2014-08

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Gummerum, M

10.1037/a0037144
Developmental Psychology
American Psychological Association (APA)

RUNNING HEAD: INFORMATION SHARING IN CHILDREN

How Do Children Share Information in Groups?

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Author Note

This study was supported by grant F/00 568/V awarded by the Leverhulme Trust. We thank all participating children and schools for making this study possible and Yaniv Hanoch and Natalie Wyer for feedback on earlier versions of this manuscript.

Abstract

Group decision-making should be particularly beneficial when group members share unique information, because then a group can make a better decision than each group member alone. This study examined how elementary-school children share unique information during group-decision making. Seventy-nine groups of three same-sex and same-age 7- and 9-year-old children (N= 237) had to decide which one of two hypothetical candidates should play the lead role in a school musical. When information was unshared, group members had to exchange their uniquely held information to identify the best candidate. Only a minority of groups picked the best candidate when information was unshared. Yet, groups of 7-year-old children were better at identifying the best candidate and were less likely to focus on the discussion of shared information than groups of 9-year-olds. These findings are interpreted with reference to processes underlying information sharing in groups, namely collective information sampling, preference-consistent evaluation, and collaborative inhibition/inter-subjectivity.

Keywords: Information sharing; groups; decision making; children; hidden profile effect

How do children share information in groups?

Common wisdom tells us that two heads are better than one, and thus that groups are better at making decisions than individuals. Children routinely collaborate making decisions in peer groups (e.g., Boulton, 2005; Piaget, 1965) and contributing to group decisions in the family context (e.g., Thornton, Shaw, & Williams, 1997). Working in groups is an important feature of educational contexts. For example, in the United Kingdom the National Curriculum for primary schools (serving children from 4 to 11 years) stipulates that effective participation and communication in small groups is a key skill that helps children to improve their learning and performance in education, work, and life (Department for Education, 2013). Indeed, empirical research has shown that collaborating with peers leads to better learning outcomes and cognitive-developmental gains (Azmitia, 1988; Doise & Mugny, 1984; Howe, Tolmie, & Rodgers, 1992). Because of the importance of group collaboration in children's educational and personal lives, it is critical to understand the processes that lead to groups achieving the best outcomes. The current study focused on one type of group collaboration, namely children's group decision-making, and assessed how groups of children process relevant and available information to reach a decision together.

We were particularly interested in how groups of children process and exchange information that is uniquely held by one group member. Social psychological research on group decision-making assumes that the discussion and exchange of unique information among group members leads to a higher quality decision than one that would have been made just by an individual (Kerr & Tindale, 2004). Group decisions should be especially beneficial when each individual does not know the best alternative, but when every group member holds (some) unique information, which is then exchanged in the group (Greitemeyer & Schulz-Hardt, 2003). In these cases, the exchange and integration of unique information enables group members to find the best alternative. In contrast, when all available

information is shared from the beginning, group discussion is basically redundant, because a high quality decision can be made on the basis of an individual group member's knowledge.

Investigating how children share uniquely held information in a group has both theoretical and practical importance. Some pedagogical techniques strongly rely on students exchanging uniquely acquired information in groups. For instance, in the "jigsaw classroom" (Aronson & Patnoe, 1997), students were allocated to groups of five or six and asked to individually research and become an expert in a subtopic of a larger theme. Eventually, each individual student returned to his or her jigsaw group and presented and exchanged his or her unique knowledge in the group. So far, very little research has examined whether and how children exchange such unique information in a group, how information sharing influences the quality of the group's product, and whether the same processes can explain information sharing in children of different age groups. The present study seeks to examine these questions. It addresses key issues for theoretical and practical work on children's collaboration and brings together work from social and developmental psychology.

Information sharing in adult groups: The hidden profile effect

Numerous studies in social psychology have investigated whether and how groups of adults discuss and exchange unshared information and how the quality of a group decision compares to situations in which all information is shared among all group members (Stasser & Titus, 1985, 2003; Stewart & Stasser, 1995; see Kerr & Tindale, 2004, for an overview). In the typical experimental set-up, three or four group members are asked to examine information about two to four decision alternatives and agree on choosing one of them. For example, groups have to make a decision which of two candidates is best suited for a position. Each one of the applicants has some desirable characteristics, but one of them possesses more desirable (and less neutral and undesirable) qualities and is thus assumed to be the best choice. In a shared information condition each group member is initially presented

with all information about each applicant, and thus all information is shared among group members. In an unshared information, or "hidden profile" condition, information about the applicants is initially distributed among group members so that no individual member can identify the best choice on the basis of his or her information alone.

Overall, research with adults has shown that groups are rather bad at choosing the best alternative in the unshared information condition. A number of explanations have been proposed for this "hidden profile effect" (Kerr & Tindale, 2004). The collective information sampling (CIS) model (Stasser & Titus, 1985, 1987, 2003) suggests that shared information enjoys a sampling advantage over information that is held by one person. Only one member needs to mention a piece of information to bring it to the group's attention. Because all members can contribute shared information, but only one person can contribute unique information, the probability of a piece of information entering the group discussion increases with the number of group members possessing it.

The CIS model is often regarded as a baseline model for predicting how much shared and unshared information will be discussed in the group. However, additional factors, such as people's initial preferences, might affect the amount of information discussed (see Reimer, Kuendig, Hoffrage, Park, & Hinsz, 2007). Greitemeyer and Schulz-Hardt (2003) have shown that adults evaluate and reinterpret the information they receive from other group members in line with the individual preferences they formed pre-discussion and therefore stick with their initial preferences and choices (preference-consistent evaluation). Therefore, even when all shared and unshared information is presented to participants during a group discussion, this information does not change the preferences group members formed individually on the basis of incomplete and suboptimal information before the group discussion.

Children's collaboration and information sharing

So far, very few studies have examined whether children exchange information during

group decision-making and other collaborative tasks. None has studied the hidden profile effect in children. Gummerum, Leman, and Hollins (2013) investigated whether groups of three 7- and 9- year-old children mention shared and unshared information during collaborative recall in which group members had to recall word lists together. In both age groups a higher proportion of shared than unshared information was recalled, indicating that processes of collective information sampling underlie children's collaborative recall of shared and unshared information. However, groups of 7-year-olds recalled more unshared items than predicted by the CIS model. These age differences found for the recall of unshared information can be attributed to processes of collaborative inhibition operating in groups of 9-, but not 7-year-old children (see Leman & Oldham, 2005).

Collaborative inhibition (e.g., Basden, Basden, Bryner, & Thomas, 1997; Weldon, Blair, & Huebsch, 2000) refers to the phenomenon that when recalling or producing ideas in a group, fewer items or ideas are generated than in same-sized "nominal" groups, in which individuals recall items on their own and non-redundant items are then added up to create a nominal group score. According to the retrieval strategy disruption hypothesis (Basden et al., 1997; Finlay, Hitch, & Meudell, 2000), recalling items in a real group interrupts individuals' retrieval strategies. When group members encode items individually, each one of them structures this material in an idiosyncratic way. For instance, one individual might use a primacy strategy, another a recency strategy. Attending to other group members' recall impedes and disrupts these idiosyncratic retrieval strategies. Because members of nominal groups recall as individuals, they are not affected by these interruptions and therefore do not suffer from collaborative inhibition.

Leman and Oldham (2005) found different degrees of collaborative inhibition in the collaborative recall of 7- and 9-year-old children. Like adults, groups of 9-year-olds recalled more items in nominal than real groups, whereas among 7-year-olds there was no difference

in recall between real and nominal groups. Leman and Oldham (2005) argued that that these age differences are based on more general developmental differences in children's orientation to collaboration or their inter-subjectivity (Leman & Duveen, 1996). Thus 9-year-old children regard collaborative recall, and collaboration in general, as a social process that requires members of a group to work together, understand each other's roles, share a joint focus, and coordinate resources and perspectives. Seven-year-old children, on the other hand, tend to regard collaborative recall as an individualistic activity which does not involve the coordination of roles and perspectives. Similar age effects have been found by Baines and Howe (2010) who investigated how dyads of 4-, 6-, and 9-year-old children organize their conversational interactions and achieve a shared understanding by agreeing, repeating, acknowledging, clarifying, or requesting new information. While children of all ages were able to engage in cooperative dialogue only the conversations of older children were mutually responsive, with group members connecting and commenting on each other's arguments and ideas. Thus, the ability to successfully employ inter-subjective skills in collaboration seems to develop over middle childhood.

In line with this research, Gummerum et al. (2013) found significantly fewer instances of inter-subjective interactions in 7- than 9-year-old collaborating groups. Furthermore, inter-subjectivity in a group's interaction was negatively related to the number of words recalled in a collaborative recall task, particularly among 9-year-old children. This indicates that (just as suggested by Leman & Oldham, 2005, and retrieval strategy disruption hypothesis, Basden et al., 1997) paying attention to others during collaborative recall interrupts one's individual retrieval strategy and leads to collaborative inhibition in real groups.

The present study

The present study had two main objectives: First, we examined age differences in 7- and 9-year-old children's sharing of unique information during group decision-making, and

whether information sharing affected the outcome of group decisions. Second, we were interested in the processes underlying the sharing of information in different age groups. Groups of three same-age and same-sex participants had to make a decision about which one of two hypothetical candidates should be awarded the lead role in a school musical. One candidate had more desirable characteristics and was thus the best choice. In a shared condition, all information about the two candidates was known to all group members. In an unshared condition, information about the best candidate was distributed among the three group members so that groups had to exchange unique information to identify the best candidate. We expected that groups would be more likely to choose the best candidate in the shared than the unshared condition (Hypothesis 1).

We investigated three processes that might underlie information sharing in such "hidden profile" situations. These processes and the predictions they make concerning the sharing of information in the unshared information condition are summarized in Table 1. The CIS model predicts that group members discuss shared information more frequently than unshared information and should thus be unable to pick the best candidate (Hypothesis 2). Preference-consistent evaluation theory assumes that group members are reluctant to revise the choice they made before the discussion. Therefore, groups should not choose the best candidate, and the amount and type of information discussed during group collaboration should not predict preferences (Hypothesis 3). Collaborative inhibition explanations assume that other group members disrupt individuals' retrieval of pre-discussion information during group collaboration. Because 9-, but not 7-year-olds were shown to be subject to collaborative inhibition, 7-year-olds should be more likely to discuss unshared information and decide in favour of the best candidate than 9-year-olds (Hypothesis 4).

Earlier research suggested that a failure to fully appreciate the significance of others' perspectives and contributions for effective collaboration is an important social-cognitive

process underlying collaborative inhibition (see Basden et al., 1997). If this is correct, we expected that those groups who solve the hidden profile effect and choose the best candidate should engage in significantly less inter-subjective exchanges than groups who do not pick the best candidate (Hypothesis 5). Furthermore, we predicted more instances of inter-subjective exchanges in the group interactions of 9- than 7-year-old children (Hypothesis 6).

We decided to investigate groups of 7- and 9-year-old children as previous research has shown that 9-year-olds, but not 7-year-olds, show collaborative inhibition (Gummerum et al., 2012; Leman & Oldham, 2005). Three-person groups were chosen, because this is the minimal number of group members employed in previous adult research on the hidden profile effect in group decision-making (Stasser & Titus, 2003) and ensures comparability of the present study to earlier developmental and social psychological research.

Method

Participants

Seventy-nine groups of three children (N= 237) participated: 38 triads of 7-year-olds (n = 114; M_{Age} = 92 months, SD = 3.24 months; 51 girls, 63 boys) and 41 triads of 9-year-olds (n = 123; M_{Age} = 117 months, SD = 3.59 months; 51 girls, 72 boys). Participants were recruited from primary-schools in southern England which serve working- and middle-class communities. Ninety-six per cent of the sample was British with the remaining 4% of children having an Eastern European or Asian background. Only children who received parental consent participated in the study.

Design

A 2 x 2 between-subjects design was employed, with the two independent factors age (7 years, 9 years) and information distribution (shared, unshared). Groups of three 7- or 9-year-old children received either identical information about two hypothetical candidates auditioning for the lead role in a school play (shared condition) or information about the best

candidate was distributed among the three group members (unshared condition).

Materials

Participants were presented with a decision task, in which their group had to pick the most qualified (hypothetical) candidate for the lead role in a school musical. Each group had to choose between two candidates, named Person Red and Person Blue who possessed a number of positive characteristics and abilities that are important for the lead actor in a school musical (e.g., can sing, learns text quickly). These attributes had been selected in a pretest in which 17 items were rated by an independent sample of 80 7- to 10-year-old children (see online supplemental materials for more information about the pretest).

Each group member received a booklet containing information about Person Red and Person Blue. The candidates were represented by a cartoon drawing of a boy or girl (matched to participants' gender), and attributes characterizing the candidate were written underneath the candidate's picture and name. In the shared condition, each group member received the same complete information about the two candidates. One candidate was characterized by seven positive attributes and considered the best choice; the other candidate was characterized by four positive attributes. The information distribution in the unshared condition was based on the severely biased distribution case in Stasser and Titus (1985): Each group member received one shared piece of information about the best candidate and two unique pieces of information. Thus, if the three group members pool their information, the best candidate is characterized by seven positive attributes. The second candidate was characterized by four positive attributes, which all three group members shared. Table 2 shows the attributes associated with each candidate and the distribution of information about the two candidates in the shared and unshared condition. We counterbalanced whether Person Red or Person Blue was the best candidate to make sure that participants' choice was not influenced by color preference.

Procedure

Participants were randomly assigned to either the shared or unshared condition and were tested in a separate room of their school by a female experimenter who briefed the children about the study, explained that responses would remain anonymous, and asked whether the children would like to participate. Three same-age and same-sex children were allocated to a group.

Group members were told that their task was to pick the best candidate for the lead role in a hypothetical school musical. Each group member was given a booklet with information about Person Red and Person Blue, presented in counterbalanced order. In addition, participants listened once, via headphones, to a recording of the information about the candidates on a digital Dictaphone. In the shared condition, all three group members received the same information about both candidates. In the unshared condition, information about the best candidate was distributed among group members. In both conditions, participants were told that the information each individual group member received about the two candidates might or might not be the same for the three group members.

After participants read and listened to the information about the candidates, all booklets and Dictaphones were collected by the experimenter. Thus, no written or recorded information about the two candidates was available to participants in the subsequent stages of the experiment. Participants completed a pre-discussion preference task and indicated individually and privately which of the two candidates they would give the lead role in the school musical to. They were then asked to select, unanimously, the best candidate for the school musical in groups of three. The group discussions and decisions were video-taped. After the group decision, participants were again asked to indicate their individual preference for one of the two candidates individually and privately (post-discussion preference). Finally, participants were thanked, debriefed and accompanied to their classroom.

Coding

Information mentioned. The CIS model assumes that mentioning information during group discussion is a disjunctive task, because only one group member needs to contribute an item once to bring it to the attention of the group (Stasser & Titus, 1987). Therefore, in line with practices in the hidden profile paradigm, it was counted whether (instead of how often) each piece of shared or unshared information was mentioned for each group. Whenever a group member stated one of the eleven pieces of information available to the group members it was counted once, and repetitions of the same piece of information were not counted again. Two independent coders watched and coded the discussions of ten 7-year-old groups and ten 9-year-old groups. Inter-rater agreement was excellent, $\kappa = .98$.

Inter-subjectivity. Children's video-taped interactions during group decision-making were coded for elements of inter-subjectivity based on a coding manual adapted from Göncü (1993; see also Gummerum et al., 2013; Whitington and Floyd, 2009). The following elements of inter-subjectivity were coded:

- Joint focus: Group members look at each other, share an affective state (e.g., smile at each other), engage with the same object, or follow gestural points from another group member.
- Meta-communication: Communications among group members that initiate, maintain, and terminate collaborative activities, such as invitations (e.g., "let's start", "what do you think?"), making plans for collaboration (e.g., "Should we take turns?", "you have a go") and signalling the end of collaboration (e.g., "Are we done?").
- Communication: Utterances that repeat or complement another group member's previous utterance (e.g., Person A: "He can dance, as well", Person B: "and sing") or conversations or mutual talk between participants (e.g., Person A: "It was Blue who could sing properly, and Red who had a loud voice", Person B: "Yes, but Blue is the

one that can make people laugh"). Importantly, utterances or conversations that are not linked or relevant to a partner's previous utterance are not included in this category (e.g., Person A: "I like Blue because she can sing", no reaction or response from another group member).

The videotaped group discussions were coded for occurrences of these elements using an event-coding technique (Pellegrini, 2004). That is, it was counted how often each one of the three elements of inter-subjectivity appeared during the groups' interactions. Two independent coders watched and coded 15 group discussions. Inter-rater agreement was good with $\kappa = .77$. Disagreements between raters were mainly due to the coding of the "Communication" category. Specifically, raters sometimes diverged when deciding whether an utterance was part of a conversation (i.e., one group member's utterance was followed by the response of another) or whether an utterance was not linked to a partner's response. Disagreeing scores were discussed among the raters until agreement was reached.

Results

Preliminary analyses did not show any significant effects of gender, and therefore data were collapsed across genders.

Decisions

In the shared condition, all the information about each candidate was known by each group member so groups should have had no difficulties picking the best among the two candidates. Indeed, 74% of 7-year-old groups and 86% of 9-year-old groups picked the best candidate in the shared condition. In the unshared condition, information about the best candidate is distributed among the three group members and so participants have to pool information to find the best choice. Thirty-seven percent of 7-year-old groups and 11% of 9-year-old groups picked the best candidate.

To assess the effect of information distribution condition and age on the decision of

picking the best candidate, hierarchical (hi-) log-linear and log-linear analyses with the variables decision [best candidate (*r*), second candidate], age [7 years (*r*), 9 years], and condition [unshared (*r*), shared] were run, with *r* indicating the reference category of each factor for the *z* value. Unit of analysis was group decision. First, a saturated hi-log-linear model containing all main and interaction effects of the variable Decision was computed. A model fit greater than $p = .05$ indicates a fitting hi-log-linear model (Wickens, 1989). The hi-log-linear analysis revealed the saturated model of Decision × Condition × Age as the final model. Because the saturated model contains the interaction effects of all variables in the model and because the expected frequencies correspond to the observed frequencies, it fits the data perfectly (Green, 1988). Second, we conducted log-linear analyses to estimate parameters on the basis of the final model. These analyses revealed significant interaction effects of Decision × Condition, ($z = 4.64$, $p < .01$) and Decision × Condition × Age ($z = 2.03$, $p < .05$). In both age groups, groups were significantly more likely to choose the best candidate in the shared than the unshared condition (*OR* = 13.29, 95% *CI* = 4.54-38.95). The tendency to choose best candidate in the shared compared to the in the unshared condition was weaker in 7-year-old groups (*OR* = 4.80, 95% *CI* = 1.20-19.13) but was stronger in 9-year-old groups (*OR* = 53.83, 95% *CI* = 8.01-361.76) compared to the overall (marginal) *OR*.

Discussion of shared and unshared information

This analysis focused only on the groups in the unshared condition. In line with practices in the hidden-profile paradigm, we calculated the proportions of shared and unshared information. The number of unshared information mentioned by a group was divided by 6 (maximum number of unshared information a group could have mentioned) and the number of shared information a group mentioned was divided by 5 (maximum number of shared information a group could have mentioned). Table 3 shows the average proportions of shared and unshared information discussed in groups of 7- and 9-year-olds.

The average length of group discussions in the unshared condition did not significantly differ between 7- and 9-year-old groups (7 years: *M* = 2:55 mins, *SD* = 1:48 mins, range = 00:55 – 7:42 mins; 9 years: *M* = 2:55 mins, *SD* = 2:05 mins, range = 1:00 – 10:14 mins, $t(35) = .07$, $p = .95$, $d = .02$). Because Pearson's G indices indicated that length of group discussion was positively skewed (7 years: *G* = 1.07; 9 years: *G* = 2.83), this variable was log-transformed. Preliminary analyses showed no significant correlations between log-transformed variable length of group discussion and proportion of shared information, $r\ (36) = -.17$, $p = .31$, proportion of unshared information, $r\ (36) = .08$, $p = .63$, and group decision, $\rho\ (36) = .16$, $p = .35$.

A repeated-measures Analysis of Variance (ANOVA) with the within-subject variable type of information (shared, unshared) and the between-subject variable age revealed a significant main effect of type of information, $F(1, 36) = 39.24$, $p < .01$, $\eta_p^2 = .52$. Overall, a higher proportion of shared than unshared information was mentioned during the group discussion in both age groups. This main effect was qualified by a significant interaction of type of information x age, $F(1, 36) = 13.17$, $p < .01$, $\eta_p^2 = .29$**.** Nine-year-olds mentioned significantly higher proportions of shared than unshared information, $t(18) = 7.08$, $p < .01$, $d = 2.04$, whereas the difference in the discussion of shared and unshared information was only marginally significant in 7-year-olds, $t(18) = 1.84$, $p = .08$, $d = .55$ (see Table 3).

Did groups who picked the best candidate in the unshared condition discuss shared and unshared information to a different degree than groups who did not pick the best candidate? As shown in Table 3, 7-year-olds groups who chose the best candidate discussed significantly more unshared information than groups who did not pick the best candidate, $t(17) = 2.64$, $p = .02$, $d = 1.28$. There was also a tendency for groups who picked the best candidate to discuss less shared information than groups who did not choose the best candidate, even though this difference was not significant. Because only two groups among

the 9-year-olds picked the best candidate we did not conduct similar statistical analyses. However, these groups tended to discuss more unshared information than groups who did not pick the best candidate (Table 3).

These results indicate that groups of 7-year-olds were more likely than groups of 9-year-olds to detect the hidden profile and pick the best candidate because the ratio of shared to unshared information discussed was smaller in 7- compared to 9-year-olds. To test this, we composed a difference score by subtracting the proportion of unshared items mentioned during the discussion from the proportion of shared items (positive score: proportion of shared items is higher; negative score: proportion of unshared items is higher; zero score: shared and unshared items are mentioned to an equal degree). The difference score was positive in both age groups (7 years: $M = .13$, $SD = .30$; 9 years: $M = .48$, $SD = .30$), but significantly smaller in groups of 7- than 9-year-old children, $t(36) = 3.63$, $p = .001$, $d = 1.21$.

Inter-subjectivity

The three elements of inter-subjectivity were highly correlated (joint focus – meta-communication: $r(35) = .43$, $p = .008$; joint focus – communication: $r(35) = .78$, $p < .001$; meta-communication – communication: $r(35) = .48$, $p = .003$), and we created the variable inter-subjectivity which was based on the mean of the three inter-subjectivity elements. Because the number of inter-subjectivity elements coded during group discussion correlated marginally significantly with the length of a group's interaction, $r(36) = .30$, $p = .07$, we additionally calculated the variable relative inter-subjectivity (inter-subjectivity divided by length of group interaction) for each group. Nine-year-old groups showed significantly higher levels of relative inter-subjectivity ($M = .05$, $SD = .03$) than 7-year-old groups ($M = .03$, $SD = .02$), $t(35) = 2.10$, $p = .04$, $d = 0.71$.

An independent sample t-test indicated that those groups who detected the hidden profile and chose the best candidate showed significantly lower levels of relative inter-

subjectivity (M = .03, SD = .01) than those groups that did not discover the hidden profile (M = .05, SD = .02), $t(35) = 2.34$, $p = .03$, $d = 0.79$. This difference was marginally significant among 7-year-olds, $t(16.80) = 2.02$, $p = .06$, $d = 0.99$ (Table 3). Because only two groups picked the best candidate among 9-year-olds, no similar analyses were conducted. However, compared to groups that picked the second candidate, groups that picked the best candidate tended to exhibit lower levels of relative inter-subjectivity among 9-year-olds (Table 3).

Comparison of pre- and post-discussion preferences

In the unshared condition, a majority of participants in both age groups did not pick the best candidate either before or after the group discussion. Among 7-year-olds, 26% of participants chose the best candidate pre-discussion, and 37% of participants chose the best candidate post-discussion. Among 9-year-olds, 19% of participants chose the best candidate before, but only 9% of participants chose the best candidate after the discussion.

We calculated a preference difference score by subtracting the post-discussion preferences from the pre-discussion preferences. A score of – 1 indicates that participants picked the best candidate after, but not before the group discussion. A score of 0 indicates that participants did not change their choices from pre- to post-discussion. A score of 1 indicates that participants picked the best candidate before, but not after the discussion. This preference difference score was negative among 7-year-olds (M = -.11, SD = .52), but not significantly different from 0 (no change), $t(56) = 1.51$, $p = .14$, $d = 0.40$. The preference difference score was positive among 9-year-olds (M = .11, SD = .36) and marginally significantly different from 0, $t(53) = 1.94$, $p = .06$, $d = 0.53$.

The preference difference score correlated significantly and positively with proportion of shared information discussed and significantly and negatively with the proportion of unshared information discussed (see Table 4). A linear regression analysis with the dependent variable preference difference score and the independent variables proportion of shared

information and proportion of unshared information showed that the two independent variables significantly predicted preference differences, $R^2 = .11$, $F(2, 111) = 7.30$, $p < .01$. The proportion of shared information significantly and positively predicted preference difference, $\beta = .29$, $p = .002$. This indicates that the more shared information is mentioned during group discussion, the more likely participants are to shift from choosing the best candidate before discussion to not choosing the best candidate after discussion. The proportion of unshared information mentioned during the group discussion significantly and negatively predicted preference difference, $\beta = -.23$, $p = .02$. This implies that the more unshared information was mentioned during the group discussion, the more likely participants were to pick the best candidate after, but not before, the group discussion.

Discussion

This study had two main aims: (1) to investigate whether groups of 7- and 9-year-old children exchange unique information during group decision-making and how this impacts on the outcomes of the groups' decisions; and (2) to examine the processes underlying the sharing of unique information in these age groups. Few studies have examined how groups of children deal with information that is unshared, even though exchanging and integrating unique information should help groups arrive at a better group decision than one that would have been made by an individual group member (Greitemeyer & Schulz-Hardt, 2003).

Information sharing in groups of 7- and 9-year-old children

In line with previous social psychological research with adults (e.g. Stasser & Titus, 1985, 1987, 2003), we found that 7- and 9-year-old children are rather bad at discussing relevant unshared information during the group decision making process. Like adults, the majority of groups were unable to detect the hidden profile and pick the best candidate when information about this candidate is unshared. Participants' failure to exchange unshared information during group decision making and to pick the best candidate cannot be explained

by an inability to consider relevant information for their decision: In the shared condition, the majority of groups in both age groups picked the best candidate, as predicted by Hypothesis 1. However, in the unshared condition, unique information was mentioned less frequently than information that was shared among group members, and the majority of groups in both age groups did not pick the candidate with the best qualifications. Yet, those groups who did choose the best candidate mentioned more unshared information than groups who did not. This set of findings indicates that mentioning unshared information during group discussions affects the quality of the group decision.

We focused on three processes that might underlie information sharing in children's groups. These were collective information sampling (CIS), preference-consistent evaluation, and collaborative inhibition. The CIS model (Stasser & Titus, 1985) proposes that shared information is more likely to enter the group discussion, because more people are aware of it than of unshared information. Consequently, groups fail to uncover the hidden profile and fail to make the best choice. In accordance with the CIS model's predictions, shared information dominated group discussions in both age groups. Thus, similar to adult groups, shared information enjoys a sampling advantage in groups of elementary-school children.

Even though the majority of groups in both age groups failed to pick the best candidate in the unshared information condition, groups of 7-year-olds were better at this task than groups of 9-year-olds. Furthermore, groups that picked the best candidate discussed more unshared information than groups who did not pick the best candidate, and the ratio of shared to unshared information was significantly lower among 7-year-olds than 9-year-olds. Thus, in line with Hypothesis 4, the hidden profile effect tends to be reduced in groups of 7-year-old compared to 9-year-old children.

We explain these findings with reference to processes of collaborative inhibition that might underlie information sharing in children's groups in addition to CIS. Collaborative

inhibition explanations assume that group members fail to produce unique information, because their retrieval of information learned individually before group interaction is disrupted by other group members (Basden et al., 1997; Finlay et al., 2000). Being confronted with or attending to others interrupts idiosyncratically developed retrieval strategies. Thus, while the given distribution of shared compared to unshared information leads to a sampling advantage of shared items (as suggested by the CIS model), collaborative inhibition affects the probability that a group member will recall and mention a piece of information from that distribution. We would therefore argue that both processes contribute as to whether a particular item will be discussed by the group.

Leman and Oldham (2005; Gummerum et al., 2013) have shown that 9-year-old, but not 7-year-old children are subject to collaborative inhibition. These authors suggest that the different levels of collaborative inhibition in groups of 7- and 9-year-old children might be due to different amounts of inter-subjective exchanges in those groups. Nine-year-old, but not 7-year-old, children regard collaboration as a social process that requires attending to and coordinating with others. Thus, because 9-year-olds are more likely than 7-year-olds to pay attention to and coordinate their actions with those of other group members, they tend to be more likely to suffer from collaborative inhibition. In line with Hypotheses 5 and 6, we find that higher instances of inter-subjective exchanges in groups of 9-year-olds than 7-year-olds. As predicted, groups that exhibited fewer inter-subjective exchanges were more likely to detect the hidden profile and choose the best candidate.

Other previous research indicates that inter-subjectivity might negatively affect the outcomes of a group's collaboration. Studies on brainstorming in adult groups (reviewed in Kerr & Tindale, 2004) have shown that real groups suffer a "productivity loss" and generate significantly fewer ideas than same-sized nominal groups. Production blocking is one of the main processes responsible for this productivity loss in real groups (Diehl & Stroebe, 1987,

1991): Because group members take turns and only one person can speak at a time, those not speaking might forget or suppress their own ideas while attending and listening to others. Thus, similar to the findings of the current study and research on children's collaborative recall (Gummerum et al., 2013), paying attention to and coordinating one's activity with other group members can have detrimental effects on a group's productivity.

It should be noted, however, that there are certainly collaborative activities that rely on group members developing inter-subjective awareness or sharing intentions with others. In order to engage successfully in collaborative activities partners have to jointly attend to the same "object", they need to formulate joint goals as to the outcome of the collaboration, and they have to cognitively represent their own and their interaction partners' intentions (see Tomasello, Carpenter, Call, Behne, & Moll, 2005). Empirical research (e.g., Carpenter, Tomasello, & Striano, 2005; Hamann, Warneken, & Tomasello, 2012) has shown that children develop an understanding of joint intentions and joint goals in their second to third years of life. Indeed, we found instances of inter-subjective exchanges in the group discussions of children from both age groups, even though there was a higher number of inter-subjectivity elements in the interactions of 9-year-olds compared to 7-year-olds. Inter-subjectivity and active participation in a task (especially a cognitively demanding task) can increase the cognitive gains of group members after collaboration (Azmitia & Perlmutter, 1989). Furthermore, inter-subjectivity might not have negative effects on a group's productivity when group members know each other well (such as in friendship or family groups) and have a history of collaborating with each other (see Azmitia & Perlmutter, 1989; Harris, Keil, Sutton, Barnier, & McIlwain, 2011). In sum, these investigations indicate that in some instances greater inter-subjectivity can lead to better group and individual outcomes. Future research should identify at what age, in what tasks, and what type of groups inter-subjectivity impedes or improves performance in collaborative settings.

We investigated a third process that has been shown to contribute to adults' failure to detect the hidden profile in past research. According to preference-consistent evaluation theory, group members form choice preferences based on information they acquire individually before the discussion. In a hidden profile situation, pre-discussion information does not support the best candidate. Even when presented with additional (and conflicting) information during the group discussion, group members are unwilling to change their preferences. Therefore, preference-consistent evaluation theory suggests that group members do not change their choices before and after the discussion and that information presented during group discussion does not affect participants' choices (Greitemeyer & Schulz-Hardt, 2003). Even though we found that 7-year-olds were more likely to pick the best candidate after than before the group discussion and 9-year-old participants were more likely to pick the best candidate before than after the group discussion, these changes in preferences were not (or only marginally) significant. However, in contrast to the predictions by preference-consistent evaluation theory, the amount and type of information discussed in the group did affect changes in preferences. Specifically, the more shared information a group discussed, the more likely participants were to not pick the best candidate after than before the group discussion. Conversely, the more unshared information a group discussed, the more likely participants were to pick the best candidate after than before the group discussion. Thus, in line with the CIS model (Stasser & Titus, 1985), information discussed during group collaboration does not only shape a group's but also individual group members' decisions.

Implications and conclusions

Overall, we found that groups of 7-year-olds were better at detecting the hidden profile than 9-year-olds, but that shared information was still more prevalent in group discussion and decision-making in both age groups. This dominance of shared over unshared information leads to sub-optimal group (and individual) decision-making and performance.

Generally, the findings of this study are well explained by the CIS model (Stasser & Titus, 1985, 1987, 2003): Just like in adults, groups of children were more likely to mention shared than unshared information because more group members were aware of shared than unshared information. Therefore, shared information was more likely to be "sampled" during the group discussion. Furthermore, group members were more likely to change their individual preference choices on the basis of the information stated during the group discussion.

These findings have clear implications for educational practice. In educational contexts, situations occur where children are invited to exchange individually acquired information with other group members, and the success of some pedagogical interventions explicitly relies on information sharing between group members. As discussed above, in the jigsaw classroom (Aronson & Patnoe, 1997) group members have to communicate individually acquired information to others. "Exploratory talk" (Mercer, 1995; Rojas-Drummond & Mercer, 2003), an intervention technique that helps children structure and challenge each other in peer discussions, is based on the idea that discussion partners critically engage with each other's ideas and consider all relevant information (also individually-held information) when pondering a solution. To use these methods successfully, educators should be aware of the limits in children's exchange of unique information and might want to think about appropriate interventions that can overcome these limitations.

Social psychological research with adults has introduced several interventions that facilitate the mentioning of unshared information in group decision making. For example, groups with members labeled as experts in a domain with associated unique information (Stewart & Stasser, 1995) or people in leadership roles or with high status (Larson, Foster-Fishman, & Franz, 1998; Wittenbaum, 2000) mention more unshared items than groups with no designated expert or leader. Adult groups are more likely to detect the hidden profile when group members are not informed about each others' preferences in the group decision phase

(Mojzisch & Schulz-Hardt, 2010). Research on adult brainstorming groups indicated that letting groups interact electronically (where group members present their ideas through computers rather than to wait for their turn) instead of face-to-face can mitigate against production blocking and the potentially negative effects of attending to other group members (Dennis & Valacich, 1993; Gallupe, Bastianutti, & Cooper, 1991). Given that children, like adults, have difficulties with information sharing, future research should adapt some of these procedural interventions to improve children's group performance.

Future research can extend the current study in other important ways. First, participants in this study made hypothetical decisions about hypothetical people, and we cannot exclude the possibility that children did not pick the best alternative because they regarded the decision as not important enough. Yet our study is similar to most of the social psychological research in the hidden profile paradigm which uses analogous hypothetical scenarios. Furthermore, Gummerum and colleagues (2013) found a similar dominance of shared over unshared information in a collaborative recall task, in which each group member should be motivated to recall as much information (also unshared information) as possible (Stewart & Stasser, 1995). Even though these findings indicate that low motivation might not explain why groups focus more on shared than unshared information, the role of motivational factors should be explored in more detail in future research on children's information sharing.

Second, in the current study all the information participants received about the two candidates was positively correlated with the criterion. That is, both candidates possessed characteristics that are valuable for the lead actor in a school musical (e.g., can dance, can sing). However, in real-life decision situations, as well as in adult studies on the hidden profile effect, decision alternatives usually have positive, negative, and neutral attributes. It is an open question, whether we would have obtained the same findings, if the hypothetical candidates in our study had been characterized by positive, negative (e.g., cannot remember

text, is nervous), and neutral attributes. When designing the study, we intentionally picked all-positive attributes for the hypothetical candidates to make the decision task as easy as possible for children once all information was gathered. Yet, future research should replicate this study and endow the decision alternatives with positive, negative, and neutral attributes.

Third, future research might want to investigate whether the processes underlying information sharing in groups differ by gender. Like the present study, social psychological research in the hidden profile paradigm has not found any gender effects in information sharing in adult groups – in fact, the gender composition of groups was rarely reported (Kerr & Tindale, 2004; Stasser & Titus, 2003). However, developmental research suggests gender differences in the social dynamics of children's collaborations. Specifically, all-girl groups tended to interact in a more affiliative way than all-boy groups. In mixed-gender groups, boys tended to dominate their female partners (Leman, Ahmed, & Ozarow, 2005; Leman & Björnberg, 2010). This implies that gender dynamics might also affect some of the processes underlying information sharing (particularly those related to inter-subjectivity).

This study adds important and new information relating to research on peer collaboration and group decision making in children. Not only do children routinely make group decisions in educational, family, and peer contexts, but children are increasingly asked to participate in group decisions with sometimes far-reaching consequences (e.g., medical decisions, see McCabe, 1996). Given the importance of basing these decisions on relevant and exhaustive information, sharing unique information with other group members is a key process for making good decisions in these contexts.

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Table 1

Hypotheses Concerning the Processes Underlying Information Sharing in the Unshared Information Condition

Hypothesis	Process and description	Prediction
2	Collective information sampling (CIS; Stasser & Titus, 1985): Shared information is more likely to be mentioned during group discussion than unshared information.	Group members of both ages • discuss more shared than unshared information. • do not pick the best candidate (hidden profile effect).
3	Preference-consistent evaluation (Greitemeyer & Schulz-Hardt, 2003): Information presented during the group discussion does not change individuals' pre-discussion preference.	• Group members of both ages do not pick the best candidate either before or after the discussion. • Amount and type (shared, unshared) of information presented during the group discussion does not influence preferences.
4	Collaborative inhibition (Leman & Oldham, 2005): Collaboratively recalling information from the pre-discussion phase disrupts individuals' retrieval of pre-discussion information. Groups of 9-year-olds are subject to collaborative inhibition, groups of 7-year-olds are not.	Groups of 7-year-olds are more likely to discuss unshared information and decide in favour of the best candidate than groups of 9-year-olds.

Table 2

Distribution of Information about Best and Second Candidate in Shared and Unshared Information Condition

	Group member		
	1	2	3
	Shared information condition		
Best candidate	Can dance	Can dance	Can dance
	Has good memory	Has good memory	Has good memory
	Has a loud voice	Has a loud voice	Has a loud voice
	Makes others laugh	Makes others laugh	Makes others laugh
	Works well with others	Works well with others	Works well with others
	Can express emotions	Can express emotions	Can express emotions
	Likes being on stage	Likes being on stage	Likes being on stage
Second	Can sing	Can sing	Can sing
candidate	Is not nervous	Is not nervous	Is not nervous
	Is musical	Is musical	Is musical
	Learns text quickly	Learns text quickly	Learns text quickly
	Unshared information condition		
Best candidate			
Shared	Can dance	Can dance	Can dance
Unshared	Has loud voice	Can express emotions	Works well with others
	Has good memory	Likes being on stage	Makes others laugh
Second			
candidate	Can sing	Can sing	Can sing

Shared	Is not nervous	Is not nervous	Is not nervous
	Is musical	Is musical	Is musical
	Learns text quickly	Learns text quickly	Learns text quickly

Table 3

Mean Proportion (and SD) of Shared and Unshared Information Discussed and Mean Level (and SD) of Relative Inter-subjectivity in 7- and 9-year-old Groups in the Unshared Information Condition

	Shared information	Unshared information	Relative inter-subjectivity
7 years			
Overall	.51 (.22)	.38 (.25)	.04 (.02)
Best candidate chosen (n = 7)	.40 (.31)	.55 (.27)	.02 (.01)
Second candidate chosen (n = 12)	.57 (.14)	.28 (.18)	.04 (.03)
9 years			
Overall	.78 (.22)	.30 (.25)	.06 (.03)
Best candidate chosen (n = 2)	1.00 (.00)	.42 (.12)	.04 (.03)
Second candidate chosen (n = 17)	.75 (.22)	.28 (.26)	.06 (.03)

Table 4

Correlations Between Preference Difference Score, Proportion of Shared Information, and Proportion of Unshared Information Discussed in the Unshared Information Condition.

Variable	1	2	3
1. Preference difference score	--		
2. Proportion of shared information	.26**	--	
3. Proportion of unshared information	-.20*	.13	--

* $p < .05$. ** $p < .01$.