

Mechanisms of Epistemic Change – The Role of Reflection and Social Interaction

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Introduction

Recent studies on epistemic beliefs (i.e., beliefs about the nature of knowledge and knowing) have shown that these beliefs affect individuals' learning and information processing (e.g., Barzilai & Zohar, 2012; Kardash & Howell, 2000; Rosman, Peter, Mayer, & Krampen, 2018), especially when dealing with multiple sources (Barzilai & Strømsø, 2018; Bråten, Britt, Strømsø, & Rouet, 2011; Bråten, Ferguson, Strømsø, & Anmarkrud, 2013, 2014). Because of this, a multitude of epistemic change interventions, which strive to foster advanced epistemic beliefs (e.g., the believe that knowledge claims can be weighed depending on their context), have been developed (see Muis, Trevors, & Chevrier, 2016).

As a theoretical foundation and inspiration for this type of intervention, the vast majority of studies currently draws on Bendixen and Rule's (2004) integrative model of epistemic change (Bråten, 2016). In this process model, Bendixen and Rule (2004) propose that epistemic change has three central process components – *epistemic doubt* (i.e., a cognitive incongruity which most likely results from a conflict between prior epistemic beliefs and new information), *epistemic volition* (i.e., the will to address this doubt and question one's beliefs) and *resolution strategies* (i.e., ways of dealing with this doubt). Considering the model's popularity, it might be striking that—as Bråten (2016) concluded reviewing the literature on epistemic change interventions—its “mechanism [of change] essentially lacks empirical backing” (p. 361). Starting from this point, we developed interventions that explicitly target the former components of Bendixen and Rule's (2004) model, epistemic doubt (Kerwer & Rosman, 2018) and epistemic volition (Kerwer, Rosman, Wedderhoff, & Chasiotis, 2019), and scrutinized these components' effects on epistemic change in previous studies. However, even though epistemic doubt itself and the will to resolve epistemic doubt (i.e., epistemic volition) are very central to Bendixen and Rule's (2004) model, it might even be more central how students actually act on their epistemic doubt (i.e., their resolution strategies). Thus, it might be surprising that—while some evidence backs its crucial role in epistemic change (e.g., Ferguson, Bråten, & Strømsø, 2012)—the resolution strategies component is still the least developed one in Bendixen's model (i.e., in terms of its definition, its properties, and its underlying psychological mechanisms). In this study, we will therefore investigate if epistemic change can be fostered by triggering resolution strategy use during an experimental task in which subjects deal with conflicting evidence.

For this purpose, we draw on the work by Bendixen and colleagues (e.g., Bendixen, 2002, 2016; Bendixen & Rule, 2004; Rule & Bendixen, 2010) and focus on *reflection* and *social*

interaction as the two probably most prototypical—and certainly most frequently mentioned—resolution strategies in their process model.

Research Questions

We will scrutinize the role of the resolution strategy component in Bendixen and Rule's (2004) model by comparing the amount of epistemic change in a combined intervention, which targets both reflection *and* social interaction (RSI), to the amount of change in an intervention that aims at reflection *only* (R) and the amount of change in two control groups. In one of these control groups, no epistemic change intervention is administered (C), while the other control group receives an epistemic doubt and volition intervention (Kerwer et al., 2019), which is not explicitly designed to trigger resolution strategies use (DV).

Hypotheses

H1. For epistemic change on self-report measures (FREE-GST, justification beliefs; see below), we expect the following differences between intervention conditions:

H1a. All epistemic change interventions (RSI, R, DV) will promote stronger change towards advanced epistemic beliefs compared to the control condition (C).

H1b. Epistemic change interventions targeting epistemic doubt, epistemic volition and resolution strategies (RSI and R) will promote stronger epistemic change compared to an intervention targeting epistemic doubt and volition only (DV).

H1c. An epistemic change intervention targeting epistemic doubt, epistemic volition, as well as both reflection and social interaction (RSI), will have higher effects on epistemic change compared to an intervention targeting epistemic doubt, epistemic volition, and reflection only (R).

H2a to H2c. The pattern of effects described in H1a to H1c does not only apply to change in epistemic beliefs, but also to source evaluation task performance.

Sampling Plan

Data collection procedures

Participants will be recruited by means of flyers, mailing lists and Facebook groups at Trier University. Only psychology students that are enrolled at Trier University for less than four semesters are eligible for study participation. Upon study completion, all participants will be paid 20 Euro.

Data collection for the pre-intervention measurement will take place from October 17th to December 1st, 2019. The intervention and post-intervention measurement will take place from October 28th to December 20th, 2019.

Pre-intervention measurements will take place online. At this online measurement occasion, participants can complete the data collection independently (without instructor) using their own device (smartphone, tablet, computer, etc.). One week after they have completed the first measurement occasion, subjects will receive an invitation to participate at the second measurement occasion. At this second in-person measurement occasion, the intervention and post-intervention measurements will take place at Trier University. Depending on group assignment after pre-testing (see below), data at the second measurement occasion will be collected in one-to-one sessions or in a group setting.

Target Sample Size and Sample Size Calculation

In our sample size calculation, we drew on Kerwer et al.'s (2019) reanalysis of Kerwer and Rosman's (2018) data. They found that in Kerwer and Rosman's (2018) study, whose design was very similar to the present study, a small intervention effect existed (Cohen's $f = .094$; $r = .66$). We argue that in the present study, group differences should be more pronounced compared to Kerwer and Rosman (2018) since the resolution strategy groups receive a considerably more elaborate (and thus more 'intense') intervention compared to the control groups. Moreover, as they struggled with unexpected effects in their control group, another reason why group differences should be larger in our study is that we will employ a modified version of Kerwer and Rosman's (2018) control task, for which no significant effects on epistemic change at all were observed in a previous study (Kerwer & Rosman, under review).

Thus, we suggest that a total sample size of 180 ($n = 45$ per group) will suffice to reveal meaningful differences between intervention conditions. In accordance with this notion, a power analysis in GPower (Faul, Erdfelder, Buchner, & Lang, 2009), in which we set α to .05 in a repeated measures design with four groups, indicated that at this sample size power would be .78 for $f = .1$ and .92 for $f = .12$.

Variables

Manipulated variables

The independent variable 'intervention type' is a between-participants variable with four levels. Participants will be randomly assigned (for more details see below) to one of the following intervention conditions:

- C (Control): This group reads non-conflicting texts on students employing different learning strategies (i.e., the task used in Kerwer and Rosman (under review) and Kerwer et al. (2019)) instead of conflicting evidence. In addition, to keep the study duration constant across conditions, participants receive some additional questionnaires on learning strategies (i.e., the *Kieler Lernstrategien Inventar* (KSI; Heyn, Baumert, & Koeller, 1994), the SELMO (Fischer, Kastner-Koller, & Deimann, 2004) and the *Selbststeuerungsinventar* (SSI-K3/VCI; Kuhl & Fuhrmann, 1998)). This intervention is administered in a group setting.
- DV (Doubt and Volition): This group receives the epistemic doubt and volition intervention by Kerwer et al. (2019). This intervention is administered in a group setting.
- R (Reflection): This group also receives the epistemic doubt and volition intervention materials by Kerwer et al. (2019), but in a one-to-one setting with a student assistant as instructor. We will employ exactly the same standardized computer-administered volition intervention as in the DV condition, while participants will be additionally instructed to verbalize their thoughts and beliefs using the think-aloud method during the epistemic doubt intervention (18 texts which present resolvable controversies, Kerwer et al., 2019). Furthermore, the reflection of conflicting knowledge claims is supported by specific questions that are shown after 6, 12 and 18 texts (e.g., "Does the pattern of findings in the texts you just read seem inconsistent to you? Why? Is this pattern of findings in line with your beliefs about psychological knowledge?") and a concluding reflection task after the last text on the intervention's implications for participants' personal epistemic beliefs (cf. Bendixen and Rule's (2004) definition of reflection as "reviewing the past, analyzing belief implications, and making educated choices" (p. 73)). The purpose of the think-aloud method in this condition is twofold. First, the process of thinking itself aloud can be seen as a reflective process that boosts

students' reflections over their beliefs since it helps them to “use previously acquired mental representations to plan, evaluate, and reason between alternative solutions” (Epler, Drape, Broyles, & Rudd, 2013, p. 49; Ericsson & Simon, 1998). Second, it allows to monitor whether participants adhere to the instruction of reflecting over their beliefs—the instructor will thus provide additional reflection cues if participants' spontaneous reflection processes come to a halt. Aside from the think-aloud instructions and these additional cues, instructors will, however, not interact with the participants, thereby adopting a rather ‘professional’, impersonal stance.

- RSI (reflection and social interaction): This group receives exactly the same intervention materials as the R group (including reflection tasks in one-to-one sessions). However, in this condition, instructors (i.e., student assistants) are briefed to engage in a conversation with the participants and to actively shape their epistemic beliefs through social interaction. For example, they will act as role model by introducing themselves as a peer who has already dealt successfully with the challenge of doubting one's beliefs. Rather than acting as a ‘nameless’ instructor (cf. epistemic climate, Muis & Duffy, 2013), they will offer support if participants question existing beliefs (cf. according the notion of compassion/modeling, Rule & Bendixen, 2010), but will also (to some extent) challenge existing naive beliefs.

Dependent variables

In the following, primary, secondary and exploratory outcomes, as well as the expected direction of change for each outcome, are reported:

- Primary: Topic-specific epistemic beliefs (FREE-GST, Rosman, Mayer, Merk, & Kerwer, 2019)
 - Expected effects: Increase in the D-Index (see indices section) from pre (first measurement; see study design section) to post (second measurement)
- Secondary: Source Evaluation Task performance (Kerwer et al., 2019)
 - Expected effects: Higher values in the quality score and in the diversity score at post
- Additional outcomes (without correction for multiple testing and therefore exploratory)
 - Topic-specific epistemic beliefs (FREE-GST, Rosman et al., 2019)
 - Expected effects: Decrease in absolutism from pre to post; decrease in multiplism from pre to post; increase in evaluativism from pre to post
 - Justification beliefs questionnaire (Klopp & Stark, 2016)
 - Expected effects: Decrease in justification by authority from pre to post; decrease in personal justification from pre to post; increase in justification by multiple sources from pre to post

Manipulation check

First, we will test if subjects actually realized that the epistemic doubt intervention's texts contained conflicting knowledge claims by employing the perceived contradictoriness measure Kerwer and Rosman (2018) used in their study (sample item: “Upon reading the texts... findings seemed to be very contradictory.”). We expect higher scores on this variable in the DV, R and RSI conditions compared to the C condition.

Moreover, to test if the epistemic volition intervention worked out as intended, we will administer a state measure on epistemic volition which was developed by Kerwer et al. (2019). A sample item is: “I am feeling highly motivated to reconsider my current

understanding of psychological knowledge.”. We expect higher scores on this variable in the DV, R and RSI conditions compared to the C condition.

Additionally, to test if the reflection intervention fostered a deeper processing of the conflicting evidence which was presented in the epistemic doubt intervention, we will also administer a self-report measure on deliberate integration efforts (sample item: “Upon reading the texts... I deliberately tried to figure out under which conditions contradictions between the short texts occurred.”) in the R, RSI, and DV conditions. We expect higher scores on this variable in the R and RSI conditions compared to the DV condition.

Finally, participants in the ‘reflection and social interaction’ condition should perceive their interaction with the instructor during the reflection task to be more similar to a ‘normal conversation’—at least compared to participants in the ‘reflection-only’ condition, who are thought to perceive the interaction with the instructor to be artificial and one-sided. We will test this assumption by administering an additional measure in the R and RSI conditions in which participants rate their interaction with the instructor (sample item: “While thinking aloud... interacting with the instructor felt like an ordinary conversation.”). We expect higher scores on this variable in RSI condition compared to the R condition.

Covariates

Demographic variables (e.g., age, sex, study semester), as well as several other covariates, such as prior knowledge on gender stereotyping, need for cognitive closure (Schlink & Walther, 2007) and several other covariates will be assessed at the online measurement occasion. During the intervention, we will measure task-related epistemic emotions (Pekrun, Vogl, Muis, & Sinatra, 2017). All analyses involving covariates will be exploratory.

Indices

Absolutism, multiplism and evaluativism scores will be computed as mean scores of the FREE-GST (Rosman et al., 2019). Primary outcome will be the D-Index, which aggregates advanced beliefs (Krettenauer, 2005) and is computed as $2 * \text{Evaluativism} - (\text{Absolutism} + \text{Multiplism})$.

A diversity score and a quality score will be computed for source evaluation task performance (Kerwer et al., 2019).

Epistemic change will be operationalized as a latent change score.

Design Plan

Blinding

Subjects will not know the treatment group to which they have been assigned.

Study design

We will use a 4x2 pre-post design with 1 within-subjects factor (repeated measurement factor with two levels [pre-/post-intervention]) and 1 between-subjects factor (intervention type with 4 levels).

Randomization

A two-step randomized assignment of participants to treatment conditions will be carried out using the respective functions of the survey software Unipark. First, immediately after completing the first measurement occasion, subjects will be randomly assigned to either the

group setting conditions (C, DV) or the one-to-one conditions (R, RSI). At the beginning of the second session, they will then be randomly assigned to the one of the groups within this intervention mode. In order to control for potential confounding effects due to different intervention instructors in the one-to-one conditions, assignment to intervention groups (R vs. RSI) will be stratified by intervention instructor.

Analysis Plan

Statistical models

We will use latent difference score modeling (McArdle, 2009) to analyze our primary and exploratory outcome data. The dependent variable is change in epistemic beliefs (FREE-GST, justification beliefs). Independent variables are dummy coded intervention variables where one dummy-coded variable will be created for each intervention component (i.e., the doubt and volition component [C = 0; DV, R, RSI = 1], the reflection component [C, DV = 0; R, RSI = 1] and the social interaction component [C, DV, R = 0; RSI = 1]). Thus, intervention effects can be analyzed and hypotheses tested based on (functions of) these dummy-coded variables' incremental effects.

For source evaluation task performance (which is only measured once), ordinal logistic regression analyses will be conducted, again with dummy coded intervention component variables as independent variables.

Transformations

Pre- and post-intervention measures of outcome variables will be standardized using their pre-intervention mean and standard deviation.

Inference criteria

We will use the standard $p < .05$ criterion for determining if the estimated effects of (dummy coded) intervention components are significantly different from those expected if the null hypothesis was correct. Where appropriate, one-sided hypothesis testing will be performed.

Data exclusion

Analyses will be performed without univariate outliers (based on z -scores; criterion: $p(z) < .001$). Moreover, specific cases may be eliminated if major protocol deviations occur (premature study termination, refusal to think aloud, hostility towards the instructor, etc.). The decision to eliminate such cases will be made prior to looking at the data.

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