Assessing epistemic sophistication by considering domain-specific absolute and multiplicistic beliefs separately

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Abstract

Background. Especially in higher education, not only a view of science as a means of finding absolute truths (absolutism), but also a view of science as generally tentative (multiplicism) can be unsophisticated and obstructive for learning. Most quantitative epistemic belief inventories neglect this and understand epistemic sophistication as disagreement with absolute statements.

Aims. This article suggests considering absolutism and multiplicism as separate dimensions. Following our understanding of epistemic sophistication as a cautious and reluctant endorsement of both positions, we assume evaluativism (a contextually adaptive view of knowledge as personally constructed and evidence-based) to be reflected by low agreement with both generalised absolute and generalised multiplicistic statements.

Samples. Three studies with a total sample size of $N = 416$ psychology students were conducted.

Methods. A domain-specific inventory containing both absolute and multiplicistic statements was developed. Expectations were tested by exploratory factor analysis (EFA), confirmatory factor analysis (CFA), and correlational analyses.

Results. Results revealed a two-factor solution with an absolute and a multiplicistic factor. Criterion validity of both factors was confirmed. Cross-sectional analyses revealed that agreement to generalised multiplicistic statements decreases with study progress. Moreover, consistent with our understanding of epistemic sophistication as a reluctant attitude towards generalised epistemic statements, evidence for a negative relationship between epistemic sophistication and need for cognitive closure was found.

Conclusions. We recommend including multiplicistic statements into epistemic belief questionnaires and considering them as a separate dimension, especially when investigating individuals in later stages of epistemic development (i.e., in higher education).

Keywords: Epistemic beliefs, absolutism, multiplicism, evaluativism, higher education, psychology students, assessment

1 Introduction

The aim of this work is to introduce a novel approach to conceptualising and assessing epistemic sophistication in individuals with advanced epistemic beliefs (e.g., in higher education). Epistemic beliefs are defined as individual conceptions about the nature of knowledge and the process of knowing (Hofer, 2000; 2001). Due to their significance for information processing (Kardash & Howell, 2000), learning (Cano, 2005; Pieschl, Stahl, & Bromme, 2008), written argumentation (Bråten, Ferguson, Strømsø, & Anmarkrud, 2014), and academic achievement (Schommer, 1993; Phan, 2008), the development and structure of epistemic beliefs have attracted considerable research interest.

Since Schommer introduced the "Epistemological Belief Questionnaire" (EBQ) in 1990, Likert-type questionnaires containing epistemic statements are on the rise. Epistemic sophistication is frequently operationalised as *dis*agreement with absolute statements (e.g., "Knowledge is absolute and certain.") so that agreement with absolute statements reflects low whereas disagreement with the same statements indicates high sophistication. However, in light of recent developments in the field, this approach seems no longer satisfactory. For instance, Elby and Hammer (2001) emphasise that multiplicistic beliefs (e.g., "Knowledge is tentative and uncertain.") might also be unsophisticated: Instead of believing that everything is uncertain, it would be more appropriate to conceptualise knowledge to be (un)certain to different degrees, because some issues are more controversial than others. Especially among individuals in later stages of epistemic development (e.g., higher education students), it thus becomes crucial to differentiate between blanket generalisations and contextually adaptive views on knowledge and knowing when striving to assess epistemic sophistication.

In this article, we therefore challenge the common approach of operationalising epistemic sophistication as disagreement with absolute statements (as is often done in questionnaires drawing on Hofer and Pintrich's [1997] framework). Instead, we plead that at

least in higher education, generalised multiplicistic beliefs (e.g., a view of science as generally tentative) should also be considered as unsophisticated. Therefore, we propose to assess epistemic beliefs by instruments measuring absolutism and multiplicism on separate scales. Moreover, we assume epistemologically sophisticated individuals to be cautious and reluctant towards both generalised absolute and generalised multiplicistic statements, and thus suggest that epistemic sophistication (i.e., evaluativism) is reflected by low scores on both dimensions. Both on a conceptual and on an empirical level, we provide evidence for our assumptions and demonstrate that our approach enables, among others, a more detailed examination of the developmental processes leading to increased epistemic sophistication.

2 Background

Kuhn (1991) describes the development of epistemic beliefs as a sequence of three successive stages which are characterised by different, partly opposing conceptions of knowledge and knowing. Development begins in a stage called *absolutism*: Knowledge and knowing are conceptualised in dualistic, absolute contrasts, such as right-and-wrong or truth-and-untruth (Hofer & Pintrich, 1997). By contrast, in the second, so-called *multiplicism* stage, different opinions are assumed to be freely chosen, equally valid, and exchangeable. Multiplicists thus are at risk to become fully arbitrary in their views on science (*radical subjectivity*; Hofer & Pintrich, 1997). In the final stage, individuals realise that "viewpoints can be compared and evaluated to assess relative merits" (Hofer & Pintrich, 1997, p. 104). This stage is called *evaluativism*, as individuals see themselves to be part of the process of knowledge by evaluating and weighting different positions to issues.

According to Kuhn (1991), development proceeds following this sequence when new experiences are incompatible with current conceptions. Not surprisingly, epistemic

sophistication closely relates to age and educational level (Schommer, 1998). For example, King and Kitchener (1994; 2002) showed that secondary school students predominantly reveal thinking referring to absolute beliefs, whereas college students evidence the use of multiplicistic or evaluativistic assumptions. Especially students in senior college classes reveal multiplicistic thinking, which is why King and Kitchener (2002) assume a shift from absolutism to multiplicism during college. Authors agree that the most sophisticated forms of epistemic thinking (i.e., evaluativism) are usually achieved only by those with advanced educational levels (e.g., doctoral students; Magolda, 2002; King & Kitchener, 2002; Hofer, 2001). Nonetheless, considering Kuhn, Cheney, and Weinstock (2000) reporting tendencies towards absolute, multiplicistic, as well as evaluativistic thinking within the same levels of education (even among primary school students), it is noteworthy that epistemic sophistication varies widely among peers. Consequently, it becomes essential to focus not only on earlier, but also on later stages of epistemic development (e.g., multiplicism and evaluativism), especially when investigating epistemic beliefs in higher education.

In addition to developmental approaches, recent research strives towards a more fine-grained analysis of the dimensional structure of epistemic beliefs. A common conception (Hofer & Pintrich, 1997) subdivides epistemic beliefs into the four dimensions "certainty of knowledge" (beliefs about the stability/tentativeness of knowledge), "simplicity of knowledge" (beliefs about the complexity/texture of knowledge), "source of knowledge" (beliefs about where knowledge originates from), and "justification of knowing" (beliefs about how knowledge can be evaluated). Furthermore, many emphasise the domain-specificity of epistemic beliefs (Buehl, Alexander, & Murphy, 2002), as studies reveal inter-individual (e.g., Paulsen & Wells, 1998; Trautwein & Lüdtke, 2007) as well as intra-individual (e.g., Stahl & Bromme, 2007) differences with respect to different scientific domains.

With varying conceptual priorities, different instruments to assess epistemic beliefs have been developed. Since Schommer introduced the EBQ in 1990, Likert-type questionnaires comprising epistemic statements have been gaining ground (e.g., Hofer, 2000; Nussbaum & Bendixen, 2003; Wood & Kardash, 2002; Elder, 2002). Most of these questionnaires predominantly contain absolute statements (e.g., "Truth is unchanging in this subject"; Hofer, 2000). Some also contain statements reflecting multiplicistic (e.g., "The only thing that is certain is uncertainty itself"; Schommer, 1990) or evaluativistic beliefs (e.g., "Truth means different things to different people"; Nussbaum & Bendixen, 2003).

Disagreement with absolute statements is frequently interpreted to reflect epistemic sophistication (Hofer, 2000). However, this approach cannot differentiate between multiplicistic and evaluativistic positions, because both students with multiplicistic and with evaluativistic beliefs would likely reject such statements (Hofer & Bendixen, 2012). This is aggravated by the fact that, in some cases, multiplicistic beliefs impede achievement even more severely than absolute beliefs. For instance, Elby and Hammer (2001) argue that in introductory physics, absolute thinking might be a better precondition for successful learning than multiplicistic thinking. They expect learners to be more persistent in trying to understand the coherence of physical laws if they believe them to be certain (compared to learners who believe them to be tentative; Elby & Hammer, 2001; diSessa, Elby, & Hammer, 2003). In line with this, Franco, Muis, Kendeou, Ranellucci, Sampasivam, and Wang (2012) argue that learning is most productive if the *epistemic nature* of a learning task corresponds with the learner's epistemic beliefs. Hence, regarding the challenges that especially psychology students face during their studies, neither absolutism nor multiplicism seems helpful. For instance, writing a thesis usually requires differentiated examinations of the literature on a certain topic and reflective evaluations of current research approaches. We assume neither absolute nor multiplicistic beliefs to be helpful to meet these demands. Contrastingly,

evaluativistic beliefs would very well be helpful. Thus, even though *agreement* with absolute statements might well be seen as an indicator for *un*sophisticated beliefs, we conclude that the rejection of absolute beliefs cannot be taken as a trustworthy indicator for epistemic sophistication.

In some cases, agreement with multiplicistic statements is also referred to as indicating sophistication (e.g., Schommer, 1990). The underlying idea seems to be that epistemic sophistication follows a linear trend analogous to the developmental trend postulated in the stage models (e.g., Kuhn, 1991): Epistemic development begins at the unsophisticated stage of absolutism, sophistication increases once individuals reach the stage of multiplicism, and ends at the stage of evaluativism. Agreement with multiplicistic statements would thus indicate higher sophistication. We nevertheless think this assumption is flawed. In fact, it is highly questionable whether agreement with generalised multiplicistic statements such as "Nothing is certain but death and taxes" (Schommer, 1990) implies sophistication. Such blanket generalisations do not attend to context and therefore do not reflect differentiated epistemic thinking. Instead of believing that everything is uncertain, it would be more appropriate to conceptualise knowledge, depending on the issue in question, to be (un)certain to different degrees. Elby and Hammer (2001) thus refer to sophistication as a case-based (context- and content-related) adaptivity: An epistemically sophisticated person does not believe in generalisations about the nature of knowledge, but will, depending on the epistemic nature of the issue in question, choose the position that is most appropriate. For these reasons, we propose to interpret agreement to generalised multiplicistic statements to indicate undifferentiated multiplicistic thinking.

Up to this point, we have argued that neither disagreement with absolute nor agreement with generalised multiplicistic statements reflects epistemic sophistication. One may thus conclude that agreement with evaluativistic statements is the best approach to

measuring sophistication. Unfortunately, students with multiplicistic beliefs (e.g., considering science to be generally tentative) will likely also agree to evaluativistic statements such as "Ideas in science sometimes change" (Conley, Pintrich, Vekiri, & Harrison, 2004). Findings from Kuhn et al. (2000) and Conley et al. (2004) support this, as even primary school students scored extremely high on evaluativism scales. This stands in sharp contrast to researchers broadly agreeing that evaluativism is rarely observed – even in college students (e.g., Hofer, 2001). For these reasons, we do not expect evaluativistic items to provide more insight than absolute or multiplicistic items.

To resolve these issues, we suggest including both generalised absolute and generalised multiplicistic statements into epistemic belief questionnaires. From a developmental perspective, this enables absolutism and multiplicism to be assessed and thus recognise the transition from absolutism towards multiplicism. We assume absolute positions to be reflected by agreement with absolute and disagreement with multiplicistic statements, and multiplicistic positions by disagreement with absolute and agreement with multiplicistic statements. Moreover, following the view of sophistication as a context-based adaptivity (Elby & Hammer, 2001), considering both types of statements might also enable the assessment of evaluativism. In fact, one might figure evaluativism as an adaptive (content- and context-based) endorsement of absolute and multiplicistic beliefs, and perhaps the most important precondition for this adaptivity might be a personal stance *not* to overgeneralise: Students who realise that the (un)certainty of an issue depends on the issue itself and on the context it is embedded in will likely rate both generalised absolute and multiplicistic statements lower than students with undifferentiated absolute or multiplicistic beliefs. This rather fundamental personal stance should thus manifest in a more cautious and reluctant attitude towards generalised epistemic statements. Hence, we assume evaluativistic positions

to be reflected by disagreement with *both* generalised absolute and generalised multiplicistic statements.

3 The present study

In a first step, a domain-specific questionnaire of 35 items, containing 19 generalised absolute and 16 generalised multiplicistic statements to be rated on a 5-point Likert scale, was developed. The questionnaire's introduction stated that students should designate their degree of agreement with the domain of psychology in mind. Care was taken that the four dimensions by Hofer and Pintrich (1997) were equally represented across all items and stages. Some of the items (see Table 1) were adapted from existing questionnaires; others were devised by the authors.

We expected absolute and multiplicistic statements to load onto separate factors. This was derived from our theorising that evaluativism is associated with low agreement to both generalised absolute and generalised multiplicistic statements. Therefore, with increasing epistemic sophistication, correlations between absolute and multiplicistic scales should decrease, since high scores on the absolute scale would no longer be associated with low scores on the multiplicistic scale (or vice-versa). Considering this, absolutism and multiplicism cannot be viewed as opposite poles on a single dimension, but rather as separate dimensions.

To examine criterion validity of both dimensions, the CAEB (Stahl & Bromme, 2007) was used. The CAEB measures domain-specific epistemic beliefs on two scales (variability and texture), each with an underlying absolute and multiplicistic pole. It contains adjective pairs with opposing terms, and participants are instructed to designate whether they view knowledge in a certain domain, e.g., to be rather "objective" or "subjective". High scores

reflect multiplicism; low scores reflect absolutism. We thus assumed our absolutism scale to correlate negatively, and our multiplicism scale to correlate positively with both CAEB scales.

Expectation 1: An exploratory factor analysis (EFA) with all 35 items will reveal two factors, of which one may be interpreted as "absolutism", the other as "multiplicism". Factor structure can be confirmed by confirmatory factor analysis (CFA).

Expectation 2: The CAEB correlates negatively with the absolutism and positively with the multiplicism scale.

Moreover, in an effort to investigate whether epistemic sophistication is reflected by low scores on both scales, we assumed our approach to be able to detect differences in epistemic beliefs among psychology students of different semesters: With increasing study duration, agreement to both generalised absolute and generalised multiplicistic statements should decrease, as students realise that the (un)certainty of an issue depends on the issue itself and on the context it is embedded in (i.e., they increasingly turn towards evaluativism, which is supported by a vast body of research; e.g., Magolda, 2002; King & Kitchener, 2002; Hofer, 2001). To gain an easy-to-interpret indicator for generalised epistemic thinking, we additionally computed a reverse-coded, aggregate score of absolutism and multiplicism. First, the arithmetic mean of absolutism and multiplicism was calculated. To facilitate interpretation, this new variable was z-standardised and subsequently multiplied by minus one. The multiplication by minus one "flips" the variable (positive z-scores become negative and vice-versa) and thus accounts for *low* scores on absolutism and multiplicism reflecting sophistication. Higher values on this score generally indicate lower agreement to both absolute and multiplicistic statements.

Expectation 3: Agreement to absolute and multiplicistic statements will diminish with increasing duration of studies.

Expectation 4: A reverse-coded, aggregate score of absolutism and multiplicism constitutes an indicator for epistemic sophistication (i.e., evaluativism). Epistemic sophistication will increase with duration of studies.

Finally, along with our view of evaluativism as a more cautious and reluctant endorsement of generalised absolute and multiplicistic statements, we expected the most important precondition of evaluativism to be a personal stance *not* to overgeneralise. As students with high need for cognitive closure seek "easy" solutions and strive to avoid ambiguity (Webster & Kruglanski, 1994), they might thus be inclined to approve generalised absolute and/or multiplicistic statements. Contrastingly, students with low need for closure might well find pleasure in comparing and integrating competing points of view, which constitutes a central component of evaluativism. As a positive relationship between unsophisticated (naïve) beliefs and need for closure has already been demonstrated (DeBacker & Crowson, 2006), we thus expect a negative relationship between epistemic sophistication – defined as disagreement with both absolute and multiplicistic statements – and need for closure.

Expectation 5: Absolutism and multiplicism correlate positively with need for closure.

Expectation 6: Epistemic sophistication (i.e., evaluativism) correlates negatively with need for closure.

4 Method

4.1 Participants and procedure

Data from three studies with a total of 416 psychology students from a large German university were used to test our assumptions.

4.1.1 Study 1

An online-version of the questionnaire was answered by 175 psychology students in a self-chosen environment (e.g., at home). After descriptive analyses, one participant was excluded due to more than 50 percent missing values, and three participants were excluded due to extreme response tendencies. The remaining 171 participants (26 males, 145 females) were M = 22.68 (SD = 2.68) years old. The sample consisted of 35 first-year undergraduates, 34 second-year undergraduates, 71 third-year-or-later undergraduates, and 31 graduate students (seeking a master's degree).

4.1.2 Study 2

Data were collected at the pre-test stage of two information literacy interventions. An online-version of the questionnaire was administered to 139 psychology students; data collections were conducted in a computer lab in groups of 9 to 20 students. 14 participants were excluded as they had already taken part in Study 1. The remaining 117 participants (16 males, 101 females) were M = 23.35 (SD = 3.53) years old. The sample consisted of 32 first-year undergraduates, 23 second-year undergraduates, 30 third-year-or-later undergraduates, and 32 graduate students.

4.1.3 Study 3

An online-version of the questionnaire was to be answered in a self-chosen environment by 128 first-year psychology undergraduates (24 males, 104 females). Participants were $M = 20.47$ ($SD = 2.58$) years old.

4.2 Measures

In each study, students were asked to designate their agreement with the 35 epistemic statements on a 5-point Likert scale. To acknowledge for the possibility that epistemically sophisticated students might be more reluctant towards answering generalised absolute and multiplicistic statements, a "don't know" response option was added. The proportion of participants who chose this option varied between 1 and 15 percent per statement, and participants made use of this option for 0 to 43 percent of the questionnaire. The vast majority of participants (92 %) used the option for less than 15 percent of the statements. No significant relationships between the use of the "don't know" option and sociodemographic variables (age, sex, study progress) as well as absolutism or multiplicism were found. Moreover, a non-significant Little's MCAR test (Little & Rubin, 2002) indicates that the option was not used systematically. "Don't know" answers were thus treated as missing data and handled by Multiple Imputation (Rubin, 2004). Five imputations were conducted by Bayesian linear regression; statistical coefficients were averaged.

Additionally, all participants of Studies 2 and 3 ($N = 245$) completed the CAEB (Stahl & Bromme, 2007; see above). The 17 adjective pairs had to be rated on 7-point scales. Scale values were calculated in a way that lower scores indicate absolute and higher scores indicate multiplicistic tendencies.

Moreover, participants of Study 3 (N = 128) completed the need for cognitive closure questionnaire by Schlink and Walther (2007). 16 Items (e.g., "I don't like unpredictable situations.") were to be rated on a 6-point Likert scale.

5 Results

To test Expectation 1, a principal component analysis with varimax rotation was conducted with all 35 items for the total sample (N = 416). Scree plot examinations revealed two points of inflexion; the first suggesting a two-factor and the second a four-factor solution. As the four-factor solution was not unambiguously interpretable, the two-factor solution was preferred. The final solution was obtained by stepwise exclusion of items with factor loadings below .30 (Field, Miles, & Field, 2012). This solution (27 % of total sample variance explained) included 23 items; 12 absolute statements loading on the first factor (Eigenvalue: 3.83; 14 % explained variance) and 11 multiplicistic statements loading on the second factor (Eigenvalue: 2.41; 13 % explained variance; see Table 1). Both factors included at least two items of each facet of Hofer and Pintrich's framework (1997).

------ Insert Table 1 here ------

To further investigate the questionnaire's factor structure, a CFA with the remaining 23 items was conducted using Mplus 7.11 (Muthén & Muthén, 1998-2012; estimator: ML). As both factors included items from all four facets of Hofer and Pintrich's (1997) framework (see Table 1), the resulting CFA models were rather elaborate: The single-factor model (Model 1; see Figure 1) included four first-order latent factors representing the four facets

(complexity, source, justification, and stability) of Hofer and Pintrich (1997) and one second-order latent factor as a general epistemic belief factor. Moreover, for each of the four facets, residuals of absolute and multiplicistic items were allowed to correlate because absolute and multiplicistic statements of each facet likely share common unexplained variance. For example, both absolute and multiplicistic items of the stability dimension may include unexplained variance that relates to how students interpret what is "stable" knowledge. Fit indices indicated moderate model fit with the exception of very low CFI and TLI values (see Figure 1).

------ Insert Figure 1 here ------

The two-factor model (Model 2; see Figure 2) had the same nested structure and again allowed residuals of absolute and multiplicistic items to correlate. In contrast to Model 1, all first- and second-order latent factors were split up so that "absolute" items would load onto absolute, and "multiplicistic" items would load onto multiplicistic factors. Fit indices indicated good model fit for all indicators except CFI and TLI (see Figure 2). Since CFI and TLI tend to decrease with an increasing number of variables in the model (Kenny & McCoach, 2003), especially when correlations between the variables are rather low (as one would expect for a multifaceted measure like ours), fit indices can be considered acceptable. Model 2 fit was clearly superior to Model 1 fit, thus suggesting that – as expected – Model 2 fits the data better. A chi-square difference test confirmed this (χ^2[194] 522.64 - χ^2[189] 363.80 = χ^2[5] 158.84; $p < .001$).

------ Insert Figure 2 here ------

Subsequently, scale values (arithmetic means) were calculated for both absolute and multiplicistic items. Boxplots and scatterplots were used for outlier screening. In Study 3, one bivariate outlier was eliminated from the dataset. Table 2 shows scale reliabilities in all three studies. To test Expectation 2, (criterion validity) data from Studies 2 and 3 were used. In Study 2, Pearson correlations between the absolutism scale and both CAEB dimensions revealed negative relationships, whereas the multiplicism scale positively correlated with both CAEB dimensions (see Table 3): The more participants agreed to absolute generalisations, the more they rated CAEB's adjective pairs towards absolutism, and the more they agreed to multiplicistic generalisations, the more they rated CAEB's adjective pairs towards multiplicism. This was replicated in Study 3 (see Table 4) and thus demonstrates criterion validity of both scales.

------ Insert Tables 2, 3, and 4 here ------

Pearson correlations were also calculated to examine relations between absolutism and multiplicism. In Study 1, no significant correlation was found (r = -.11; *ns*). In Study 2, a small but negative correlation between both scales was found (r = -.21; $p < .05$), which was corroborated in Study 3 (r = -.26; $p < .01$).

Furthermore, differences in epistemic beliefs with regard to participants' study progress (in years) were examined. Because data on study progress were ordinal (four levels; see Table 5), Spearman correlations were calculated. In Study 1, the correlation between study progress and absolute beliefs was not statistically significant (r = .01; *ns*). With regard to multiplicism, the respective correlation was – although very low – significant and negative

(r = -.13; p < .05; see Table 5). This indicates that multiplicism indeed slightly decreases over the course of psychology studies, a pattern that was replicated in Study 2 (absolutism: r = -.04; *ns*; multiplicism: r = -.22; p < .01). Even though we acknowledge that the corresponding relationships were weaker than expected, we see Expectation 3 as partially supported.

To test Expectation 4, a reverse-coded, aggregate score of absolutism and multiplicism (higher scores = lower scores on both scales) was calculated as an indicator for epistemic sophistication. In Study 1, the Spearman correlation between study progress and sophistication was not significant (r = .11; *ns*). In Study 2, the correlation was – even though again rather weak – significant (r =.24; p < .01). Expectation 4 is partially supported.

------ Insert Table 5 here ------

Data from Study 3 were used to test Expectations 5 and 6. Need for cognitive closure correlated positively with absolutism (r = .19; p < .05). Nevertheless, this correlation was very low. With regard to multiplicism, the correlation was not significant (r = .14; *ns*). Expectation 5 is therefore only partially supported. With regard to Expectation 6, a significant negative relationship between need for closure and epistemic sophistication (aggregate score; r = -.27; p < .01) indicates that students with low need for closure indeed might have more sophisticated beliefs. Expectation 6 is fully supported.

6 Discussion

The aim of this work was to introduce a novel approach to conceptualise and assess epistemic sophistication in individuals with more advanced epistemic beliefs. Our approach

follows the argument by Elby and Hammer (2001) who stress that not only absolute, but also multiplicistic beliefs may be unsophisticated. Based on a common approach which measures epistemic beliefs by the degree of agreement with domain-specific epistemic statements, we adopted a view of absolutism and multiplicism as separate dimensions and developed an inventory containing both generalised absolute and generalised multiplicistic statements. Considering our understanding of epistemic sophistication as a cautious and reluctant endorsement of generalised epistemic statements, we assumed evaluativism to be reflected by low scores on both scales.

Principal component analysis revealed a two-factor solution, which was subsequently corroborated by confirmatory factor analysis. Criterion validity of the two scales was confirmed by means of correlations with the CAEB. Only low to moderate negative relationships between the absolute and the multiplicistic scale were found, which suggests that absolutism and multiplicism represent two different facets of epistemic thinking and should not be measured on a single bipolar scale. Interestingly, the pattern of correlations in the three studies also supports our assumption that low scores on both scales reflect epistemic sophistication (i.e., evaluativism): Our theorising predicts that (negative) correlations between absolutism and multiplicism will decrease with increasing sophistication, as high absolutism no longer implies low multiplicism (or vice-versa). Our data support this assumption, as correlations between absolutism and multiplicism were indeed highest in the third study that only comprised (assumingly less sophisticated) freshmen.

Differences in epistemic beliefs with regard to study progress further support the assumption that sophistication is reflected by low agreement to both generalised absolute and generalised multiplicistic statements. Previous research has shown that educational level is one of the best predictors for epistemic sophistication. In line with this, we found epistemic sophistication – operationalised as a decrease on both absolutism and multiplicism – to

slightly increase with study duration. While investigating both scales separately, we found this to be primarily originated by a gradual decrease in multiplicism. Absolute beliefs were low but relatively stable. These somewhat counterintuitive findings (researchers generally expect a shift from absolutism towards multiplicism at early phases of college; King & Kitchener, 2002) might be due to our rather selective sample. In fact, mostly high achievers are admitted for psychology studies in Germany. As academic achievement closely relates to epistemic sophistication, it comes as no surprise that absolutism was particularly low in our studies. Thus, we assume the denoted shift from absolutism towards multiplicism (which would imply decreases in absolute and increases in multiplicistic beliefs) to occur even earlier in this population.

Finally, in our view of epistemic sophistication as a development towards a more cautious and reluctant endorsement of generalised epistemic statements, we expected positive correlations between need for cognitive closure and both scales: Students who seek "easy" solutions and strive to avoid ambiguity are more likely to agree with generalised absolute and multiplicistic statements, whereas students with a lower need for closure are more reluctant towards these statements. Our data partially support this expectation, which also suggests that epistemic sophistication might be more closely related to personality than generally assumed, and that need for closure might constitute a prerequisite for the development of sophisticated beliefs.

6.1 Limitations

A first limitation is that our research draws on a rather selective sample, and one might question whether our conclusions are transferrable to other domains (e.g., "hard" sciences). Second, the validity of cross-sectional analyses is generally limited because selectivity bias cannot be ruled out. The differences in multiplicistic beliefs between undergraduate and

graduate students, which heavily contribute to the increase in sophistication throughout students' course of studies, might not only be related to students' educational progress, but also to selection effects regarding the admission to master studies. Third – a common issue in epistemic beliefs research – some of the results concerning our inventory were less robust than expected. For example, correlations of the inventories' dimensions with need for cognitive closure and with study progress were very low, which might be due to complexity and the abstract nature of the concept of epistemic beliefs. Moreover, the amount of total sample variance explained by the two extracted factors in our factor analysis was also rather low. Especially the latter might be a consequence of the broad focus of our instrument, as both scales contain items that relate to all four dimensions distinguished by Hofer and Pintrich (1997). Additionally, we wish to point out that the primary purpose of this article is not the introduction of a new instrument, but the presentation of a conceptually and methodically sound approach to the measurement of evaluativism.

6.2 Conclusions, implications, and future directions

Despite these constraints, we assume that our work makes an important theoretical contribution to the field. Measuring evaluativism has always been an issue in research on epistemic beliefs. By considering absolutism and multiplicism as separate dimensions and viewing evaluativism as a cautious and reluctant endorsement of both generalised absolute and generalised multiplicistic statements, we propose a simple and convenient approach to circumvent the issue. This approach is especially valuable in higher education, where many have already undergone the shift from absolute to multiplicistic beliefs. Our research shows that operationalising epistemic sophistication as disagreement with absolute statements (as is often done in questionnaires drawing on Hofer and Pintrich's [1997] framework) might neglect important aspects of the construct. Therefore, it also serves as a potential explanation

for inconsistent findings on the relationship between epistemic beliefs and e.g., learning or conceptual change.

We thus recommend including multiplicistic statements into epistemic belief questionnaires and considering them as a separate dimension. In addition to providing detailed information about developmental progresses, the advantages of this approach become obvious when one bears in mind that in some cases, multiplicistic beliefs are obstructive for learning (Elby & Hammer, 2001; Bråten, Ferguson, Strømsø, & Anmarkrud, 2013). To foster student learning and satisfaction in psychology curricula, it might therefore prove useful not only to further reduce absolute, but also to buffer generalised multiplicistic beliefs (Rosman, Mayer, Peter, & Krampen, under review). Moreover, Franco et al. (2012) showed that learning improves when students' epistemic beliefs fit the epistemic nature of knowledge representations in texts. Measuring absolutism and multiplicism separately might be helpful for future research on such interactions.

In sum, the consideration of multiplicism as a separate dimension enables a more thorough and differentiated measurement of epistemic sophistication. For example, individuals with more sophisticated beliefs might be more capable in ignoring poor arguments and be less confused by conflicting arguments. Such research nevertheless requires not only to distinguish between absolute and non-absolute thinking, but also to assess epistemic sophistication in the sense of evaluativism. We think that our approach is especially suitable for this.

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Table 1

Two-factor solution of the inventory

	Factor 1: Absolutism	**Factor 2: Multiplicism**
Truth doesn't change in this subject. (certainty)	**0.55**	-0.02
Many theories in this subject have already been proven, and will not be refuted in the future. (certainty)	**0.46**	-0.25
In this subject, there are standard techniques which are suitable for all objectives. (justification)	**0.34**	0.10
The better the reputation of researcher in this subject, the better their scholarly work. (justification)	**0.46**	0.00
In this subject, valuations concerning the quality of a scientific work made by several researchers are very similar. (justification)	**0.37**	-0.21
With respect to the major topics in this subject, opinions of all researchers correspond. (complexity)	**0.53**	-0.20
There is always a true answer to questions in this subject. (complexity)	**0.56**	-0.09
If somebody is not able to take a position on a matter in this subject, he/she is not sufficiently informed. (complexity)	**0.44**	0.02
If views held by two researchers in this discipline are contradictory, one of the views must be wrong. (complexity)	**0.60**	-0.08
If the content of a textbook in this subject is contradictory compared with own experiences, you should align your opinion to the textbook. (source)	**0.50**	-0.04
To form an opinion concerning a topic in this subject, it is most suitable to adopt the opinion of an expert. (source)	**0.57**	0.02
If something in this subject appears to be very complicated, you should search for an explanation by an expert or in a textbook	**0.42**	0.00

and adopt it. (source)		
In this subject, what is regarded as correct by researchers, changes permanently. (certainty)	-0.21	**0.54**
In this subject, no theory can be seen as established in the long term; everything can be refuted at any moment. (certainty)	-0.14	**0.65**
In this subject, only uncertainty appears to be certain. (certainty)	-0.05	**0.58**
What is seen as valid knowledge today can already tomorrow be regarded as obsolete in this subject. (certainty)	-0.20	**0.69**
Criteria for the evaluation of the quality of scientific work are vague in this subject, because they are understood in very different ways. (justification)	0.21	**0.38**
In this subject, different researchers come to very different valuations concerning a scientific work. (justification)	-0.03	**0.57**
To answer questions in this subject adequately, concepts always have to be applied flexibly and combined creatively. (complexity)	-0.15	**0.41**
In this field, even with regard to well understood findings, researchers have different, but equally valid explanations. (complexity)	-0.29	**0.33**
There are always different answers to questions in this subject and you can never distinguish reliably which one is better. (complexity)	-0.09	**0.42**
What is right or wrong in this subject can exclusively be decided by one's own thinking. (source)	0.20	**0.46**
To form an opinion about a matter in this subject, it is most suitable to rely on one's own experience. (source)	0.16	**0.46**

Note: All items were administered in German language. The original items are available upon request. Elements in parentheses are the dimensions from Hofer and Pintrich's (1997) framework. Factor loadings are averaged coefficients from a multiple imputation procedure.

Table 2

Reliabilities (Cronbach's Alpha) of the absolute and multiplicistic scale in all three studies

		Study 1	Study 2	Study 3
1	Absolute scale	.72	.66	.69
2	Multiplicistic scale	.70	.61	.72

Note: $N_{\text{Study 1}} = 171$; $N_{\text{Study 2}} = 117$; $N_{\text{Study 3}} = 127$; Cronbach's Alphas are averaged coefficients from a multiple imputation procedure.

Table 3

Intercorrelations and reliabilities of all variables in Study 2

		1	2	3	4
1	Absolute scale	**(.66)**			
2	Multiplicistic scale	-.21*	**(.61)**		
3	CAEB: Variability	-.35***	.38***	**(.71)**	
4	CAEB: Texture	-.20*	.23**	.31***	**(.76)**

Note: N = 117; CAEB = Connotative Aspects of Epistemological Beliefs; Values on bold on the diagonal = Cronbach's Alpha.

* $p < .05$.

** $p < .01$.

*** $p < .001$.

Table 4

Intercorrelations and reliabilities of all variables in Study 3

		1	2	3	4	5	6
1	Absolute scale	**(.69)**					
2	Multiplicistic scale	-.26***	**(.72)**				
3	CAEB: Variability	-.45***	.51***	**(.68)**			
4	CAEB: Texture	-.18*	.41***	.41***	**(.73)**		
5	Epistemic sophistication	-.52***	-.69***	-.11	-.23**	-	
6	Need for Cognitive Closure	.19*	.14+	-.13+	-.03	-.27**	**(.80)**

Note: N = 127; CAEB = Connotative Aspects of Epistemological Beliefs; Epistemic sophistication = sum of absolute and multiplicistic scores; Values on bold on the diagonal = Cronbach's Alpha.

+ $p < .10$.

* $p < .05$.

** $p < .01$.

*** $p < .001$.

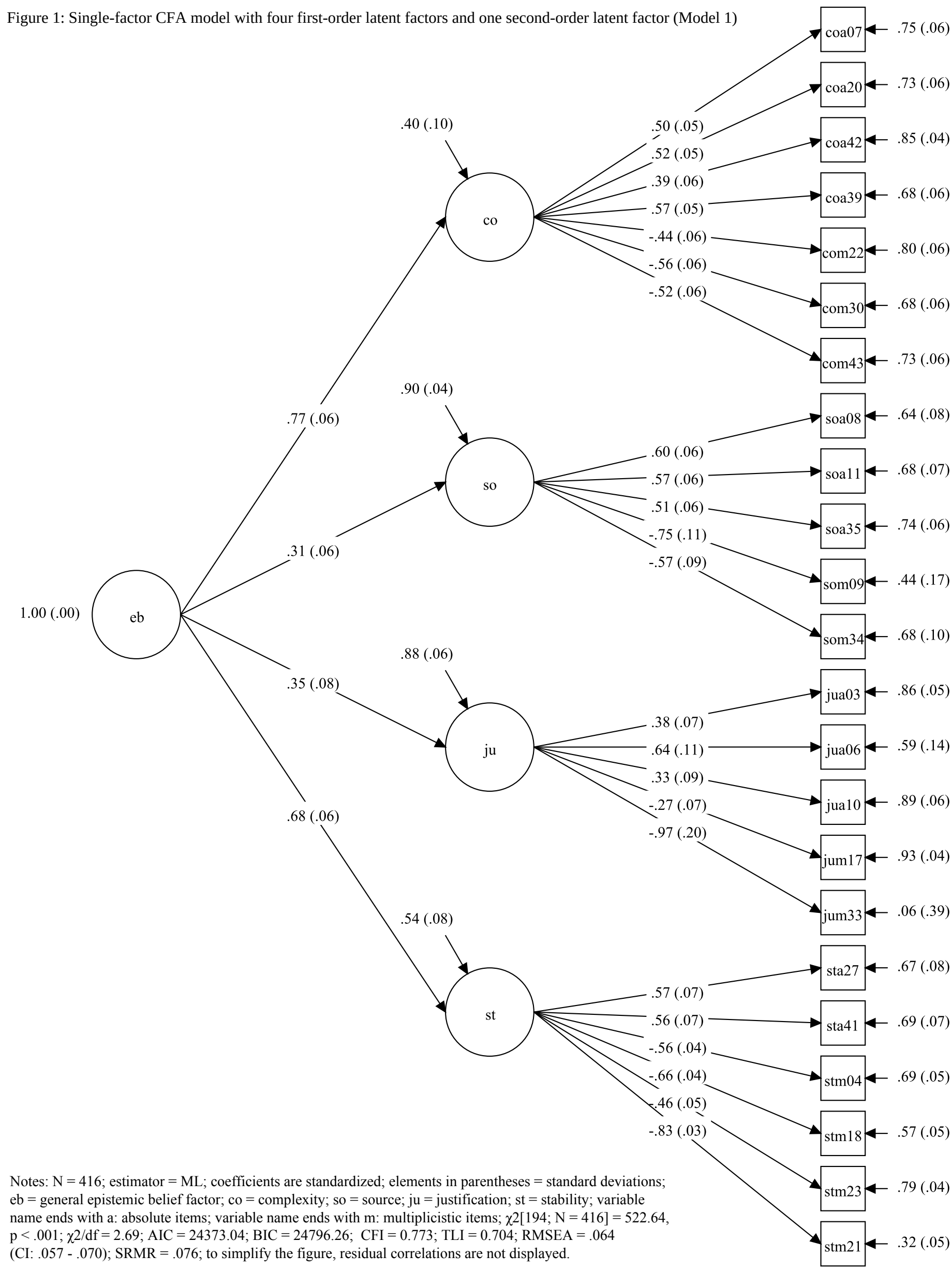
Table 5

Means and standard deviations of the absolute and the multiplicistic scale depending on study progress in Study 1 and Study 2

		Means (Standard deviations)			
		UG1	UG2	UG3+	MD
Study 1	Absolute scale	2.16 (0.43)	2.07 (0.63)	2.08 (0.44)	2.13 (0.40)
	Multiplicistic scale	3.23 (0.55)	3.25 (0.54)	3.19 (0.51)	3.01 (0.54)
	Epistemic Sophistication	-0.17 (0.96)	-0.05 (1.36)	0.02 (0.85)	0.21 (0.91)
Study 2	Absolute scale	2.07 (0.43)	2.08 (0.55)	1.91 (0.43)	2.04 (0.38)
	Multiplicistic scale	3.37 (0.40)	3.47 (0.42)	3.26 (0.47)	3.11 (0.54)
	Epistemic Sophistication	-0.22 (0.90)	-0.41 (1.28)	0.25 (0.84)	0.29 (0.88)

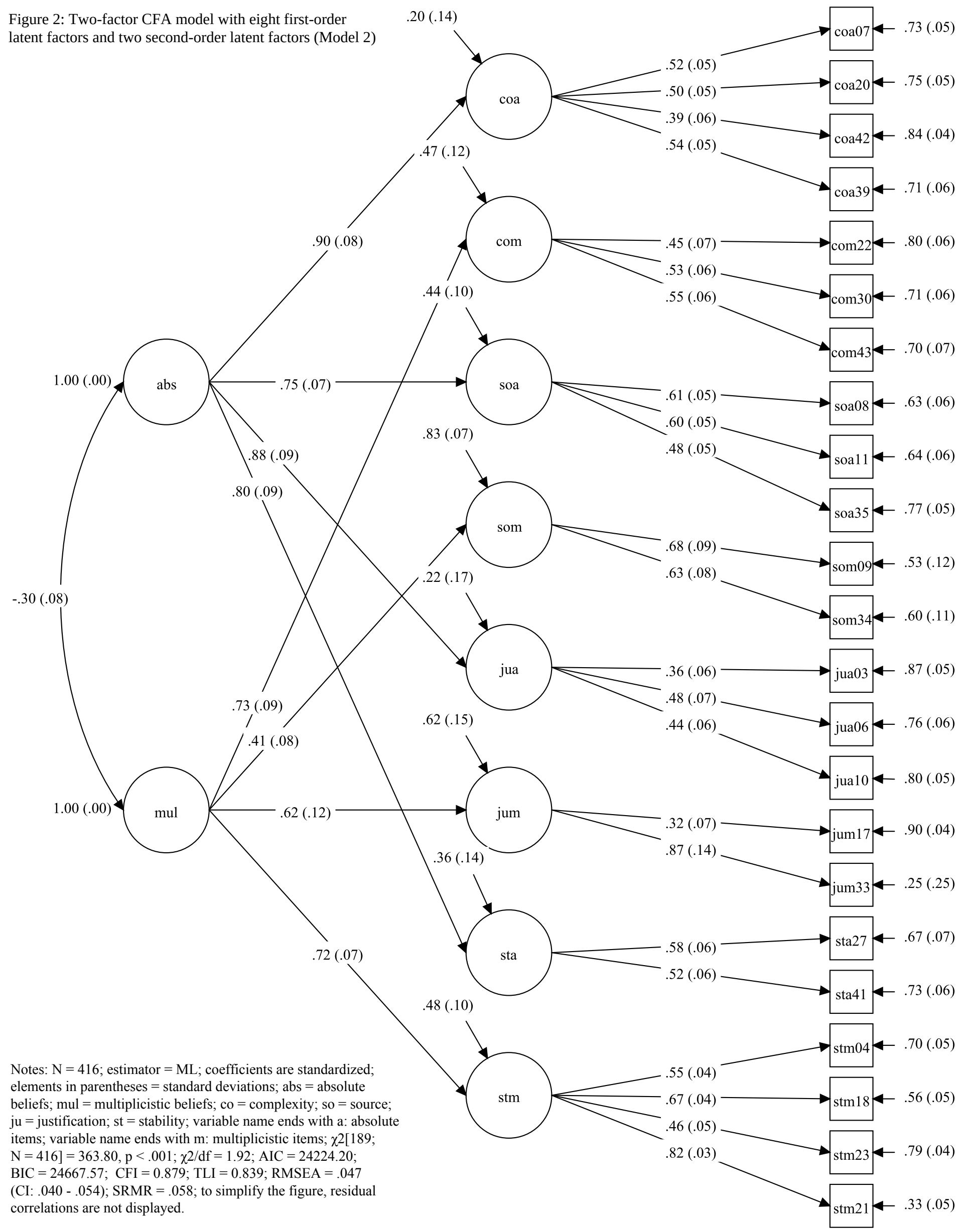
Note: $N_{\text{Study 1}} = 171$; $N_{\text{Study 2}} = 117$; UG1 = undergraduate students in their first year; UG2 = undergraduate students in their second year; UG3+ = undergraduate students in their third year or later; MD = graduate students seeking a master's degree.

Figure 1: Single-factor CFA model with four first-order latent factors and one second-order latent factor (Model 1)



Notes: N = 416; estimator = ML; coefficients are standardized; elements in parentheses = standard deviations; eb = general epistemic belief factor; co = complexity; so = source; ju = justification; st = stability; variable name ends with a: absolute items; variable name ends with m: multiplicistic items; $\chi 2[194; N = 416] = 522.64$, $p < .001$; $\chi 2/df = 2.69$; AIC = 24373.04; BIC = 24796.26; CFI = 0.773; TLI = 0.704; RMSEA = .064 (CI: .057 - .070); SRMR = .076; to simplify the figure, residual correlations are not displayed.

Figure 2: Two-factor CFA model with eight first-order latent factors and two second-order latent factors (Model 2)



Notes: N = 416; estimator = ML; coefficients are standardized; elements in parentheses = standard deviations; abs = absolute beliefs; mul = multiplicistic beliefs; co = complexity; so = source; ju = justification; st = stability; variable name ends with a: absolute items; variable name ends with m: multiplicistic items; $\chi 2[189; N = 416] = 363.80$, $p < .001$; $\chi 2/df = 1.92$; AIC = 24224.20; BIC = 24667.57; CFI = 0.879; TLI = 0.839; RMSEA = .047 (CI: .040 - .054); SRMR = .058; to simplify the figure, residual correlations are not displayed.