information might especially be suited (and has been shown) to reduce absolute beliefs and foster a view of scientific knowledge as tentative and evolving (Gill, Ashton, & Algina, 2004; Kienhues et al., 2008; Kienhues et al. 2016; Porsch & Bromme, 2011).

Since high multiplicism might be maladaptive in certain domains, it is nevertheless not only important to sensitize students for the *existence* of different opinions or positions. In line with Bendixen's (2002) model, we posit that especially in psychology, comprehensive epistemic belief instruction should consist of in-depth examinations of different positions to issues, allowing discussion and social interaction, and highlighting the active role of learners in knowledge construction. This has been adopted by some through focusing on the knowledge building process in more constructivist learning environments (Kienhues et al., 2016), usually aiming at changing epistemic beliefs in curricular courses over several months (e.g., Marra, Palmer, B., & Litzinger, 2000; Brownlee, Purdie, & Boulton-Lewis, 2001; Muis

& Duffy, 2013). For example, Muis and Duffy (2013) used constructivist teaching techniques (i.e., discussion and reflection) to foster epistemic beliefs over one semester in a social sciences statistics class (e.g., discussing different statistical methods to approach a specific problem). Highly significant intervention effects were found on “constructivist” epistemic beliefs (i.e., a view of knowledge as complex, tentative, and personally constructed; Muis & Duffy, 2013).

Finally, some complement the above mentioned techniques by direct instruction on epistemic beliefs or critical thinking principles (e.g., Brownlee et al., 2001; Valanides & Angeli, 2005; Hefter, Renkl, Riess, Schmid, Fries, & Berthold, 2015). This might be especially fruitful in the domain of psychology since views of psychological knowledge as generally tentative should not be strengthened further. Instead, cautiously “guiding” students towards evaluativism (i.e., through moderated discussion and brief instruction) might be a helpful addition to confrontations with scientific controversies.

In an effort to reduce both absolutism and multipicism, we thus designed an intervention aimed at increasing students’ awareness for the existence of differing positions towards issues while at the same time – through both constructivist teaching techniques and direct instruction – conveying the ideas that in psychology, (1) existing theories might be challenged by further research, (2) inconsistencies and contradictions between different theories are central for research progress, and that, (3) due to varying empirical evidence and argumentative quality, context-dependent weighting of different theories is nevertheless possible. We expect the intervention, which is described in greater detail in the methods section, to impact all three mechanisms of change postulated in Bendixen’s (2002) model.

Hypothesis 1: In a pre-post design, epistemic belief instruction is associated with a decline in both absolute (H1a) and multipicistic (H1b) domain-specific epistemic beliefs.

1.3 Individual differences in epistemic change

As mentioned above, the efficacy of epistemic belief interventions might be moderated by individual differences, especially when these are likely to influence motivation for epistemic change (Kienhues et al., 2016). Kruglanski and Webster (1996) argue that students with high need for closure have a strong desire to arrive at quick solutions to problems (*seizing*) and are motivated “to preserve (or safeguard) prior knowledge and to protect it for the future” (*freezing*; DeBacker & Crowson, 2009, p. 308).

Need for closure relates positively to both absolutism (DeBacker & Crowson, 2006) and multiplicism (Peter, Rosman, Mayer, Leichner, & Krampen, 2015). Individuals striving to avoid ambiguity and seeking “easy” solutions (high need for closure) tend to overgeneralize and will therefore likely develop highly generalized absolute or multiplicitic beliefs. On the other hand, individuals with lower need for closure “might well find pleasure in comparing and integrating competing points of view, which constitutes a very central component of evaluativism” (Peter et al., 2015, p. 7).

Still, research on how need for closure might influence *changes* in epistemic beliefs is scarce. This is striking, since both *seizing* and *freezing* are prone to interfere with the mechanisms of change in Bendixen’s (2002) process model. Since they have a desire for quick solutions (*seizing*), individuals with a higher need for closure might find it difficult to accept the key messages of epistemic instruction (e.g., that “easy” solutions are scarce and that advanced epistemic thinking is effortful). Moreover, once a certain belief has been adopted, individuals high in need for closure develop a permanence tendency (i.e., *freezing*), “which is marked by high subjective confidence in the new knowledge [and] low openness to new information” (DeBacker & Crowson, 2009, p. 308). They therefore might choose to ignore or reject information that is incompatible with current beliefs (Kunda, 1990; Chinn &

Brewer, 1993), thus neglecting their epistemic doubt. This argument also applies to epistemic volition, since the desire of safeguarding prior knowledge might lead to devaluating intervention contents instead of reflecting and eventually changing one's beliefs. In sum, both seizing and freezing might manifest themselves in reduced epistemic doubt and in dysfunctional resolution strategies like (1) reduced engagement in discussions on epistemic beliefs, (2) a lower amount of reflection (Bendixen & Rule, 2004), and (3) less openness for diverging opinions (e.g., in group discussions; DeBacker & Crowson, 2009).

Hypothesis 2: Need for cognitive closure moderates instruction effectiveness in the epistemic belief instruction group: With decreasing need for closure, changes in absolute (H2a) and multiplicitic (H2b) beliefs will become more pronounced.

2 Method

2.1 Epistemic belief instruction

With the intent of reducing absolute and multiplicitic beliefs, a 90-minute small-group intervention was developed. The intervention uses a *multiple-texts* approach (i.e., contradicting texts on a certain issue to be read by participants; Ferguson et al., 2012; Ferguson, Bråten, Strømsø, & Anmarkrud, 2013) complemented by constructivist teaching techniques and direct instruction. It is based on six text pairs containing short descriptions of contradicting psychological studies (around 60-90 words each). All studies were fictitious to ensure that prior knowledge and beliefs would not interfere with the instructional mechanisms. For example, the first text pair involved two studies testing a new teaching method; one study found beneficial effects and the other did not (see Figure 1). Each pair included specific cues (e.g., methodological aspects of the studies, potential moderators, etc.) that might account for the contradictions (e.g., different samples; see Figure 1). Since most

undergraduate psychology curricula have a strong empirical focus, the majority of text pairs focused on methodological aspects of psychological studies. Nevertheless, one pair also referred to the differentiation between psychoanalytic and cognitive behavioral explanations, whereas another focused the pros and cons of quantitative and qualitative research paradigms, respectively.

Researcher A works for the Department of Educational Psychology at Franzenheim University. He develops a new teaching method (“Learning with pictures”) and evaluates its effects in a study with 160 second graders from three different schools. Compared to “conventionally” taught pupils, the new teaching method has very positive effects on pupils’ learning. The researcher recommends the new teaching method to other teachers.

His colleague, Researcher B, examines the new teaching method in another study. Compared to “conventionally” taught pupils, no effects are found, neither in a group of 120 sixth graders at secondary schools (two different schools) nor in a group of 70 high school students. The researcher strongly advises teachers against using the new teaching method.

Figure 1: Sample intervention text

After reading each text pair, an instructor encouraged students to reflect on the controversial positions, to develop hypotheses about their causes, and to share and discuss these hypotheses with the other participants. This “reflection phase” was complemented by short summaries presented orally and on flipcharts, explicitly focusing the three ideas presented in section 2.2 and instructing students on how to deal with controversies in empirical research (e.g., identify moderator variables or analyze argument strength).

We expected the intervention to impact all three mechanisms of change suggested by Bendixen (2002). The intervention was developed based on the three mechanisms of change (epistemic doubt, epistemic volition, and resolution strategies) suggested in Bendixen’s (2002) epistemic change process model. Presenting controversial evidence might, at first,

make multiplicistic beliefs more salient (and also induce severe epistemic doubt regarding absolutism; Kienhues et al., 2008). As the apparent contradictions are subsequently straightened out, epistemic doubt might intensify and incline students to question their actual beliefs. Moreover, reflection and discussion phases enable students to resolve – through epistemic change – the disequilibrium that emerges between their current beliefs and the newly made experiences (Bendixen, 2002; Muis & Duffy, 2013). We see it as crucial that these phases are carefully moderated by an instructor, since this allows guiding the discussion towards the three instructional goals and ensuring that the instruction will not “backfire” by, for example, fostering absolutism through a reduction of multiplicism. On this account, the instructor also serves as a role model as he/she explicitly takes the position that most inconsistencies *can* indeed be resolved.

2.2 Participants and procedure

A randomized field experimental study³ using a pre-post-design with one experimental condition and two control groups was carried out. Sample size determination was performed with G*Power 3.1 (Faul, Erdfelder, Buchner, & Lang, 2009), and revealed that with a 3x2 repeated measures design, a sample size of $N = 22$ subjects per group would be sufficient to reveal a small to moderate intervention effect ($f = 0.20$). To be prepared for possible dropouts, we decided to recruit up to 84 participants ($N = 28$ per group). Participants were recruited by means of flyers and a mailing list inviting them to take part in an intervention study on academic skills. Eighty-three undergraduate psychology freshmen (first-semester students seeking a Bachelor’s degree) were eventually recruited. Two participants missed post-testing and were discarded from all analyses. The remaining 81 participants (68 females, 13 males) were $M = 20.38$ ($SD = 2.36$) years old. Data were collected in groups (4 to 18 subjects). Pre-

³ The study was conducted in German language.

test data were collected over the two weeks preceding the interventions; post-test data were collected right after the respective interventions.

Participants were randomly assigned to one of three conditions: Subjects from the experimental group ($n = 27$) participated in a 90-minute epistemic belief intervention. Participants from the first control group ($n = 27$) were assigned to an intervention on learning strategies that was methodologically equivalent to the epistemic belief intervention (i.e., group discussions based on six pairs of texts featuring students who employ different learning strategies). The learning strategy intervention was chosen to demonstrate the specificity of the instruction affecting epistemic beliefs (in contrast to other interventions that might be of use for freshmen, but do not focus the nature of knowledge and knowing). Since participants were neither informed about the intervention goals nor about which intervention group they had been assigned to, this design also reduces possible Hawthorne effects (i.e., participants adapting their behavior to conform to the researchers' expectations). The second control group consisted of $n = 27$ untreated subjects who just completed pre- and post-test.

Both interventions were carried out by a 30 year old, female researcher holding a master's degree in psychology and who did not take part in the development of the intervention or in the generation of hypotheses. The interventions were designed for approximately six students. Due to practical issues (e.g., participants needing reschedules), group size varied between four and six participants in the intervention group and three to seven participants in the learning strategy control group.

2.3 Measures

Epistemic beliefs were measured with a German questionnaire developed by Peter et al. (2015). The questionnaire is based on previous epistemic belief measures (e.g., Schommer, 1990; Hofer, 2000) and consists of 23 generalized (i.e., undifferentiatedly targeting

psychology in general) epistemic statements. Subjects are requested to indicate their agreement with these statements on 5-point Likert scales. The questionnaire draws on a developmental approach and therefore measures absolutism ($k = 12$; e.g., “Truth doesn’t change in this subject.”) and multiplicism ($k = 11$; e.g., “In this subject, only uncertainty appears to be certain.”) on separate scales. The measure’s reliabilities can be found in Table 1.

Need for cognitive closure was measured with a questionnaire by Schlink and Walther (2007), which is based on a short version of the English scale by Webster and Kruglanski (1994). Subjects had to rate 16 Items (e.g., “I don’t like unpredictable situations.”) on a 6-point Likert scale.

3 Results

Table 1 shows means, intercorrelations, and reliabilities of all study variables. In the learning strategy control condition, one univariate outlier was discovered on the post-test multiplicism variable ($z = 3.42$), whom we eliminated from all analyses involving this respective variable.

Table 1

Intercorrelations and reliabilities of all study variables

	<i>M</i>	<i>SD</i>	1	2	3	4	5	6	7
1 Absolute beliefs T1	2.20	0.41	(.66)						
2 Absolute beliefs T2	2.07	0.38	.62***	(.61)					
3 Absolute beliefs residualized gain	-	-	.00	.79***	-				
4 Multiplicistic beliefs T1	3.48	0.39	-.06	-.31**	-.35**	(.58)			
5 Multiplicistic beliefs T2	3.45	0.45	-.24*	-.27*	-.16	.45***	(.72)		
6 Multiplicistic beliefs residualized gain	-	-	-.18	-.12	-.01	-.09	.85***	-	
7 Need for Cognitive Closure	3.26	0.58	.02	-.06	-.09	-.08	.23*	.34**	(.77)

Note: $N = 81$; M = arithmetic mean; SD = standard deviation; Values in bold on the diagonal = Cronbach's Alpha.

* $p < .05$.

** $p < .01$.

*** $p < .001$.

Table 2

Pre- and post-test means and standard deviations of epistemic beliefs in all three conditions

	Absolute beliefs			Multiplicistic beliefs		
	Epistemic change instruction	Learning strategy control	Untreated control	Epistemic change instruction	Learning strategy control	Untreated control
Pre-test (T1)	2.14 (0.51)	2.25 (0.36)	2.21 (0.36)	3.52 (0.42)	3.54 (0.43)	3.36 (0.30)
Post-test (T2)	1.88 (0.39)	2.19 (0.32)	2.15 (0.35)	3.32 (0.54)	3.48 (0.35)	3.49 (0.35)

Note: $N_{\text{epistemic intervention}} = 27$; $N_{\text{learning strategy control}} = 27$; $N_{\text{untreated control}} = 27$; Values in parentheses = standard deviations.

3.1 Hypothesis 1

Univariate analyses of variance (respectively a chi-square test for sex) revealed no significant pre-test-differences between the three experimental conditions with regard to age ($F[2.78] = 0.16; p = .85$), sex ($\chi^2[2, N = 81] = 2.38; p = .30$), absolutism ($F[2.78] = 0.46; p = .63$), multiplicism ($F[2.78] = 1.77; p = .18$), and need for closure (NCC; $F[2.78] = 0.16; p = .85$). For the epistemic instruction group, decreasing scores on both absolutism and multiplicism from pre- to post-test were found (see Table 2). Multiple regression analyses were conducted to investigate whether changes in epistemic beliefs differed between the experimental group and the control groups. First, two residualized gain scores (one for absolute beliefs, one for multiplicistic beliefs; Cronbach & Furby, 1970) were calculated by regressing post-test on pre-test epistemic belief scores. These gain scores served as dependent variables in subsequent multiple regressions. Moreover, group membership (experimental vs. learning strategy control vs. untreated control) was dummy coded (Aiken & West, 1991) with the experimental condition as reference category (0/0 coding). As our design used three conditions, two dummy variables were created. The first dummy variable (D1) tested the learning strategy control against the epistemic change instruction group; the second dummy variable (D2) tested the untreated control against the epistemic change instruction group. To evaluate the effects of group membership on changes in absolutism (H1a) and multiplicism (H1b), two separate multiple regression procedures predicting the respective gain score (H1a: changes in absolutism; H1b: changes in multiplicism) from both dummy variables were conducted. Even with age and sex as covariates, all dummy variables were positive and significant (see Table 3). This indicates that the change in epistemic beliefs was indeed higher in the experimental group compared to both the learning strategy (D1) and the untreated control group (D2). Intervention effects on absolutism were somewhat more robust than effects on multiplicism.

To investigate whether a decrease in multiplicistic beliefs would be associated with an increase in absolute beliefs (which would indicate that our intervention had “backfired”; see section 2.2), correlations between both residualized gain scores were calculated. In the experimental group, no correlation was found ($r = .05$; $p = ns$), whereas in the learning strategy group, both scores correlated negatively ($r = -.48$; $p < .01$).

Table 3

Multiple regression predicting residualized gain scores in absolute and multiplicistic beliefs from dummy coded group membership

	Absolute beliefs (residualized gain)					Multiplicistic beliefs (residualized gain)				
	β	R^2	ΔR^2	F	df	β	R^2	ΔR^2	F	df
Block 1		.01		0.23	2;78		.01		0.49	2;77
age (control)	-.02					-.02				
sex (control)	.08					.11				
Block 2		.16*	.15**	3.56	4;76		.10	.08*	1.98	4;75
age (control)	-.03					-.03				
sex (control)	.03					.10				
D1 (learning strategy control vs. epistemic change instruction group)	.41**					.19				
D2 (untreated control vs. epistemic change instruction group)	.38**					.33**				

Note: $N_{\text{absolute beliefs}} = 81$; $N_{\text{multiplicistic beliefs}} = 80$; Method: Enter; control variables were entered first (Block 1); dummy variables (D1 and D2) were entered subsequently (Block 2); β = standardized regression weight; R^2 = total variance explained; ΔR^2 = change in R^2 from block 1 to block 2; F = F-value; df = degrees of freedom.

* $p < .05$.

** $p < .01$.

3.2 Hypothesis 2

Hypothesis 2 was tested by multiple regression procedures for testing interactions between continuous and dummy coded variables (Aiken & West, 1991). In a first step, two separate multiple regressions predicting the respective residualized gain score (H2a: changes in absolutism; H2b: changes in multiplicism) from (z-standardized) NCC and both dummy variables (Block 1), as well as their interaction terms (Block 2), were conducted. With all variables in the equation, a significant effect of NCC indicates that in the reference category (epistemic change group), the dependent variable (the gain score) is indeed influenced by NCC (Aiken & West, 1991). With regard to absolutism, no significant effects of need for closure, nor any significant interactions, were found (see Table 4). Hypothesis H2a is therefore not supported. With regard to multiplicism (Hypothesis H2b), all of the aforementioned effects were highly significant: need for closure indeed moderates intervention efficacy in the experimental group. Hence, with increasing need for closure, changes in multiplicism tend to become positive; with decreasing need for closure, changes in multiplicism tend to become negative. The significant beta-weights of both interaction terms (see Table 4) indicate that this effect varies among experimental conditions. Therefore, simple slope tests were conducted. The slope of NCC in the intervention group equals its beta-weight in the aforementioned calculations ($\beta = .77; p < .001$). In the other two conditions, the effects of NCC on multiplicism changes were calculated by changing the respective reference group in the dummy coding (to learning strategy, and later on, to untreated control condition) and running the aforementioned procedure again (see Aiken & West, 1991). As expected, no significant effect of need for closure on change in multiplicism in both the learning strategy and the untreated control condition was found.

Table 4

Multiple regression predicting residualized gain scores in absolute and multiplicitic beliefs from dummy coded group membership, need for cognitive closure, and their interactions

	Absolute beliefs (residualized gain)					Multiplicitic beliefs (residualized gain)				
	β	R^2	ΔR^2	F	df	β	R^2	ΔR^2	F	df
Block 1		.17*		3.09	5;75	.19**			3.55	5;74
age (control)	-.03					-.04				
sex (control)	.04					.07				
ZNCC (Need for Cognitive Closure, z-standardized)	-.11					.32**				
D1 (learning strategy control vs. epistemic change instruction)	.41**					.20 ⁺				
D2 (untreated control vs. epistemic change instruction)	.39**					.31**				
Block 2		.19*	.02	2.39	7;73	.31**	.12**	4.63	7;72	
age (control)	.01					-.10				
sex (control)	.05					.01				
ZNCC (Need for Cognitive Closure, z-standardized)	-.21					.77**				
D1 (learning strategy control vs. epistemic change instruction)	.41**					.18 ⁺				
D2 (untreated control vs. epistemic change instruction)	.39**					.31**				
D1*ZNCC (interaction)	.16					-.48**				
D2*ZNCC (interaction)	-.03					-.30**				

Note: $N_{\text{absolute beliefs}} = 81$; $N_{\text{multiplicitic beliefs}} = 80$; Method: Enter; ZNCC, D1, and D2 were entered first (Block 1); Interaction terms (D1*ZNCC and D2*ZNCC) were entered subsequently (Block 2); β = standardized regression weight; R^2 = total variance explained; ΔR^2 = change in R^2 from block 1 to block 2.

⁺ $p < .10$.

* $p < .05$.

** $p < .01$.

4 Discussion

The present article investigated the role of individual differences in need for cognitive closure with regard to epistemic belief instruction effectiveness. Instruction primarily aimed at reducing absolutism and multiplicism. We expected need for closure to impede intervention effectiveness because it likely is likely to interfere with the mechanisms of change postulated in Bendixen's (2002) model.

4.1 Instructional effects on absolutism and multiplicism

The instruction had a strong negative impact on absolute beliefs. Even though absolutism was already low at pre-test, it decreased even more upon participation in the instruction. This is not surprising, because the first intervention part uses a multiple-texts approach, which has been shown to induce epistemic doubt and reduce views of scientific knowledge as certain and simple (Ferguson et al., 2012; Ferguson et al., 2013). Nevertheless, our intervention does not stop at this point. With the intent of reducing multiplicism, we also aimed to convey the idea that even though inconsistencies are frequent (and sometimes frustrating) in psychology, most of them can be resolved by, for example, focusing on methodic aspects of the studies or identifying moderator variables. Results regarding this hypothesis were less robust, especially since no significant differences between the experimental group and the learning strategy control group were found concerning changes in multiplicism. This again highlights the need for a differentiated investigation of individual factors moderating intervention efficacy, which are discussed in the next section.

4.2 Effects of need for cognitive closure on epistemic belief instruction

While testing Hypothesis 2, we found evidence for a particularly strong moderator effect of need for closure on changes in multiplicism. This explains the somewhat less robust instructional effects on multiplicism: The intervention seems to work particularly well for

students with low need for closure, whereas students with higher need for closure do not benefit that much. Need for closure thus indeed seems to influence the mechanisms of change (epistemic doubt, epistemic volition, and resolution strategies) postulated in Bendixen's (2002) model and should be considered in future research.

With regard to absolutism, no evidence for a moderation of instruction efficacy by need for closure was found. Since our primary goal was to reduce multiplicism, this does not depreciate our conclusions. Nevertheless, the following might explain the absence of a moderator effect with regard to absolutism: Our primary goal in administering controversial evidence, besides preparing the ground for fruitful discussion, was to induce changes in *absolute* beliefs. This evidence might have been particularly strong and compelling for all subjects. In fact, it might be hard, even for individuals with high need for closure, to disregard or deny the existence of controversies in psychology. Reductions in multiplicism, on the other hand, were supposed to mainly come about through discussion, reflection, and role modeling by the instructor. As students with high need for closure are *motivated* to remain in their state of closure (Kruglanski & Webster, 1996), they will likely just devalue the intervention, thus impeding its efficacy.

4.3 Conclusions, limitations, and future directions

Our findings are particularly important since well-conducted research on epistemic change instruction is still scarce (Muis & Duffy, 2013), and (to our knowledge) no interventions specifically designed to reduce multiplicism have been published. Moreover, along with the idea that low scores on *both* absolute and multiplicitic scales constitute a prerequisite for evaluativism (Peter et al. 2015), our findings provide some preliminary evidence for intervention-induced increases in epistemic sophistication beyond multiplicism. Finally, our findings on need for closure highlight – in line with so-called *person-centered approaches*

(e.g., Chen, 2012; Ferguson & Bråten, 2013) – the crucial role of individual differences in epistemic belief change.

The present article has several implications for research and practice: First, other individual difference variables potentially effecting the mechanisms of change postulated by Bendixen (2002) might well be worthy of investigation. Moreover, individual differences in need for cognitive closure might explain why epistemic belief instruction works for some and does not work for others, and we urge researchers to consider this when evaluating epistemic belief instruction effectiveness. Practitioners might also try to mitigate the negative effects of high need for closure: First, they might assess need for closure prior to epistemic belief instruction, and have the instructor focus even more intensely on students high in need for closure (e.g., by encouraging them to take part in the discussion, asking questions about their opinion, etc.). Second, one might try to influence need for closure as such. For example, time pressure, environmental noise, or demands for unidimensional (i.e., global and undifferentiated) judgments are commonly used to experimentally raise need for cognitive closure (Kruglanski & Webster, 1991; Freund, Kruglanski, & Shpitzajzen, 1985). Our research thus highlights the benefits of a calm, open-minded group atmosphere that rewards diverging opinions and does not seek “easy” solutions. Additional literature on how to influence need for closure can be found in Kruglanski and Webster (1996).

Nevertheless, our study still has some limitations: Measuring epistemic beliefs by means of Likert-Type questionnaires is problematic because people are often unaware of their actual beliefs. For example, with regard to the distinction between *professed* (i.e., measured by a questionnaire) and *enacted* (i.e., measured by behavioral observation) epistemic beliefs (Limón, 2006), research shows that beliefs measured by questionnaires often do not correspond with those derived from actual behavior (Leach, Millar, Ryder, & Séré, 2000; Bell

& Linn, 2002). Complementing quantitative analyses by in-depth interviews may thus be meaningful (Greene & Yu, 2014).

In line with this argument, we cannot completely rule out the presence of response biases (e.g., Hawthorne effects) since the intervention also included direct instruction on how to deal with scientific controversies. Student might thus have responded in a normatively desired direction at posttest. Nevertheless, this limitation does not apply to our findings on need for closure.

A third limitation concerns our measure, as we were, due to sample size restrictions, not able to carry out factor analyses. Furthermore, the measure's reliabilities were rather low, which might be caused by the multifaceted nature of our scale and by the abstract nature of the concept. Other researchers have experienced similar problems (e.g., DeBacker, Crowson, Beesley, Thoma, & Hestevold, 2008; Gill et al., 2004).

Finally, since the intervention took only 90 minutes and the posttest was conducted right after the intervention, one might question the stability of our findings. Long-term effects of epistemic belief instruction have – to our knowledge – not yet been studied. Ferguson et al. (2012) pointing to Vygotsky's (1978) argument that “processes normally occurring over longer periods of time may be compressed in shorter time periods through experimentation” (p. 105) kind of supports an optimistic view that the findings might be stable (and also alleviates the issue that developmental approaches (e.g., Kuhn, 1991) usually assume a slower process of epistemic development). On the other hand, Kienhues et al. (2016) refer to a high flexibility and context-dependability of epistemic beliefs (their so-called “generative” nature). Accordingly, our intervention might have activated and changed certain aspects of beliefs, but one may wonder whether these changes also manifest themselves in other contexts (e.g., while students are studying for term papers). Therefore, we agree with Kienhues' and

colleagues (2016) call for a more fine-grained investigation of epistemic change, which underlines a need for future research in a field that connects, in our opinion, theory and practice in a most rewarding way.

References

- Aiken, L. S., & West, S. G. (1991). *Multiple regression: Testing and interpreting interactions*. Newbury Park, CA: Sage.
- Barzilai, S., & Weinstock, M. (2015). Measuring epistemic thinking within and across topics: A scenario-based approach. *Contemporary Educational Psychology, 42*, 141-158. doi: 10.1016/j.cedpsych.2015.06.006.
- Bell, P., & Linn, M. C. (2002). Beliefs about science: How does science instruction contribute? In B. K. Hofer, & P. R. Pintrich (Eds.), *Personal epistemology: The psychology of beliefs about knowledge and knowing* (pp. 321-346). Mahwah, NJ: Erlbaum.
- Bendixen, L. D. (2002). A process model of epistemic change. In B. K. Hofer, & P. R. Pintrich (Eds.), *Personal epistemology: The psychology of beliefs about knowledge and knowing* (pp. 191–206). Mahwah, NJ: Erlbaum.
- Bendixen, L. D., & Rule, D. C. (2004). An integrative approach to personal epistemology: A guiding model. *Educational Psychologist, 39*(1), 69–80. doi: 10.1207/s15326985ep3901_7.
- Bråten, I., Ferguson, L. E., Strømsø, H. I., & Anmarkrud, Ø. (2013). Justification beliefs and multiple-documents comprehension. *European Journal of Psychology of Education, 28*(3), 879–902. doi: 10.1007/s10212-012-0145-2.

- Bråten, I., Strømsø, H. I., & Ferguson, L. E. (2016). The role of epistemic beliefs in the comprehension of single and multiple texts. In P. Afflerbach (Ed.), *Handbook of Individual Differences in Reading: Reader, Text, and Context* (pp. 67-79). New York and London: Routledge.
- Bråten, I., Strømsø, H. I., & Samuelstuen, M. S. (2008). Are sophisticated students always better? The role of topic-specific personal epistemology in the understanding of multiple expository texts. *Contemporary Educational Psychology, 33*(4), 814–840. doi: 10.1016/j.cedpsych.2008.02.001.
- Bromme, R., Kienhues, D., & Porsch, T. (2010). Who knows what and who can we believe? Epistemological beliefs are beliefs about knowledge (mostly) attained from others. In L. D. Bendixen, & F. C. Feucht (Eds.), *Personal Epistemology in the Classroom: Theory, Research, and Implications for Practice* (pp. 163-193). Cambridge: Cambridge University Press. doi:10.1017/CBO9780511691904.006.
- Brownlee, J., Purdie, N., & Boulton-Lewis, G. (2001). Changing epistemological beliefs in preservice teacher education students. *Teaching in Higher Education, 6*(2), 247-268. doi: 10.1080/13562510120045221.
- Cano, F. (2005). Epistemological beliefs and approaches to learning: Their change through secondary school and their influence on academic performance. *British Journal of Educational Psychology, 75*(2), 203–221. doi: 10.1348/000709904X22683.
- Chen, J. A. (2012). Implicit theories, epistemic beliefs, and science motivation: A person-centered approach. *Learning and Individual Differences, 22*(6), 724-735. doi: doi:10.1016/j.lindif.2012.07.013.
- Chinn, C. A., & Brewer, W. F. (1993). The role of anomalous data in knowledge acquisition: A theoretical framework and implications for science instruction. *Review of Educational Research, 63*(1), 1–49. doi: 10.3102/00346543063001001.

- Conley, A. M., Pintrich, P. R., Vekiri, I., & Harrison, D. (2004). Changes in epistemological beliefs in elementary science students. *Contemporary Educational Psychology, 29*(2), 186–204. doi: 10.1016/j.cedpsych.2004.01.004.
- Cronbach, L. J., & Furby, L. (1970). How we should measure "change" – Or should we? *Psychological Bulletin, 74*(1), 68–80. doi: 10.1037/h0029382.
- DeBacker, T. K., & Crowson, H. M. (2006). Influences on cognitive engagement: Epistemological beliefs and need for closure. *British Journal of Educational Psychology, 76*(3), 535–551. doi: 10.1348/000709905x53138.
- DeBacker, T. K., & Crowson, H. M. (2009). The influence of need for closure on learning and teaching. *Educational Psychology Review, 21*(4), 303–323. doi: 10.1007/s10648-009-9111-1.
- DeBacker, T. K., Crowson, H. M., Beesley, A. D., Thoma, S. J., & Hestevold, N. L. (2008). The challenge of measuring epistemic beliefs: An analysis of three self-report instruments. *Journal of Experimental Education, 76*(3), 281-312. doi: 10.3200/jexe.76.3.281-314.
- Elby, A., & Hammer, D. (2001). On the substance of a sophisticated epistemology. *Science Education, 85*(5), 554–567. doi: 10.1002/sce.1023.
- Faul, F., Erdfelder, E., Buchner, A., & Lang, A.-G. (2009). Statistical power analyses using G*Power 3.1: Tests for correlation and regression analyses. *Behavior Research Methods, 41*, 1149–1160. doi: 10.3758/brm.41.4.1149.
- Ferguson, L. E., & Bråten, I. (2013). Student profiles of knowledge and epistemic beliefs: Changes and relations to multiple-text comprehension. *Learning and Instruction, 25*, 49-61. doi: 10.1016/j.learninstruc.2012.11.003.

- Ferguson, L. E., Bråten, I., & Strømsø, H. I. (2012). Epistemic cognition when students read multiple documents containing conflicting scientific evidence: A think-aloud study. *Learning and Instruction, 22*(2), 103-120. doi: j.learninstruc.2011.08.002.
- Ferguson, L. E., Bråten, I., Strømsø, H. I., & Anmarkrud, Ø. (2013). Epistemic beliefs and comprehension in the context of reading multiple documents: Examining the role of conflict. *International Journal of Educational Research, 62*, 100-114. doi: 10.1016/j.ijer.2013.07.001.
- Freund, T., Kruglanski, A. W., & Shpitzajzen, A. (1985). The freezing and unfreezing of impressional primacy effects of the need for structure and the fear of invalidity. *Personality and Social Psychology Bulletin, 11*(4), 479-487. doi: 10.1177/0146167285114013.
- Gill, M. G., Ashton, P. T., & Algina, J. (2004). Changing preservice teachers' epistemological beliefs about teaching and learning in mathematics: An intervention study. *Contemporary Educational Psychology, 29*(2), 164-185. doi: 10.1016/j.cedpsych.2004.01.003.
- Green, H. J., & Hood, M. (2013). Significance of epistemological beliefs for teaching and learning psychology: A review. *Psychology Learning & Teaching, 12*(2), 168-178. doi: 10.2304/plat.2013.12.2.168.
- Hefter, M. H., Renkl, A., Riess, W., Schmid, S., Fries, S., & Berthold, K. (2015). Effects of a training intervention to foster precursors of evaluativist epistemological understanding and intellectual values. *Learning and Instruction, 39*, 11-22. doi: 10.1016/j.learninstruc.2015.05.002.
- Hofer, B. K. (2000). Dimensionality and disciplinary differences in personal epistemology. *Contemporary Educational Psychology, 25*(4), 378-405. doi: 10.1006/ceps.1999.1026.

- Hofer, B. K. (2001). Personal epistemology research: Implications for learning and teaching. *Educational Psychology Review, 13*(4), 353–383. doi: 10.1023/A:1011965830686.
- Hofer, B. K., & Pintrich, P. R. (1997). The development of epistemological theories: Beliefs about knowledge and knowing and their relation to learning. *Review of Educational Research, 67*(1), 88–140. doi: 10.3102/00346543067001088.
- Kardash, C. M., & Howell, K. L. (2000). Effects of epistemological beliefs and topic-specific beliefs on undergraduates' cognitive and strategic processing of dual-positional text. *Journal of Educational Psychology, 92*(3), 524–535. doi: 10.1037/0022-0663.92.3.524.
- Kienhues, D., Bromme, R., & Stahl, E. (2008). Changing epistemological beliefs: The unexpected impact of a short-term intervention. *British Journal of Educational Psychology, 78*(4), 545–565. doi: 10.1348/000709907x268589.
- Kienhues, D., Ferguson, L. E., & Stahl, E. (2016). Diverging information and epistemic change. In J. A. Greene, W. A. Sandoval, & I. Bråten (Eds.), *Handbook of Epistemic Cognition* (pp. 318-360). New York, NY: Routledge.
- Kruglanski, A. W. (1990). Motivations for judging and knowing: Implications for causal attribution. In E. T. Higgins, & R. M. Sorrentino (Eds.), *The handbook of motivation and cognition: Foundation of social behavior* (pp. 333–368). New York, NY: Guilford Press.
- Kruglanski, A. W., & Webster, D. M. (1991). Group members' reactions to opinion deviates and conformists at varying degrees of proximity to decision deadline and of environmental noise. *Journal of Personality and Social Psychology, 61*(2), 212–225. doi: 10.1037//0022-3514.61.2.212.
- Kruglanski, A. W., & Webster, D. M. (1996). Motivated closing of the mind: “Seizing” and “freezing”. *Psychological Review, 103*(2), 263–283. doi: 10.1037//0033-295x.103.2.263.

- Kuhn, D. (1991). *The skills of argument*. Cambridge, UK: Cambridge University Press.
- Kuhn, D., & Weinstock, M. (2002). What is epistemological thinking and why does it matter? In B. K. Hofer, & P. R. Pintrich (Eds.), *Personal epistemology: The psychology of beliefs about knowledge and knowing* (pp. 121–144). Mahwah, NJ: Erlbaum.
- Kunda, Z. (1990). The case for motivated reasoning. *Psychological Bulletin*, *108*(3), 480–498. doi: 10.1037//0033-2909.108.3.480.
- Leach, J., Millar, R., Ryder, J., & Séré, M. G. (2000). Epistemological understanding in science learning: The consistency of representations across contexts. *Learning and Instruction*, *10*(6), 497-527. doi: 10.1016/s0959-4752(00)00013-x.
- Limón, M. (2006). The domain generality-specificity of epistemological beliefs: A theoretical problem, a methodological problem or both? *International Journal of Educational Research*, *45* (1-2), 7-27. doi: 10.1016/j.ijer.2006.08.002.
- Maggioni, L., Alexander, P., & van Sledright, B. (2004). At a crossroads? The development of epistemological beliefs and historical thinking. *European Journal of School Psychology*, *2*(1-2), 169-197. doi: 10.1177/0143034312455857.
- Marra, R. M., Palmer, B., & Litzinger, T. (2000). The effects of a first-year engineering design course on student intellectual development as measured by the Perry scheme. *Journal of Engineering Education*, *89*(1), 39-45. doi: 10.1002/j.2168-9830.2000.tb00492.x.
- Muis, K. R., Bendixen, L. D., & Haerle, F. C. (2006). Domain-generality and domain-specificity in personal epistemology research: Philosophical and empirical reflections in the development of a theoretical framework. *Educational Psychology Review*, *18*(1), 3-54. doi: 10.1007/s10648-006-9003-6.
- Muis, K. R., & Duffy, M. C. (2013). Epistemic climate and epistemic change: Instruction designed to change students' beliefs and learning strategies and improve achievement. *Journal of Educational Psychology*, *105*(1), 213–225. doi: 10.1037/a0029690.

- Muis, K. R., Trevors, G., Duffy, M. C., Ranellucci, J., & Foy, M. J. (2015). Testing the TIDE: Examining the nature of students' epistemic beliefs using a multiple methods approach. *Journal of Experimental Education*. Advance online publication. doi: 10.1080/00220973.2015.1048843.
- Palmer, B., & Marra, R. M. (2008). Individual domain-specific epistemologies: Implications for educational practice. In M. S. Khine (Ed.), *Knowing, knowledge and beliefs: Epistemological studies across diverse cultures* (pp. 325-350). Dordrecht, Netherlands: Springer.
- Peter, J., Rosman, T., Mayer, A.-K., Leichner, N. & Krampen, G. (2015). Assessing epistemic sophistication by considering domain-specific absolute and multiplicitic beliefs separately. *British Journal of Educational Psychology*. Advance online publication. doi: 10.1111/bjep.12098.
- Porsch, T., & Bromme, R. (2011). Effects of epistemological sensitization on source choices. *Instructional Science*, 39(6), 805-819. doi: 10.1007/s11251-010-9155-0.
- Rosman, T., Peter, J., Mayer, A.-K., & Krampen, G. (submitted). *Conceptions of scientific knowledge influence learning of academic skills: Epistemic beliefs and the efficacy of information literacy instruction*.
- Schlink, S., & Walther, E. (2007). Kurz und gut: Eine deutsche Kurzskala zur Erfassung des Bedürfnisses nach kognitiver Geschlossenheit [A German short scale to measure the need for cognitive closure]. *Zeitschrift für Sozialpsychologie*, 38(3), 153–161. doi: 10.1024/0044-3514.38.3.153.
- Schommer, M. (1990). Effects of beliefs about the nature of knowledge on comprehension. *Journal of Educational Psychology*, 82(3), 498–504. doi: 10.1037/0022-0663.82.3.498.

Schommer, M. (1993). Epistemological development and academic performance among secondary students. *Journal of Educational Psychology, 85*(3), 406–411. doi:

10.1037/0022-0663.85.3.406.

Valanides, N., & Angeli, C. (2005) Effects of instruction on changes in epistemological beliefs. *Contemporary Educational Psychology, 30*(3), 314-330. doi:

10.1016/j.cedpsych.2005.01.001.

Vygotsky, L. (1978). *Mind and Society: The development of higher psychological processes*. Cambridge, MA: Harvard University Press.

Webster, D. M., & Kruglanski, A. W. (1994). Individual differences in need for cognitive closure. *Journal of Personality and Social Psychology, 67*(6), 1049–1062. doi:

10.1037//0022-3514.67.6.1049.