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Does epistemic change in short-term interventions adhere to processes outlined in models of long-term epistemic development?

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Abstract

Prior research has shown that epistemic beliefs (individual beliefs about the nature of knowledge and knowing) are closely connected to learning outcomes and multiple source use. As a consequence, an increasing number of studies aims to (1) develop intervention programs which foster advanced epistemic beliefs, and (2) identify factors that facilitate this so-called *epistemic change* process. However, even though the overarching aim of such research is to improve our general understanding of the epistemic change process, it is still unclear if—or to what extent—processes outlined in established stage models on long-term epistemic development also apply to intervention-related changes in epistemic beliefs. The present paper addresses this research question by investigating how prior epistemic beliefs affect changes in epistemic beliefs during a short-term intervention. For this purpose, we reanalyzed data of three experimental studies ($N_{\text{total}} = 221$) which examined if an intervention that presented resolvable controversies (apparently conflicting but by means of cues reconcilable knowledge claims) promoted change towards advanced epistemic beliefs. The pattern of changes found in our analyses substantially differed from the pattern of change proposed in developmental models.

More specifically, prior absolute beliefs (level 1) unexpectedly fostered change towards evaluativism (level 3), while prior multiplistic beliefs (level 2) even impaired this change process. In line with our expectations, prior evaluativistic beliefs, however, prevented subjects from reverting to more 'naïve' epistemic positions. Practical and theoretical implications of these results are discussed.

Keywords: Epistemic Beliefs, Epistemic Change, Epistemic Development, Intervention

In today's knowledge society, epistemic beliefs, i.e. individual beliefs about the nature of knowledge and the process of knowing, are becoming increasingly important for individual learning and learning behavior. Recent meta-analytical findings by Greene, Cartiff & Duke (2018), for example, show connections between academic achievement and advanced epistemic beliefs (e.g. the belief that even with contradictory information, approaching truth is possible). More and more studies are therefore devoted to promoting such beliefs and examining the processes underlying epistemic development by means of short-term interventions. The outstanding feature of such short-term interventions is that they are limited in time and subject matter and are usually conducted in a laboratory setting. For example, Kienhues, Stadler & Bromme (2011) investigated how the presentation of consistent or conflicting medical evidence during a 30-minute information search on the causes and effects of high cholesterol levels affected the medically related epistemic beliefs of the participants. Despite the increasing popularity of such short-term interventions, comparatively little is known about how epistemic change¹ occurs in

¹ In the context of this work, the term *epistemic change* includes short-term processes of change evoked in laboratory settings, while the term *epistemic development* refers to epistemic life-span development unaffected by such factors.

the context of such interventions, and whether mechanisms of long-term "natural" development and change induced by short-term interventions are fundamentally the same or fundamentally different (Bråten, 2016). In the present study, this research question is addressed by investigating, in the context of a short-term intervention, how prior epistemic beliefs affect epistemic change itself, and by testing whether the observed pattern of action of these prior beliefs corresponds to the pattern of action to be expected on the basis of models of epistemic life-span development.

Stage models of epistemic development and epistemic change in short-term interventions

In the past, epistemic development has been conceptualized in a variety of ways, with qualitative longitudinal studies characterizing the research area, especially at the beginning (Hofer & Pintrich, 1997). Subsequently, Kuhn, Cheney and Weinstock (2000) developed what is currently probably the most widespread stage model of epistemic development. According to this model, development begins at the stage of *absolutism*, in which individuals emphasize the objectivity and immutability of knowledge. This view is revised and reversed in the next stage, *multiplism*. Characteristically, knowledge at this stage is regarded as subjective to the point that knowledge claims are regarded as equally valid opinions regardless of other criteria (e.g. their evidence strength). In the last and most advanced stage, *evaluativism*, individuals finally integrate the positions of the two preceding stages of development; while acknowledging a certain subjectivity of knowledge, they no longer deny that opposing knowledge claims can be weighed against each other. However, it is precisely this transition to evaluativistic beliefs that is seen as *fragile* and not necessarily made by all individuals (Kuhn et al., 2000). Although correlations with age and educational level have been demonstrated for this development (Kuhn et al., 2000, but also Krettenauer, 2005), there is considerable inter- and intra-individual

variation in epistemic development. Starting from this point, Muis, Bendixen and Haerle (2006) assume in the *Theory of Integrated Domains in Epistemology* (TIDE) that epistemic beliefs about different domains exist at an individual level (e.g. on both educational psychology and psychology in general) and mutually influence each other - an idea that has recently been extended to topics (e.g. research on gender stereotyping in schools) within such domains (e.g. educational psychology) (Merk, Rosman, Muis, Kelava & Bohl, 2018).

Based on the Kuhn's model, Krettenauer (2005) created a German instrument for assessing the domain-general stage of epistemic development with the *Fragebogen zur Erfassung des Entwicklungsniveaus epistemologischer Überzeugungen* (FREE), which was later adapted by Rosman, Mayer, Merk and Kerwer (2019) for domain-specific (educational psychology) and topic-specific (gender stereotyping) use. A special feature of these and comparable non-German measurement instruments (e.g. Barzilai & Weinstock, 2015) is that they allow a simultaneous and gradual assessment at the level of the individual developmental stages - thus, for example, a person can have high multiplistic and medium absolute beliefs at the same time. Even though this kind of simultaneous assessment of Kuhn's developmental *stages* as different *types of beliefs* may seem inconsistent at first glance, Barzilai and Weinstock (2015) have convincingly argued that the assumption of a "coordination" of different conflicting epistemic positions characterizes Kuhn's model. Last but not least, this also makes it possible to determine the differential effects of individual types of beliefs within the framework of variable-centered analysis procedures (which can, for example, consider correlative relationships between multiplistic beliefs and other variables or, generally speaking, analyze relationships between variable *scores* across individuals). Further work by Barzilai et al., for example, was able to show that a tendency towards multiplistic beliefs is associated with lower performance (Barzilai,

Tzadok & Eshet-Alkalai, 2015) and a tendency towards evaluativism with higher performance (Barzilai & Ka'adan, 2017) in multiple sources use, thus also empirically demonstrating the fruitfulness of a variable-centered approach in relation to Kuhn's model. Moreover, this kind of simultaneous assessment allows us by means of longitudinal designs to study the patterns of interrelationships between the individual types of beliefs and therefore to address the research question described at the beginning of this article as to whether epistemic change in short-term interventions adheres to the assumptions of models on life-span development, such as Kuhn's model.

To induce epistemic change in short-term interventions, confrontation with conflicting scientific evidence has proven to be a reliable tool (Kienhues, Ferguson & Stahl, 2016). Rosman et al. (2019), for example, were able to show that the presentation of resolvable controversies on the topic of "gender stereotyping in secondary schools" as well as the reflection of these controversies in a writing task promoted topic-specific epistemic change towards advanced beliefs. In accordance with the assumptions of the TIDE, this topic-specific change was also transferred to epistemic beliefs on higher domains, such as beliefs on educational psychology (Rosman et al., 2019). The special feature of the resolvable controversies approach is that it is not limited to the presentation of contradictory evidence in the first part of the intervention (i.e. short texts suggesting that there is scientific evidence for discrimination against both boys and girls), but also allows and actively supports the resolution of this controversy. Within the short texts, for example, there are moderators (e.g. school subject) who are to be identified in a writing task in the second part of the intervention and who allow the apparent controversy to be resolved (e.g. "boys are discriminated against in languages and literature, girls in mathematics"). With reference to Kuhn's model, the resolvable controversies intervention thus aims to evoke

doubt regarding both absolute (since contradictions exist) and multiplistic (since contradictions can be weighed up) views and at the same time illustrate evaluativistic thinking (i.e. identifying factors that allow weighting knowledge claims). Therefore, since all the stage transitions envisaged in Kuhn's model (absolutism → multiplism as well as multiplism → evaluativism) should occur within this intervention approach, it is particularly well-suited for testing the transferability of Kuhn's model to epistemic change in short-term interventions. The fact that the same developmental processes should take place at the topic-specific level as a result of an intervention can again be explained by the TIDE introduced above. The TIDE assumes that externally arising developmental tasks, such as contextual changes in the pedagogical setting, can trigger a relapse to more "naive" (i.e. absolute or multiplistic) epistemic beliefs and the repeated passage through one or more development cycles (so-called recursions) (Muis et al., 2006). Since topic-specific interventions are an instance of such context changes that are accompanied by new development tasks, it should be possible to map superordinate processes of epistemic development here on a small scale at the topic-specific level. In accordance with this, Kuhn and Weinstock (2002) already argued when introducing their model that the same developmental processes should materialize sooner or later on different domains of epistemic development depending on the developmental task at hand. Based on the premise that the epistemic change evoked within a short-term intervention corresponds to the development predicted by Kuhn's model, the following specific assumptions for intervention-related change are therefore derived.

If at the time of the intervention there are still strong absolute beliefs, this implies that the transition from absolutism to multiplism has not yet been fully completed and that there is still

potential for change towards multiplism. This should counteract (to a certain extent) the overall reduction of multiplistic beliefs induced by the intervention.

- *Hypothesis 1:* Prior absolute beliefs (stage 1²) have a positive effect on the epistemic change towards multiplism (stage 2).

In contrast, high values for multiplism should indicate that the transition from multiplism to evaluativism is still imminent or has not yet been completed, i.e. there is immediate potential for change in the direction of evaluativism. This leads to the following assumption regarding the influence of prior multiplistic beliefs on the change towards evaluativism:

- *Hypothesis 2:* Prior multiplistic beliefs (stage 2) have a positive effect on the epistemic change towards evaluativism (stage 3).

Since the intervention materials are also intended to illustrate principles of evaluative thinking and thus promote evaluativistic thinking, it is further assumed that existing prior evaluativistic beliefs are a protective factor that hinders a regression towards absolutism or multiplism:

- *Hypothesis 3:* Prior evaluativistic beliefs (stage 3) have a negative effect on the epistemic change towards absolute (stage 1) or multiplistic beliefs (stage 2).

Methods

To test these hypotheses, data from three experimental studies were used ($N_{\text{total}} = 221$), in which Rosman et al. (2019) tested the resolvable controversies approach in psychology students. Only those cases were extracted from these data in which students received the form of resolvable controversies intervention described above (i.e. the other experimental groups used in the

² This work draws on a simultaneous and gradual assessment of epistemic belief types. The term "stage" is used here only for classification in Kuhn's model.

article by Rosman et al. [2019] were excluded from the analysis). Epistemic beliefs before and after this intervention were measured by the FREE-GST, which is tailored to the topic "gender stereotyping in secondary schools". For a detailed description of the individual studies and the intervention materials and procedures used, please refer to Rosman et al. (2019).

Epistemic change was operationalized within the analyses for absolutism, multiplism and evaluativism as a latent difference score (McArdle, 2009), whereby inter-individual differences in epistemic change were predicted by the participants' prior epistemic beliefs to address the research question formulated above. This means that we controlled for the effect of the respective belief type itself (e.g., the effect of prior multiplistic beliefs on change in multiplism), and then examined whether above/below-average values on prior beliefs of the two remaining belief types tended to lead to an increase or decrease in the belief type in question.

This method of analysis clearly follows a variable-centered approach (cf. Laursen & Hoff, 2006).

Within this approach, however, it cannot be ruled out that individuals may be assigned (e.g. via person-centered analysis procedures in which individual persons [groups] and their belief configurations constitute the unit of analysis) to different subsamples in which the (variable-centered) pattern of relationships differs from the pattern observed for the overall sample. As Laursen and Hoff (2006) argued, the validity of variable-centered findings can therefore be strengthened by the complementary use of a person-centered approach. For this purpose, a hierarchical cluster analysis according to Ward, screening various quality criteria, was performed in the R-package *nbclust* (Charrad, Ghazzali, Boiteau & Niknafs, 2014) and the cluster variable obtained was used for a multi-group analysis.

Results³

Results are shown in Figure 1. On a descriptive level, it was found that, as expected, the change towards multiplistic beliefs was stronger for highly pronounced prior absolute beliefs. However, the associated effect was not statistically significant, which is why Hypothesis 1 must be rejected. Unexpectedly, the effect of prior multiplistic beliefs on change towards evaluativism was negative and statistically significant, so that Hypothesis 2 must also be rejected.

Interestingly, however, change towards evaluativistic beliefs was more pronounced for higher scores on prior absolute beliefs. With regard to Hypothesis 3, it turned out, in line with our expectations, that prior evaluativistic beliefs counteracted a change towards absolutism or multiplism. Hypothesis 3 can thus be regarded as confirmed. Furthermore, a weak positive correlation in the residuals of change in absolute and multiplistic beliefs ($r = .178, p < .01$) contradicts a linear sequence of the two types of belief, since an increase in multiplism should be accompanied by a decrease in absolutism if this was true (i.e. a negative correlation should occur). Instead, this pattern rather indicates that a simultaneous decrease of corresponding beliefs took place.

Cluster analysis of the individual prior epistemic beliefs indicated that a solution with three clusters provided the best fit with our data. One of these clusters was more evaluativistic ($n = 76, M_A = -0.672, M_M = 0.172, M_E = 0.978$), while another was characterized by "generally naïve" beliefs ($n = 88, M_A = 0.418, M_M = 0.581, M_E = -0.512$) and the third cluster had low multiplistic beliefs ($n = 57, M_A = 0.251, M_M = -1.126, M_E = -0.514$). The subsequent multi-group analysis showed that the effects of the prior beliefs on epistemic change did not differ significantly

³ A summary of the R-code of the analyses performed as well as descriptive statistics and inferential statistical tests are given in [OD 1](#).

between these clusters ($\chi^2 = 19.93$, $df = 18$, $p = .34$). Since the observed regression coefficients themselves did not deviate from those of the main analyses, this finding corroborates the results of the variable-centered analyses.

Discussion

In the first two hypotheses of the present study, it was assumed that high values on the more "naive" types of belief of Kuhn's model, absolutism and multiplism, should each favor an intervention-related change to the next type of belief implied by the model. Contrary to this expectation, such paired relationships could not be demonstrated either for the change from absolutism to multiplism (Hypothesis 1) or for the change from multiplism to evaluativism (Hypothesis 2). In the change to evaluativism, surprisingly, the opposite pattern of effects, a negative effect of multiplistic beliefs, was present, while prior absolute beliefs seemed to foster this change. This means that in the course of the intervention, students with rather absolute prior beliefs seem to realize not only that knowledge about gender stereotyping has a subjective component, but also that knowledge claims in this area can be weighed against each other. From a practical point of view, this pattern is very gratifying and in line with the aims of the resolvable controversies intervention, which is intended to generate doubt regarding both absolute and multiplistic beliefs. At the same time, however, it must be noted that the results regarding Hypothesis 1 and 2 thus cast doubt on the transferability of Kuhn's model to epistemic change in short-term interventions.

What may be positive is that pronounced evaluativistic beliefs actually seem to protect against a regression to "naive" epistemic beliefs, as assumed in Hypothesis 3. In other words, the danger of unintentionally triggering a relapse to "naive" beliefs with a short-term intervention diminishes as the more advanced beliefs become established.

However, the present study is of course not without its limitations. The validity of Kuhn's model was simply assumed in this study. The fact that the presumed patterns of relationships could not be found can thus also be seen as an indication that at least a further empirical validation of the applicability of such measuring methods, which simultaneously capture different types of beliefs, seems to be advisable for Kuhn's stage model. Furthermore, it cannot be excluded that mechanisms of epistemic change could be fundamentally different at the topic-specific and domain-general level or that the time perspective of change observed in this study is too limited. It is possible that the assumed pattern of interrelationships would indeed only be found if change is triggered at higher domains (e.g. in longer, thematically broader, more intensive short-term interventions) and is also examined there over an extended period of time longitudinally using a person-centered analysis methodology. It also remains questionable - even if cluster-analytical findings indicate a certain stability of the pattern of relationships between epistemic change and prior beliefs - to what extent the pattern of effects that we found can be generalized beyond the context of the study to other groups of subjects and other types of short-term interventions. A special feature of the resolvable controversies approach is that it clearly aims at a change towards evaluativistic beliefs while reducing absolute and multiplistic positions. It is thus possible that the "natural" development process along Kuhn's model was "compressed" in the context of the intervention (cf., Ferguson, Bråten & Strømsø, 2012), i.e. individuals initially switched from absolute to multiplistic beliefs, but jumped directly to evaluativistic beliefs. This would explain an apparent "developmental leap" even within the framework of Kuhn's model - prior absolute beliefs would in this case simply be an indicator of existing developmental potential in the direction of evaluativism.

However, if the finding that such "developmental leaps" can be initiated comparatively easily in short-term interventions could be confirmed, this would have far-reaching consequences for the conception of interventions in the field of epistemic change. A currently frequent intervention goal is to question absolute beliefs and to motivate participants to recognize that knowledge is subjective and fluid (and thus to initiate a development towards multiplism). However, if the transition to evaluativism were to be made more difficult rather than easier by multiplistic beliefs, it would rather be advisable to develop interventions that directly promote the change from absolutism to evaluativism and counteract the development of a position of radical subjectivity (cf. Rosman et al., 2019). This argumentation is supported by the findings mentioned at the beginning on the performance-reducing effects of multiplistic beliefs (e.g. Barzilai et al., 2015).

In summary, it can be said that although the present study questions the transferability of classical stage models to epistemic change in short-term interventions, it also demonstrates the usefulness of these stage models for theory formation and practice. More specifically, our analyses isolated a type of belief of Kuhn's model, multiplistic beliefs, which appears to have an inhibitory effect on epistemic change, and derived a goal for future interventions from this finding. However, the question raised by Bråten (2016), whether the underlying processes of intervention-related change and "naturally" occurring development are congruent, cannot be answered conclusively.

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