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RESEARCH ARTICLE

One task, divergent solutions: high- versus low-status sources and social comparison guide adaptation in a computer-supported socio-cognitive conflict task

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Abstract This experimental study extends conflict elaboration theory (1) by revealing social influence dynamics for a knowledge-rich computer-supported socio-cognitive conflict task not investigated in the context of this theory before and (2) by showing the impact of individual differences in social comparison orientation. Students in two conditions ($N = 59$) compared their self-created task solution with a partly correct solution presented additionally, deviating from their solution. The other solution's source was introduced either as a low status source ("peer") or as a high status source ("textbook") whereas the presented solution was identical. In a baseline condition, this comparison possibility was missing. Students in the textbook condition experienced more socio-cognitive conflict and adapted their solution more often to the correct aspect of the presented solution than students in the peer condition. Students low in social comparison orientation adapted their solution more extensively in the textbook condition than in the peer condition.

Keywords Socio-cognitive conflict · Conflict elaboration theory · High- versus low-status sources · Adaptation · Social comparison orientation

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Introduction

In the realm of theories on social influence, the *conflict elaboration theory* (Mugny et al. 1995) is a social theory of learning. In contrast, the related theory of *cognitive dissonance* (Festinger 1957), for example, and the notion of *normative* versus *informational social influence* (Deutsch and Gerard 1955) focus more on attitudes during a process of decision making or on making judgments than on the learning performance.

Studies on conflict elaboration theory investigate how a *socio-cognitive conflict*, for example, being confronted with another person's task solution which largely deviates from one's own solution affects a learner's performance if he or she does not know which solution is correct (Quiamzade and Mugny 2001). This study shows that a computer-based external representation can be used to trigger socio-cognitive conflict by making learners aware of a task solution that deviates from their own solution (Suthers 2006).

The impact of two factors is investigated: the status of the source of a presented solution and the learner's social comparison orientation (Buunk and Gibbons 2007).

Most previous studies on conflict elaboration theory have applied knowledge-lean problems as learning tasks (e.g., Quiamzade et al. 2009; Quiamzade 2007). The solution strategies of such problems could be learned during the course of short experiments (e.g., anagram tasks; Quiamzade et al. 2009). In contrast, knowledge-rich problems require an extensive knowledge base. Examples of knowledge-rich tasks are making medical diagnoses or solving law cases (cf. Nievelstein et al. 2010; Sweller et al. 1998). For example, solving law cases requires identifying relevant information from cases and selecting solution strategies that apply best (Nievelstein et al. 2010). Therefore, in this study, a type of task was used which had not been investigated in the context of this theory before, namely a knowledge-rich computer-supported problem solving task. This experimental study aimed at testing whether in the context of a knowledge-rich task, high-status sources of solutions have more impact on learners than low-status sources (cf. Bandura 2006; Quiamzade and Mugny 2001). More specifically, it was examined whether learners selectively adopt others' correct solutions (positive form of imitation; Quiamzade and Mugny 2001) or whether they even imitate others' errors (negative form of imitation). The role of computer support was to make learners aware of others' deviating task solutions and competence (Bodemer 2011; Buder et al. 2009; Engelmann et al. 2009) which should cause a socio-cognitive conflict to the learners (e.g. Butera et al. 2005; Quiamzade 2007). In this study, it was postulated that more socio-cognitive conflict would result in more adaptation behavior to the presented solution.

Further, this study is the first one to show that social comparison orientation as a personality trait (cf. Festinger 1954; Gibbons and Buunk 1999) moderates how readily learners adapt their solution to a presented solution.

Assumptions of conflict elaboration theory

The difference between cognitive and socio-cognitive conflict is that cognitive conflict can arise without social influence (e.g., contradictions between an individual's thoughts), whereas socio-cognitive conflict is caused by a learner's social environment (e.g., other learners' deviating solutions). If learners are presented with the source of a deviating task solution and if they are uncertain about the correct solution, the *status* of the *source* is highly relevant and can predict its social influence (Mugny et al. 1995). In some previous experiments, the source of a socio-cognitive conflict was introduced by using academic

labels such as "student" versus "professor" (Mugny et al. 1998), and in most studies by excluding verbal communication between the learner and the source of socio-cognitive conflict (e.g., Quiamzade 2007).

According to conflict elaboration theory, peer learners particularly encourage to find the best solution: If peers are uncertain about the correct solution (Quiamzade and Mugny 2001), they can neither maintain their solution nor simply imitate the peer's solution. For example, Quiamzade et al. (2009) showed in two studies that low-status sources can influence learners' behavior more than high-status sources. The tasks involved finding words containing the letter "F" and solving anagram tasks. In other experiments, a hypothesis testing task was used (e.g., Quiamzade 2007). The present study argues that previous studies advocating peer learning over learning from high-status sources applied predominantly knowledge-lean problems (cf. Scheiter and Gerjets 2004). Early (e.g. Gergen and Bauer 1967) and recent studies on social influence (e.g. Rosander and Eriksson 2012) using varying task complexity have shown that social influence dynamics change for more complex tasks. However, there is a lack of studies testing assumptions of conflict elaboration theory in the context of knowledge-rich computer-supported tasks.

Especially if learners are novices in a knowledge-rich task, it will be difficult for them to identify strategies just from being informed about another task solution. In such a situation, learners most probably will imitate a high-status source's solution (cf. Bandura 2006; Quiamzade and Mugny 2001). Two types of imitation are discussed (Quiamzade and Mugny 2001):

(a) In the positive form of imitation, learners improve their ability, because the high-status source provides helpful knowledge and information without challenging the learner's competence.
(b) In the negative form of imitation, the high-status source threatens self-esteem by challenging the learner's competence (cf. Darnon et al. 2007). In this constellation, learners tend to imitate the presented solution rapidly without learning (Quiamzade and Mugny 2001).

High-status sources' solutions are generally imitated more often (cf. Bandura 2006). However, if a learner focuses more on the task than on the source status, he or she will not imitate the presented solution completely uncritically, especially not if parts of the other source's solution are wrong. Thus, in our study, it is argued that learners will selectively adopt correct parts of the presented solution (i.e., positive form of imitation) of a high-status source (i.e., a "textbook on the subject-matter domain") more often than of a low-status source (i.e., a "peer novice"; *Hypothesis 1*). As a further aspect of the positive form of imitation, it is postulated that learners will adopt wrong parts of the presented solution of a high-status source less often than of a low-status source (*Hypothesis 2*).

The role of CSCL

Computer-supported collaborative learning (CSCL) as a field is concerned with providing media that allow for managing collaboration and meaning-making (Suthers 2006). According to Suthers (2006, p. 324), "understanding the affordances technology offers for intersubjective meaning making is as foundational to CSCL as understanding learning". Technology affordances means, for example, that different kinds of media offer different possibilities.

CSCL requires that the learners have enough time for establishing a common ground (Paulus 2009), that tasks are coordinated and that learners have some information about

their collaboration partners and their activities in a shared environment (Janssen and Bodemer 2013). For example, the strand of research on *knowledge awareness* in the context of CSCL focuses on developing and testing computer-based external representations of others knowledge and task solutions (Bodemer 2011; Engelmann et al. 2009). In the present study, computer-support is used to make learners aware of others' task solutions and status. One experience of learning in general and, thus, also of CSCL is socio-cognitive conflict. This study shows that a computer-based external representation can be used to trigger socio-cognitive conflict by making learners aware of a task solution that deviates from their own solution. Thus, this study contributes to understanding the psychological processes (i.e., socio-cognitive conflict) triggered by knowledge awareness. On the one hand, computer-support can help to overcome socio-cognitive conflicts (e.g., Buder and Bodemer 2008; Harmon 1998). On the other hand, computer-support can cause conflicts, for example, if the technology does not meet the requirements of collaboration (cf. Hughes 1993).

The question of how learners react if they are confronted with other's status or knowledge is highly relevant for educational research and application. Being aware of others' knowledge can change a learner's behavior in many ways. For example, previous studies have shown that being informed about others' knowledge and information by means of computer-support both fosters individual learning by improving peer explanations (e.g., Dehler-Zufferey et al. 2011) and collaborative problem solving (Engelmann 2014).

Socio-cognitive conflict as a mediator of learners' adaptation behavior

In some studies, being confronted with a deviating solution of another source simply was equated to socio-cognitive conflict (e.g. Butera et al. 2005; Maggi et al. 1996; Quiamzade 2007). Therefore, this study is one of the few to measure perceived socio-cognitive conflict (e.g. Darnon and Butera 2007; Darnon et al. 2007).

Conflict elaboration theory argues that learners will experience more conflict in the case of the solution of a low-status source than in the case of the solution of a high-status source (Quiamzade et al. 2009). To our knowledge, however, no study has empirically validated this assumption by measuring socio-cognitive conflict. In the present study, we assume that learners confronted with a low-status source may consider their own solution to be more plausible. Consequently, they do not experience a high degree of a socio-cognitive conflict. In contrast, it could be possible that learners confronted with a high-status source consider their own solution to be less plausible. Therefore, they do experience a high degree of a socio-cognitive conflict (*Hypothesis 3*).

Socio-cognitive conflict can be a driving force of cognitive and behavioral changes. In the context of this knowledge-rich task, it is assumed that socio-cognitive conflict mediates the influence of source status on learners' adaptation behavior. Since learners should experience more socio-cognitive conflict in the case of a high-status source than in the case of a low-status source, more conflict should result in more adaptation to the presented solution (*Hypothesis 4*). In the following section, we will extend assumptions of conflict elaboration theory further by considering a personality trait as a potential moderator of learners' behavior.

Adapting to others: why social comparison orientation matters

Individuals differ in how often they compare their own abilities with other's abilities. Reviewing previous studies on social comparison, Buunk and Gibbons (2007) conclude that individuals who frequently compare themselves to others are more uncertain about the self and are interested in reducing this self-uncertainty. For example, people high in social comparison orientation (SCO) search for information about others in order to validate their position no matter whether the others are more or less similar to themselves (Michinov and Michinov 2001). Less is known, however, about people who indicate that they do not often compare themselves to others. It is possible that people low in SCO might still emulate exemplary actions in order to improve their own performance. Especially in situations in which individuals strive to improve their performance, they are interested in the performance of others who do better on the same task and thus serve as models (Smith and Sachs 1997). This could also be true for people low in SCO (*Hypothesis 5*): Individuals high in SCO generally adapt their solution to a deviating one. For them, it does not matter whether the source has a low status versus a high status (Michinov and Michinov 2001). In contrast, people low in SCO adapt their solution more often to the one of a high-status source than to a low-status source because they strive to improve their performance (Smith and Sachs 1997).

In addition, we examined whether socio-cognitive conflict mediates the association between source status and social comparison on adaptation behavior (mediated moderation; Muller et al. 2005): People low in SCO adapt more often to a high-status source because they experience more socio-cognitive conflict than if they are confronted with a low-status source (*Hypothesis 6*). In contrast, people high in SCO generally adapt extensively to the presented solution, regardless of the amount of socio-cognitive conflict they experience.

Method

Participants and design

Fifty-nine university students (41 female, 18 male; $M = 24.46$ years, $SD = 3.20$) of different fields of study at a university in southern Germany volunteered to participate in the study for either payment or course credit. Based on the notion of technology affordances in CSCL (Suthers 2006), it was investigated whether the computer-based external representation which was applied made learners aware of another solution, the source of this solution and the status (i.e., low vs. high) of the source. For this purpose, the computer-based external representation was designed to trigger comparisons between own and the other solution (cf. Buder et al. 2009). Further, it was investigated whether these information about solution, source and its status activate a socio-cognitive conflict. The participants were randomly assigned to one of three conditions (between-subjects design): In the *"peer condition"* ($n_p = 20$), participants compared their task solution with the solution said to be of a former participant of the pilot study, that is, a low-status source. In the *"textbook condition"* ($n_t = 20$), participants compared their solution with the solution of a supposed textbook on criminal law (subject-matter domain of this study), that is, a high-status source. In fact, participants in the textbook condition and in the peer condition both received the same solution produced by a former participant of the pilot study. The

presented solution contained one correct aspect and three false aspects. Presenting partly correct solutions offered the possibility to differentiate whether a learner uncritically imitated the wrong part of the presented solution or whether he or she was able to identify it. In the *baseline condition* ($n_b = 19$), participants did not receive a solution of another source.

Procedure

The participants were tested individually. They were told that the study was about solving criminal law cases by means of a computer-presented environment. The participants filled in a web-based test of their domain-specific prior knowledge and of their social comparison orientation regarding abilities. After a short practice with the software tool, they read six solved cases from the domain of criminal law (10 min), and four unsolved cases from the same domain (6 min). Subsequently, they built pairs of the unsolved and solved cases by means of a computer-based external representation (see Fig. 1, left side and in the middle; 10 min). They were asked to arrange each unsolved case next to the solved case whose solution could be transferred best to this unsolved case. After this, the participants were randomly assigned to one of three conditions: In the peer condition, the case pairs of the participants were arranged next to the pairs that had been created by "a former, randomly chosen participant of a pilot study" (Fig. 1, right side). In the textbook condition, the same case pairs were used as in the peer condition; however, a textbook on criminal law was indicated as source of these case pairs. The participants compared their own with the provided solution (5 min). During that time, participants of the baseline condition reviewed their self-created pairs. After that, all participants had 5 min to modify their case pairs if they wished. The pairs of the other source were still present in the peer condition and in the textbook condition. In these two experimental conditions, an online test assessed whether the participants were informed of the source of presented case pairs. Subsequently, participants of these two conditions answered a socio-cognitive conflict item. An experimental session lasted 60 min. At the end of the experiment, the participants were thanked, rewarded, and debriefed.

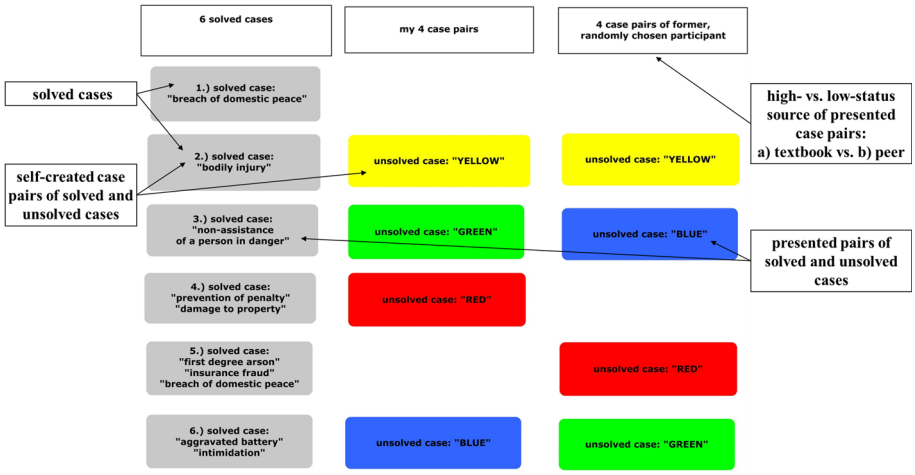

Fig. 1 Computer-based external representation of the self-created case pairs in the *middle*, and with presented case pairs of the high- versus low-status source on the *right side*

Materials and measures

Personal data (e.g., age) and *prior knowledge* of German case law were assessed by means of a web-based test (maximum score: 10 points).

The main task was to pair each of four unsolved criminal law cases with one of six solved criminal law cases, thus leaving two solved cases unpaired. The aim was to build pairs that required a similar solution so that the solution of the solved case could partly be transferred to the unsolved case (i.e., high structural similarity; see Table 1). Previous studies have shown that legal reasoning is a highly complex cognitive skill that requires a large knowledge base (Nievelstein et al. 2010). The software tool for building case pairs and for comparing solutions in the peer condition and in the textbook was *CmapTools* (cf. Novak and Cañas 2006; see, http://cmap.ihmc.us/). We assessed the *correctness* of the first version of self-created case pairs. Structural similarities between solved and unsolved cases existed only for two pairs (maximum correctness score: 2 points). The correct solution was identified in a pilot study with advanced law students ($n = 8$). The participants of the present study were not informed about the solution structure beforehand. The *match score* between the *first version* of self-created solution (Fig. 1, in the middle) and the solution presented in the peer condition and in the textbook condition (Fig. 1, right side) could range between "0" and "4" matching pairs. The *adaptation score* assessed how many pairs had been adapted to the presented ones in the *second version* of the solution (maximum score: 4 points if participant had adapted all four case pairs to the presented ones). In addition, it was assessed how often the participants of the peer condition and textbook condition had adopted the one correct and the three false pairs of the presented solution. The *correctness of the second version* of pairs was also assessed (maximum score: 2 points).

Table 1 Translated example of a correct pair of solved and unsolved cases

Solved case	Unsolved case
Ms. P. lives as a single woman in one part of a terraced house. In winter, she is obliged to strew sand and salt in the front of her part of the house. Due to an acute and heavy flu with high fever, she does not attend to her duty. Since her medicine against the flu makes her sleepy, she forgets to ask her neighbors to act for her. Then it occurs that an elderly lady slips on the icy sidewalk in the front of Ms. P.'s house and suffers a pelvic fracture. The elderly lady brings Ms. P. to trial in order to receive a compensation for her pain and suffering.	The pool attendant of a public swimming pool leaves for lunch break without giving her colleagues notice of her departure because she believes that she will be back in a short while and that nothing will happen. During this time, however, a boy is almost drowned as he gets a cramp in his leg. Another bather pulls the boy out of the water. Afterwards, the boy's parents bring the operator of the swimming pool to trial.
Case solution: Offender: Ms. P. Category of crime: omission of obligation to strew sand or salt Elements of a crime: bodily injury Offense accomplished By negligence Justification: She could not follow her obligation to strew sand or salt due to an acute disease Not fully responsible for her action due to action of a drug	

A multiple-choice item tested whether participants of the peer and textbook condition remembered the *source of the presented solution* correctly (cf., *knowledge awareness*, Engelmann et al. 2009, 2010). Six options were presented: "The most prevalent solutions gathered from former participants in a pilot study", "a textbook on criminal law", "a random generator", "an expert in criminal law", "a former, randomly chosen participant of a pilot study", and "a group of experts in criminal law" (correct source: one point; wrong alternative: zero points). In addition, the case pairs of the other source had to be reproduced from memory (maximum score: four points).

The following item assessed in retrospect whether a *socio-cognitive conflict* was experienced after being confronted with the deviating solution of another source: "I had doubts about one or more of my case pairs when I saw the other case pairs that were provided". The participants answered the item on a 5-point rating scale (from 1 for "low agreement" to 5 for "high agreement"). This item assesses one aspect of the component "Recognition of Contradiction" of the Cognitive Conflict Levels Test by Lee et al. (2003).

A German translation of the items of the factor *Social Comparison Orientation Regarding Abilities* (6 items, Cronbach's $\alpha = .87$) of the Iowa-Netherlands Comparison Orientation Measure (INCOM, Gibbons and Buunk 1999) was administered in the peer condition and in the textbook condition. The participants indicated on 5-point rating scales (from 1 for "I disagree strongly" to 5 for "I agree strongly") how often they compare themselves to others with respect to, for example, what they have accomplished in life.

Results

Cohen's *d* is reported as effect size measure (Cohen 1988), adjusted for interactions. First, the results of the control measures and of the manipulation check will be presented. After this, the results of the hypotheses tests will be reported.

Control measures and manipulation check

No statistically significant differences were found between the three conditions regarding gender distribution (Pearson-χ^2 $(2, N = 59) = 0.35$, $p > .10$), age ($F < 1$) and *domain-specific prior knowledge* ($F < 1$) which was medium, $M_{overall} = 5.17$; $SD = 1.93$.

As baseline, the three conditions did not differ regarding the *correctness of the first version* of case pairs, $F < 1$. Since no differences emerged between the baseline condition and the two experimental conditions regarding the control measures, we present the results of the two experimental conditions only in Table 2 and the following tables. For 68 % of

Table 2 Means (and standard deviations) of control measures and correctness of the 2nd version of computer-presented task solutions

	Peer condition ($n_p = 20$) *M* (SD)	Textbook condition ($n_t = 20$) *M* (SD)
Domain-specific prior knowledge	5.60 (1.98)	5.15 (2.25)
Match between 1st version of self-created versus presented task solutions (peer condition and textbook condition)	1.15 (0.93)	1.15 (0.88)
Correctness of 1st version of task solutions	1.10 (0.64)	0.95 (0.83)
Correctness of 2nd version of task solutions	1.05 (0.60)	1.20 (0.41)

the participants ($n = 40$), none or only one of the first version of self-created pairs matched the presented ones, for 22 % ($n = 13$), two of the four pairs matched, and for 10 % ($n = 6$), three pairs matched the presented ones (cf. Table 2).

The test *item on remembering the origin of the solution* showed that the participants of the peer condition and textbook condition remembered the indicated source of the presented pairs correctly according to the instructions (i.e., as "peer" in the peer condition and as "textbook" in the textbook condition), Pearson-χ^2 $(2, N = 40) = 40.00$, $p < .01$. Further, the participants did not differ significantly in reproducing the case pairs of the other source correctly, $F < 1$.

High- versus low-status source

While creating the second version of case pairs, participants in the textbook condition adopted significantly more case pairs from the presented solution than participants of the peer condition, $\beta = .45$, $p < .01$, $R^2_{adj} = .18$, $F(1, 38) = 9.77$, $p < .01$, $d = 0.89$ (cf. Table 3).

Participants, however, did not differ in how often they adopted the false aspect of the presented solution, $\beta = .13$, $p = .43$, $F < 1$, $d = 0.26$ (cf. Table 3). Instead, learners in the textbook condition selectively adopted the correct aspect of the presented solution more often than learners in the peer condition, $\beta = .42$, $p < .01$, $R^2_{adj} = .15$, $F(1, 38) = 8.10$, $p < .01$, $d = 0.83$ (Table 3). Consequently, the textbook condition tended to arrive at a more correct task solution than the peer condition, $\beta = .21$, $p = .11$, $d = 0.29$. Thus, Hypothesis 1 was confirmed which predicted a positive form of imitation of a high-status source's solution. Hypothesis 2, however, was rejected because learners in the textbook condition did not imitate the wrong aspects of the presented solution less often than learners in the peer condition, $\beta = -.06$, $p = .72$, $R^2_{adj} = -.02$, $F < 1$, $d = -0.11$ (Table 3).

As a secondary research question, we investigated whether the possibility to compare solutions by means of a computer-based external representation in the peer condition and in the textbook condition improves performance in contrast to the baseline condition without this comparison possibility. Students of the textbook condition achieved a more correct second version of task solutions compared to students of the baseline condition ($M_b = 1.00$, $SD_b = 0.47$), $\beta = .27$, $p = .05$, $R^2_{adj} = .34$, $F(1, 37) = 10.57$, $p < .001$,

Table 3 Means (and standard deviations) of socio-cognitive conflict, adaptation of computer-presented task solutions, and social comparison orientation of abilities in the peer condition and in the textbook condition

	Peer condition ($n_p = 20$) *M* (SD)	Textbook condition ($n_t = 20$) *M* (SD)
Socio-cognitive conflict	3.05 (1.23)	4.15 (0.93)
Extent of adaptation to presented task solution	0.45 (0.76)	1.35 (1.04)
Extent of adaptation to presented correct aspect of task solution	0.05 (0.22)	0.40 (0.50)
Extent of adaptation to presented false aspect of task solution	0.40 (0.68)	0.60 (0.88)
Extent of no adaptation to presented false aspect of task solution	2.15 (0.81)	2.05 (0.94)
Social comparison orientation regarding abilities (*z*-Scores)	0.09 (1.11)	−0.09 (0.89)

$d = 0.45$, whereas students of the peer condition did not achieve a more correct task solution compared to students of the baseline condition, $\beta = .01$, $p = .92$, $R^2_{adj} = .66$, $F(1, 37) = 37.18$, $p < .001$, $d = 0.09$.

Socio-cognitive conflict

A mediation analysis was carried out, and standardized mediation coefficients are reported in order to make the results comparable across all analyses of this study. The analysis was based on 5.000 bootstrap resamples and a bias-corrected 95 % confidence interval (*CI*).

In line with Hypothesis 3, participants of the textbook condition experienced more socio-cognitive conflict than participants of the peer condition, $\beta_{MX} = .46$, $p < .01$ (cf. Table 3). Moreover, experiencing more socio-cognitive conflict resulted in adapting one's solution more often to the presented one, $\beta_{YM,X} = .57$, $p < .001$ (Table 4), both for participants of the peer condition and of the textbook condition. As already mentioned, participants of the textbook condition adapted their solution more often to the presented one, $\beta_{YX} = .45$, $p < .01$. Socio-cognitive conflict fully mediated the relationship between the experimental conditions (peer vs. textbook) and adaptation behavior, $\beta_{YX,M} = .23$, $p = .17$. The indirect effect of the experimental conditions (peer vs. textbook) on adaptation behavior mediated by socio-cognitive conflict was significant, both as Sobel's statistic ($Z_{Sobel} = 2.49$, $SE = 0.10$, $p = .01$; Sobel 1982) and as bootstrap result ($Z_{Boot} = 0.26$, $SE = 0.08$, $CI\ \alpha = .05$ [.10; .43]). Thus, Hypothesis 4 was confirmed: The more socio-cognitive conflict was experienced, the more adaptation to the presented solution was shown.

Social comparison of abilities and adaptation

Participants of the peer condition did not differ significantly from participants of the textbook condition regarding social comparison orientation of abilities, $\beta = .09$, $p = .58$, $F < 1$ (cf. Table 3). A significant overall effect was found of the social comparison factor "Ability" (z-standardized), the peer (−1) versus textbook (+1) condition, and their interaction term on the adaptation of case pairs, $R^2_{adj} = .23$, $F(3, 35) = 4.76$, $p < .01$, $d = 0.21$. As already mentioned, participants of the textbook condition adopted more case pairs than participants of the peer condition, $\beta = .42$, $p < .01$. No significant main effect of the factor "Ability" was found, $\beta = .17$, $p > .10$. A significant interaction, however, emerged between the factor "Ability" and the peer versus textbook condition, $\beta = -.31$, $p = .05$ (Fig. 2).

Table 4 Regression results of the mediation analysis

Regression	β	SE	*t*
Adaptation on experimental condition	.45	0.14	3.13**
Socio-cognitive conflict (*M*) on experimental condition (*X*)	.46	0.17	3.18**
Adaptation (*Y*) on socio-cognitive conflict (*M*) controlling for experimental condition (*X*)	.57	0.11	4.20***
Adaptation (*Y*) on experimental condition (*X*) controlling for socio-cognitive conflict (*M*)	.23	0.14	1.41

Experimental condition: (*X*) = predictor variable, (*M*) = mediator variable, (*Y*) = criterion variable; textbook = +1, peer = −1. Coefficients are standardized β-coefficients. * $p \leq .05$, ** $p \leq .01$, *** $p \leq .001$

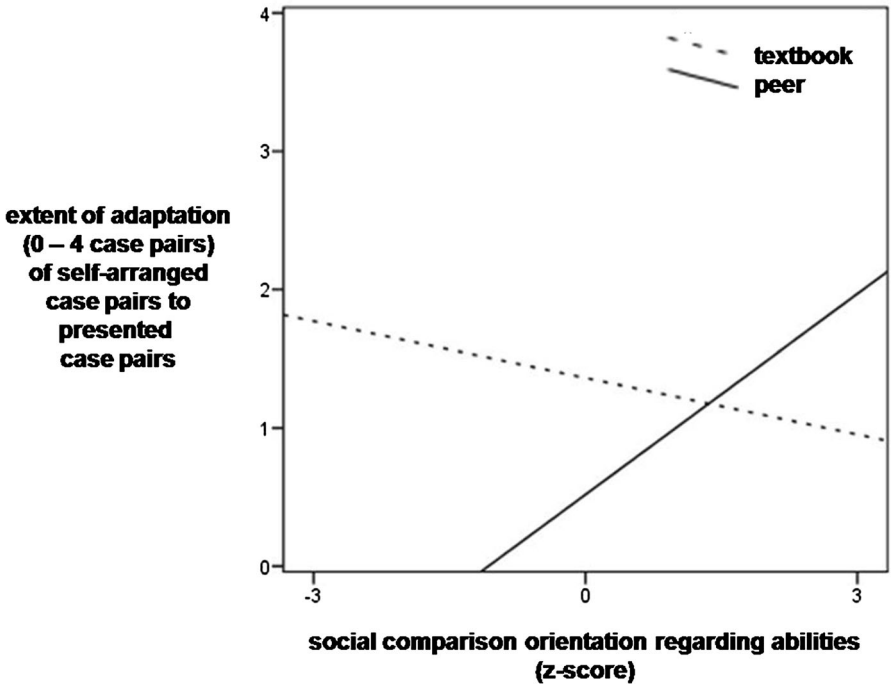

Fig. 2 Interaction between need for social comparison of abilities and high- versus low-status source of presented case pairs on extent of adaptation to the case pairs ($N = 39$)

Simple slope analyses (cf. Aiken and West 1991) indicated that only students low in SCO adopted significantly more case pairs in the textbook condition than in the peer condition, $\beta = .73$, $p < .01$, which corroborates this aspect of Hypothesis 5. Further, the pattern of results pointed in the direction that students high in SCO adapted more case pairs in the peer condition than in the textbook condition (Fig. 2) which was in contrast to our assumption. However, this pattern of results was too weak to reach statistical significance, $\beta = .11$, $p = .60$. Therefore, this aspect of Hypothesis 5 was rejected.

Mediated moderation analysis

In the case of a mediated moderation, first, a significant moderator (e.g., social comparison orientation of ability) is established and, second, a mediator (e.g., socio-cognitive conflict) is found for the relationship either between independent variable and moderator or between independent and dependent variable. In this mediated moderation analysis (Hypothesis 6; Hayes 2013), the experimental conditions (textbook vs. peer) served as independent variable (X), socio-cognitive conflict as mediator (M), social comparison orientation as moderator (W), and adaptation behavior as dependent variable (Y). Unstandardized coefficients were converted into standardized coefficients. The analysis was based on 5.000 bootstrap resamples. The 95 % confidence interval (CI) obtained for the indirect effects did contain zero, $Z_{Boot} = -0.10$, $SE = 0.09$, $CI\ \alpha = .05$ [−.30; .05] (Fig. 3). Therefore, Hypothesis 6 was rejected because it could not be concluded that a more intense adaptation behavior of students low in SCO in the textbook condition was mediated by socio-

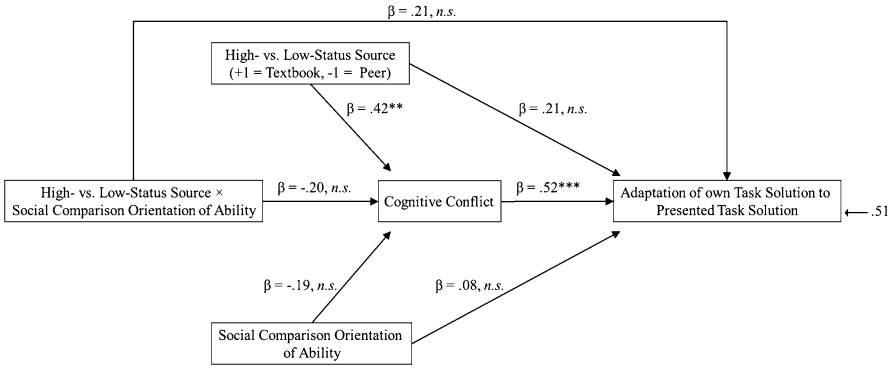

Fig. 3 Results of the mediated moderation model. All path coefficients are standardized β-coefficients. Total adjusted R^2 for the model: $R^2_{adj} = .49$, $F(4, 34) = 8.08$, $p < .001$. $^{*}p \leq .05$, $^{**}p \leq .01$, $^{***}p \leq .001$

cognitive conflict. Instead, it seems that socio-cognitive conflict as a mediator and social comparison of ability as a moderator exerted unique and independent effects on adaptation behavior in this study.

Summary and discussion

The presented experimental study informs teachers of how learners react to deviating solutions of high- versus low-status sources. A computer-based external representation was used which made learners aware of another solution, the source of this solution and the status (i.e., low vs. high) of the source (cf., Suthers 2006). In order to induce a socio-cognitive conflict, learners were confronted with a task solution that deviated from their own solution more or less. The study extended assumptions of conflict elaboration theory (Mugny et al. 1995) by using a knowledge-rich computer-supported task. By means of this socio-cognitive conflict task, the impact of a high- versus low-status source and the impact of the social comparison orientation on adaptation behavior were investigated. For this purpose, learners compared the solution presented by the computer in two experimental conditions either with the solution of a peer novice or with the solution of a supposed textbook on the subject-matter domain. Participants of the baseline condition only reviewed their self-created solution. We could show that the impact of low-status sources is much weaker than postulated in the context of previous studies on conflict elaboration theory using knowledge-lean problems (e.g., anagram tasks; Quiamzade et al. 2009). Presentation of a solution believed to originate from a highly trustworthy source more often resulted in learners improving their own solutions to a more correct form than being presented with a solution believed to be from a novice peer like themselves. One reason for this finding could be that knowledge-rich tasks are too complex in order to learn solution strategies quickly just from being provided with a deviating solution without receiving further explanations from the source of the solution. Learners may have been especially uncertain about the peer's solution. Therefore, they were more likely to trust a high-status source than a low-status source.

Moreover, the computer-supported socio-cognitive conflict task applied in this study supported some aspects of the positive form of imitation (cf. Quiamzade and Mugny 2001),

albeit not all aspects: On the one hand, learners selectively adopted the correct solution aspect of the high-status source. On the other hand, learners with a high-status source did not differ from learners with a low-status source in how often they refrained from adopting wrong parts of the presented solution. We consider adopting correct aspects of a solution as an example of accommodation (cf., Marchand 2012), that is, adapting one's own behavior to the environment. In contrast, not adopting wrong solutions could be an indicator of assimilation, that is, recognizing that some aspects of the presented solution are wrong. Adopting correct solutions is active behavior and a clear sign of learning. In contrast, not adopting wrong solutions is passive behavior. Only if it co-occurs with adopting correct solutions or with changes resulting in more correct solutions, learning can be concluded. Overall, the positive form of imitation resulted in slightly more correct task solutions. What caused this selective imitation? In this study, we could show that socio-cognitive conflict was the driving force of learners' adaptation behavior. This corroborates previous findings on the positive impact of such conflicts on learning as an educational strategy (cf. Limón 2001).

However, we could also show that in contrast to previous assumptions of conflict elaboration theory (Mugny et al. 1995; Quiamzade et al. 2009), peer learning does not necessarily result in more intense socio-cognitive conflict than learning from an expert source. In our study, learners confronted with a high-status source experienced substantially more socio-cognitive conflict than learners confronted with a low-status source. One interpretation for the weak social influence of the low-status source could be that learners have quickly dismissed the peer's solution as false and consequently, stopped thinking about it. A shortcoming of this study, however, is that the students were not asked to provide open-ended feedback about their reasons for (not) changing their solutions. Therefore, in a subsequent study using the same task, the learners had the possibility to provide open-ended feedback on their peer's solution (Baumeister et al. subm.). An alternative interpretation of the socio-cognitive conflict caused by the high-status source could be cognitive dissonance (Festinger 1957). Due to authority influence, the learners have adopted the solution of the high-status source and not because this solution did convince them. Cognitive dissonance, however, cannot explain why learners confronted with a high-status source compared to a low-status source tended to arrive at a more correct solution, whereas the notion of socio-cognitive conflict can explain such processes of learning (cf. Mugny et al. 1995).

Moreover, the more socio-cognitive conflict learners perceived, the more extensively they adapted their solution to the presented one, no matter whether they were confronted with a higher- or a low-status source. We interpret this pattern of results in reference to the specific problem solving situation created in this study: In contrast to previous studies using knowledge-lean problems whose solution strategies could be acquired in the course of the experiments (cf. Quiamzade et al. 2009), in our study, a knowledge-rich problem solving task was applied. The solution strategies of such tasks take more time to learn because they require a large knowledge base (cf. Sweller et al. 1998) which was not available to the participants of the study who were novices in the subject-matter domain. Future studies should investigate socio-cognitive conflict dynamics by varying knowledge-rich versus knowledge-lean tasks within one and the same study.

Further, in this study, persons with a low need for social comparison of abilities adapted their computer-presented task solutions especially to those of a high-status source. Thus, our study contributes to understanding how these persons react to social influence. The pattern of results illustrates that a basic human need such as the "upward drive" (i.e., comparing oneself with others who presumably do better; Buunk and Gibbons 2007;

Festinger 1954; Smith and Sachs 1997) even applies to persons who report that they do not compare themselves with others. In order to investigate the impact of the context in which the social comparison was made, future studies could involve larger groups and other types of tasks, for example. Perhaps an especially valid assessment of this personality trait requires both self-assessments and assessments by others.

Persons with a high need to compare their abilities adopted solutions of peer sources more frequently which seem to be similar to themselves than of more highly competent sources (cf. Smith and Sachs 1997).

Further, a mediated moderation analysis (cf. Fig. 3) revealed that socio-cognitive conflict was the only direct and a very strong predictor of learners' adaptation behavior. The higher- versus low-status source had an indirect impact on adaptation behavior through socio-cognitive conflict. That is, learners confronted with a high-status source's deviating solution experienced more socio-cognitive conflict than learners confronted with a low-status source's solution. Further, more perceived socio-cognitive conflict resulted in more readily adapting one's solution to the presented one. More studies with larger samples are needed to back up this new finding.

Previous studies as well as the present study illustrate that individual differences in learners' need for social comparison substantially interact with contextual factors of computer-supported learning. Ray et al. (2013) showed in two studies using a computer-supported learning environment that being confronted with others' knowledge activates social comparison processes which do not necessarily result in optimal learning behavior only. In Study 1 by Ray et al. (2013), persons high in SCO reduced information sharing with a peer due to seeking self-enhancement. In contrast, persons low in SCO did not change the amount of shared information. The present study shows that even individuals low in SCO react to social cues because they turned out to be high adopters of high-status sources' solutions.

Since the present study was conducted in a laboratory context, the practical implications are limited. In contrast to previous laboratory studies on conflict elaboration theory (e.g., Quiamzade et al. 2009), learning from a low status source did not result in superior performance than learning from a high status source. Nevertheless, we argue that the implications of this study could be relevant for online learning of spatially distributed dyads. In this context, learners are often confronted with differences between their own and others' solutions. Although high status sources sometimes are missing in the context of online learning, asymmetrically distributed knowledge is prevalent (Kozlov and Große 2016). A practical value of this study could be to inspire instructors to explore whether the positive form of selectively adopting correct solution aspects of other learners could be applied to distance learning, for example. Teachers could test whether learners critically examine differences between their own solution versus a low status source's solution and whether they search for possible shortcomings of the presented solution. A real learning situation that educators could use would be a peer-review learning scenario (e.g., Cathey 2007; Trautmann 2009). Learners could provide feedback of whether they would adopt or change others' solutions. Further, setting the goal to learn from peer solutions could encourage learners to more frequently adopt correct aspects of others' solutions. In addition, we assume that the results can be generalized to other subject-matter domains which require extracting solution-relevant information from cases and transferring solutions, for example, solving mathematical problems or making (medical) diagnoses.

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