The impact of friendship on primary school children's ability to effectively collaborate with peers: Learning outcomes on two scientific reasoning tasks

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Abstract

The present study examined whether peer collaboration between friends and acquaintances differed in respect to performance on two scientific reasoning tasks and in the processes of social interaction that occurred between the partners. Peer collaboration, where pairs of equally skilled partners work together in problem solving, has demonstrated immediate and long-term benefits on the cognitive development of children. One controversial question that remains is whether friends should be paired together, or whether the practice of pairing friends should be avoided. In the present study, sixty children aged 10-to-12 years from a suburban school in Adelaide, South Australia completed friendship and familiarity ratings. Pairs of friends and acquaintances were subsequently matched as closely as possible on familiarity. The pairs then worked together to solve two 'isolation of variables' tasks. Two weeks later an individual post-test was administered to see if any gains from collaboration persisted. Results indicated that friends outperformed acquaintances in the collaboration, but not on the individual post-test. Of the process measures, only acceptance and monitoring differed between friends and acquaintances, and only acceptance was associated with task performance. A regression analysis revealed acceptance to mediate the relationship between friendship and task performance. The results indicate that peer collaboration is an effective learning strategy for primary school children, and friends provide a unique context for increasing cognitive performance in collaboration between peers.
Introduction

Overview

Research into children's learning with peers has a long history. More recently, attention has focused on the role that the relationship between the partners has on successful peer exchange. In particular, research has demonstrated that friends typically outperform acquaintances when collaborating on problem-solving tasks. However, this research has confounded two potentially important factors; friends differ from acquaintances both in the strength of affiliation and in familiarity. The present study examined influences on the effectiveness of peer collaboration between school-aged children, comparing friends and equally familiar acquaintances as they worked together on two 'isolation of variables' problems. A central aim of the present study was to demonstrate that friendship, or the affiliative bond shared between two individuals, contributes to the effectiveness of peer collaboration over and above any contribution made by familiarity, or how well an individual knows another. In addition, aspects of the social interaction between the pairs were examined in an attempt to identify the processes that were likely to contribute to task performance.

Peer Collaboration: Background

Peer relations serve an important function in children's development, providing the foundation for developing conceptions of equality, mutual understanding, intimacy and reciprocity. Unlike adult-child relations, where a clear division of status exists between individuals in interaction, peer culture is negotiated through a mutuality of exchange that is based on equality. Accordingly, distinct patterns of interaction emerge that are not present in adult-child relations. Attempts have been made to harness the unique features of peer relations through the development of strategic approaches to peer learning. One approach is known as 'peer collaboration' and involves pairs of equally skilled partners working jointly to solve a problem. The benefits of peer collaboration have been demonstrated in conservation tasks based on those designed by Piaget, spatial representation tasks, moral dilemmas, strategic planning problems and in the acquisition of basic mathematical skills. In many cases, the benefits of collaboration have been substantial. For example, found that children working in pairs on a computer-based planning task were twice as likely to succeed compared to children working alone. In addition, they continued to be more successful when working individually at a subsequent task.

Peer Collaboration: Why is it Effective?

Two major approaches to explaining the benefits of peer collaboration have been identified in the literature. Research into socio-cognitive conflict has investigated whether the central benefits of peer collaboration are derived through the conflict that arises between partners during problem solving. It has been proposed that peer interaction in problem solving inevitably leads to disagreements about appropriate planning, strategies and solutions. Having to recognize and deal with a variety of opinions during the collaboration creates a sense of cognitive conflict within the individual. found that cognitive gains were most pronounced when members of collaborative pairings expressed disagreements, contradicted each other and made counter proposals. However, not all conflict is equally helpful. A series of studies that examined the role of socio-cognitive conflict in peer collaboration found that cognitive change was most prominent in instances of conflict in which each partner made an active contribution to the discussion and explained their viewpoint. Neither simple assertions and denials, nor 'scaffolding' in which approximations of the solution were presented, improved performance. This suggests that the type of conflict and the way it is managed is paramount in determining whether cognitive change takes place.
An alternative but related argument suggests that the level of cooperative activity or co-construction achieved among peers has a powerful influence over cognitive outcomes. Rather than working independently to understand each other's reasoning, problem solving occurs jointly between the partners in the interaction. Through mutual planning, collective sharing of ideas and reciprocal validation, insights and solutions can be developed that go beyond those possible by either individual working alone. This idea of co-construction identifies processes such as clarification, explanation and justification of meaning as those that serve to advance cognitive development. Evidence in support of the co-construction approach has been repeated across a range of domains. demonstrated that the tendency to accept and transform the information received from partners was responsible for moral advancement. found that the most effective partnerships in collaboration were those in which children showed responsiveness to the task, actively communicating through the elaboration and extension of each other's ideas. In these cases, the degree to which both parties were able to effectively construct solutions to the problem through collective activity rather than conflict was the motivating force behind learning in peer collaboration.

Both approaches serve overlapping functions and share a number of features. Indeed, success in peer collaboration appears to rely on an open-ended exchange of ideas, in which disagreements are justified and both partners play an active role in coordinating their perspectives to reach mutual solutions.

Friendship in Collaboration

Although neither of these approaches emphasizes the nature of the relationship between partners, both provide some insight into why this might be an important factor in collaboration. characterizes friendship as a relationship founded upon ideals of equality, reciprocity and commitment. Hence, the motivation to cooperate and collaborate effectively is likely to be stronger for pairs of friends than for pairs of children who do not know or like each other. The equality and reciprocity inherent in friendship suggests that friends may be more effective than acquaintances at co-constructing solutions to problems. Additionally, the commitment to maintaining the friendship may elicit greater attempts at reconciliation following disagreement or conflict.

Empirical research supports the contention that friends are more effective collaborators than other pairs of children. conducted a meta-analysis of studies that examined differences between friends and acquaintances across several domains of behaviour, including cooperation, conflict and task performance. In each of these categories, friendship was associated with better outcomes. Even so, friends are rarely given an opportunity to work together in collaboration because of a pervasive 'anti-friends' bias that permeates school classrooms (Hartup, 1996). Teachers believe that friends will engage in too much off-task behaviour that is not related to the work at hand. However, there is currently no evidence to indicate that pairing friends together for collaboration in any way undermines performance or impedes attention to task demands.

Confounding Between Friendship and Familiarity

admit that the features distinguishing friends from acquaintances are not well understood. Nevertheless, two dimensions appear to be central: affiliation and familiarity. However, familiarity is not unique to friendships. The failure of all previous studies to control for familiarity when studying the role of friendship in peer collaboration is therefore problematic. Comparing the performance of friends and strangers has confounded familiarity with liking. This makes it impossible to determine whether friends are better collaborators due to shared knowledge or the nature of the affiliative bond. Familiarity alone has been shown to encourage greater responsiveness between children. For example, acquainted children
outperform strangers. In addition, has shown that best friendships evolve through increasing shared knowledge rather than greater levels of liking between children. Thus research showing that best friends outperform good friends in collaboration suggests that a higher level of familiarity rather than increased liking impacts on performance. The consequence of failing to distinguish between 'liking' and 'knowing' therefore makes it possible that friendship's influence on cognition is simply an artifact of the degree of familiarity between the pairs of children studied. Accordingly, argue that accurately defining the level of familiarity between partners is conceptually important. In the present study, familiarity was assessed via a rating scale. Based on these ratings, pairs of friends and acquaintances could be matched as closely as possible to control the degree of familiarity between the children.

Processes of Interaction

The nature of the interactions between individuals has a critical influence over the cognitive outcomes that ensue. However, speculation continues in regard to identifying the specific processes that are responsible for the superior performance of friends in collaboration (Bigelow et al., 1996). The socio-cognitive conflict and co-construction approaches to peer collaboration can be used as a framework for isolating probable mechanisms through which friendship might mediate task performance in cognitive problem solving. In addition, metacognitive activities such as planning and monitoring have also been implicated as potential sources of cognitive enhancement, given that they allow cognitive resources to be utilized more efficiently.

Conflict/Disagreement

argues that social conflict is a powerful source of cognitive change, and may be particularly relevant for friends, who must negotiate conflict effectively in order to maintain the status of the relationship. The loyalty and trust inherent in close relationships, suggests that friends may be more comfortable in openly expressing their views and more likely to challenge each other's opinions. Support for this notion was demonstrated by who discovered that friends generated more frequent and longer-lasting conflicts than acquaintances. These differences remained after statistically controlling for the total amount of conversation that took place. tested whether friends and acquaintances responded differently in a conflict situation, and found that friends evinced more positive changes following disagreements. For acquaintances, collaboration presents an opportunity to further extend social ties, and conflict may therefore be perceived as undesirable. similarly maintain that acquaintances will initially seek to gain approval from peers and hence tend to agree more readily with a partner's solution, whereas friends are more likely to critique one another's reasoning and actively seek resolution until mutually agreeable outcomes are attained. This suggests that friends will be more likely than acquaintances to voice discrepant opinions. On the basis of these findings and previous research into peer collaboration, which demonstrated that disagreements required justification to promote development (e.g., it is expected that friends will be more likely to provide reasons for their point of view when disagreeing compared to acquaintances.

Acceptance/Conflict resolution

Evidence also suggests that responses to conflict differ between friends and acquaintances. found that friends were more likely to resolve conflict and did so more efficiently than acquaintances. Friends negotiate more with each other, disengage from conflicts more frequently, and are more likely to reach equitable outcomes and remain in interaction following conflict. Thus, it is predicted that friends will be more likely to effectively resolve disagreements than acquaintances.
Co-construction

There are similar reasons for expecting that friends may be advantaged in co-constructing solutions to problems. Friends, who have close social bonds, may be better able to contribute cooperatively with each other. Research supports this notion. found that friends utilized a scarce resource more effectively than acquaintances and tended to cooperate with each other more readily. established that a small group composed of friends was more organized and willing to share ideas on a science or language task than a group who were not friends. discovered that friends discussed more task-related information than acquaintances when exploring a 'creativity box'. suggests this is because friend's communications tend to be more mutually oriented, and so interactions in collaboration are more task-focused and managed with greater efficiency. Taken together, these findings suggest that cooperative, task-oriented activity should require less effort for friends than for acquaintances. Cognitive change may also be facilitated through conversations where participants engage in mutually affirming dialogue, rather than through resolutions of conflict. Studies of peer collaboration have shown that agreement is an important component in successful peer exchange (e.g., If cooperation and information sharing are greater for friends then it might also be expected that friends would tend to talk about the task and agree (as well as disagree) more often than acquaintances.

Metacognitive Activity: Planning and Monitoring

found that the most effective problem solving dyads of 'work friends' typically developed organisational strategies that incorporated planning and gave attention to the partner's demands through compromise and coordination of ideas. Several studies have concluded that planning enhances peer learning. For instance, found that group planning was associated with increased performance on a structure-building task. In addition, report that the choice of an adequate problem solving strategy relies on a shared conception of the task and its possible solutions, between both agents in the collaboration (i.e. it depends on planning). Planning can assist in coordination of action between partners, because each member of the pair has a specified duty to fulfill. Consequently, it is presumed that friends will utilise planning activity more often than acquaintances.

Monitoring involves repeated checking of progress towards goals or task solutions. Evaluation and assessment of goals is important, as it allows for failed plans to be overridden by newer and more progressive plans. Scientific reasoning places high demands on the cognitive resources of the child. Evaluating outcomes and monitoring progress on a task are therefore important features of effective problem solving in this context. found that task monitoring was associated with increased performance on a cognitive task that involved complex decision-making in adults. established that monitoring or checking behaviour was associated with better problem solving in children, and speculated that evaluation of progress was a key mechanism through which friendship contributed to developmental outcomes. Accordingly, it is expected that friends will demonstrate higher levels of monitoring activity more often than acquaintances.

Summary and Aims of the Present Study

The present study seeks to examine whether peer collaboration continues to be enhanced by reciprocated friendships when the level of familiarity between the partners has been controlled. If friendship provides unique advantages in peer collaboration beyond those of simply being familiar with the partner, then differences between pairs of friends and pairs of equally familiar acquaintances should be apparent. It was therefore predicted that in both the collaboration and post-test, friends would exhibit higher mean total performance scores on the 'isolation of variables' tasks compared to acquaintances.
Both theory and evidence from previous research suggest that differences in performance should be reflected in the manner in which conflict is resolved, as well as through the social interaction that takes place during the process of collaboration. Consequently, it was hypothesized that friendship pairings would demonstrate higher frequencies of disagreements with a rationale, acceptance, task-related talk, agreement, planning and monitoring compared to acquaintance pairings during the collaboration phase.

Finally, it was deemed important to test whether the relationship between friendship and task performance was mediated via the specific processes that occurred in interaction, such as acceptance, disagreements, planning, monitoring, task-related talk or agreements.

Method

Participants

Participants in the study were sixty 10-to-12 year old children (30 female, 30 male) from three classrooms of grade five, six and seven students from a school in metropolitan Adelaide. The mean age of participants was 11.2 years (range 9.5 years to 12.5 years).

Materials and Procedure

Friendship and Familiarity Ratings

An A4 size ‘classroom map’ was used to assess friendship and familiarity between classmates. It depicted the seating arrangements for individual children by representing each desk in the classroom as a square. Other prominent landmarks (e.g. the teacher’s desk and the blackboard) were also marked on the map. Appropriate names were placed on every ‘desk’, and spaces provided for the children to rate the degree of friendship and familiarity between themselves and the child who sat at that desk. Children were asked to rate separately the degree of friendship and familiarity between themselves and each of the other children in the classroom. Friendship was assessed by applying a 4-point rating scale (1=best friend; 2=good friend; 3=ok, but not a friend; 4=definitely not a friend) to every other child in the classroom. Familiarity was assessed on a five-point rating scale, with participants asked how much they knew about each of the other children in the class. A score of one indicated that the subject knew "heaps" about the other child and a score of five denoted that the subject knew "not much at all" about the other child.

Forming the Pairs

Participants were paired with a friend or an acquaintance for the problem-solving tasks. To successfully match pairs of friends and acquaintances in terms of familiarity, target children were randomly selected and based on their friendship nominations, either a reciprocating friend (friendship rating of 1 or 2) or a reciprocating acquaintance (friendship rating of 3) was randomly chosen as a partner. Where possible, the candidates were exactly matched on familiarity (i.e. same familiarity ratings for friend and acquaintance pairs). Reciprocal nominations were used to capture the essentially dyadic nature of friendship. This procedure yielded 15 pairs of friends and 15 pairs of acquaintances who had similar levels of familiarity.

The Collaboration Phase: Problem-Solving Tasks

Friend and acquaintance pairs were given a 'pizza' and a 'plant' problem to solve. These 'isolation of variables' tasks were based on two of the problems from the study ("Pizza 2" and "Plant"). The order of task presentation was counterbalanced such that pairs of friends and pairs of acquaintances had equal opportunity to be presented with either the pizza or
plant problems first. Participants were asked to work together to try to solve the problem, and to talk the task through carefully with each other before deciding on a solution. The researcher offered no assistance with the task and told the pairs to simply "do the best you can". The session was videotaped and audiotaped.

*Pizza Problem*

This task required an A4 full-colour schematic representation of a pizza cut into six slices. In each slice, the name of a person and the selected pizza ingredients they had consumed was depicted, along with either a smiling yellow face (to signify they were still living) or a frowning green face (to show that they were dead). To reduce the possibility of children telling other classmates about the solution to the problem, there were three different versions of the task. In each case, one of the causal ingredients was perfectly correlated (i.e. on all the pizza slices of the dead and none of the living individuals), and the other causal ingredient appeared only in some of the dead individuals' pizza. The pizza problem required participants to determine the pizza ingredients that may have contributed to the death of some members of a group of six friends. Participants were required to recognize that as long as an ingredient did not appear in any surviving members' pizza it could be poisoned. Participants were introduced to the pizza problem via a short introductory story involving a king (male pairings) or queen (female pairings) and the plan to kill him/her by poisoning his/her favourite food, pizza. Some loyal friends of the king or queen had volunteered to taste the pizzas first to test whether they were safe for consumption.

Based on the method, the total score for the pizza problem was determined by combining the score awarded to the children's "solution" with the score awarded for their justification of this solution. Solutions were scored on 0-2 scale. Participants received one point for correctly identifying perfectly correlated variables (i.e. that were present in all of the pizza slices of the dead and none of the pizza slices of the living individuals) and two points for identifying causal ingredients that were not perfectly correlated (i.e. that existed in the pizza slices of only some of the dead and none of the pizza slices of the living individuals). Explanations were scored on a 0-3 scale. Zero points were awarded to explanations that involved irrelevant variables or were derived from personal knowledge (e.g. "It's the olives because olives taste terrible"). One point was awarded for explanations that served only to verify the link between the causal agent and the outcome (e.g. "It's the mushrooms because they killed people"). Explanations that focused solely on the perfectly correlated variable and linked it to both outcomes ("It's the olives because all of the dead and none of the living people ate them") were awarded two points. Three points were given when the explanation linked the outcome to both the perfectly correlated variable and the variable with partial covariation ("It could be the mushrooms as well because none of the living people ate them"). Scores for both solutions and explanations thus depended on whether the children identified and explained only the perfectly correlated causal variable (range of total scores between zero and three points), or acknowledged the effect of the partial covariation variable as well (range of total scores between zero and five points). Higher scores were therefore representative of greater task performance.

*Plant Problem*

The plant problem required an A4 sheet containing four line drawings of plants "that the experimenter kept at home". Two of the plants appeared quite healthy (long green leaves) and the other two appeared dead (shorter, brown leaves). Next to each of the plants was a combination of ingredients. These included either light or dark plant food and a big or small glass of water. One of the healthy and one of the dead plants also had a small bottle of leaf lotion beside it. The experimenter introduced the plant problem by explaining that he was planning to purchase a new plant to replace the two dead ones in the picture. He needed to
know what factors had caused the two plants to die, and also what the new plant should be
given to keep it alive. Scores on the plant problem depended on whether the children were
able to successfully isolate the causal variable (dark plant food) and eliminate the irrelevant
variables (water and leaf lotion). One point was given when the dark plant food was named
as the ingredient causing the plants to die. Two additional points were granted for realizing
that the water and the leaf lotion had no effect over the health of the plant. Thus, scores
ranged from zero to three, with increased scores again representing improved performance.

The total performance score across the two problems was the sum of the scores for the
pizza and the plant problems. The range of possible scores was 0-8 points.

The Post-Test

Two weeks later target children completed a version of the pizza task in which the poisoned
ingredients differed from those in the collaboration phase. Target children
were asked to
complete this second task alone. In all other respects, the same procedures were followed
as in the collaboration phase. The children were asked to report their answers to the
researcher when they had discovered the solution. The post-test was not videotaped or
audiotaped.

Interaction Processes

Video and audio records allowed the coding of several interaction processes that have been
associated with cognitive performance in past research. Planning and monitoring assessed
some of the specific metacognitive skills involved in knowledge construction and acquisition.
Task related talk and agreements assessed co-construction, while disagreements and acceptance assessed socio-cognitive conflict. The frequency of
these behaviours during the collaboration phase was recorded. Another researcher, blind to
the composition of the pairings, coded a random portion (25%) of the video and audio
records in order to determine the inter-rater agreement for each measure. Since scores on
each of the process measures were based on ratio scale data, inter-rater reliabilities could
be reported both as Pearson correlation coefficients and as the percentage of agreements
between the raters for each of the measures. Correlations were used as an index of inter-
rater consistency and percentage agreement was used as an index of accuracy. Lower
values typically occurred in categories for which frequency was low, and hence differences
between the raters had a greater effect. These correlation and agreement values are
presented in parentheses alongside the definition of each process variable.

Disagreement

This encompassed all aspects of disagreement that occurred during the collaboration,
including critiques ("That's not right, what about the olives?") and critical evaluations of the
other person's contribution. Disagreements were coded as occurring with a rationale ($r = 0.95; 79\%$), where reasons were given for the disagreement, or without a rationale ($r = 0.92; 94\%$), where no reason was given for the disagreement. The number of total
disagreements was determined by summing scores from both of the disagreement
measures.

Acceptance

Acceptance ($r = 0.87; 88\%$) encompassed behaviours that reflected a compromise between
the pairs following disagreements. This indicated that some sort of negotiation had taken
place to reach a mutually satisfying resolution of the disagreement.
Other Task-Related Talk

This category included any statements relating to the task that were not instances of planning, monitoring, or disagreement. Task-related talk \((r = 0.98; 83\%)\) encompassed questions and explanations that either child made during collaboration.

Agreements

An agreement \((r = 0.99; 96\%)\) included any talk that suggested that one child was in favour of directly adopting the partner’s ideas or was acquiescing to the partner’s demands. Unlike instances of acceptance, which were responses to conflict, agreements could occur at any time during the collaboration.

Planning

This included instances in which a problem-solving strategy was specified and instances in which roles were delegated among the pairs. Planning \((r = 0.86; 82\%)\) included talk that defined who should perform a certain task, or how a strategy could be implemented successfully.

Monitoring

Monitoring \((r = 0.93; 67\%)\) encompassed any behaviour that suggested partners were either checking or evaluating their progress on the task (e.g. "Have we checked the olives yet?") or assessing the amount of work remaining.

Results

Controlling for Familiarity

One of the major aims of the study was to assess the differences in performance between pairs of friends and acquaintances after controlling for the level of familiarity (or knowing) between the partners. To this end, it was important to ascertain whether the attempt to control the level of familiarity between the partners (friend v acquaintance) had been successful. A multivariate analysis (MANOVA), with familiarity ratings for both children in both types of partnerships as dependent variables, revealed that there was no difference between the two types of partner in familiarity, \(F(2,27) = 1.68, p = .21\). Univariate analyses, examining target children and partner separately also confirmed that ratings for familiarity were not significantly different between friends and acquaintances (\(F(1,28) = 1.91, p = .18\), and \(F(1,28) = 1.80, p = .19\), respectively). These results suggested that the matching process had been largely effective in removing the potential confound between familiarity and friendship present in previous research.

Task Performance

To determine whether there were differences in the level of task performance between pairs of friends and pairs of equally familiar acquaintances during the collaboration, an independent t-test was applied to the data. Results indicated that pairs of friends (\(M = 5.87, SD = 0.52\)) were better at solving the problems than pairs of acquaintances (\(M = 4.80, SD = 1.47\)), \(t (17) = 2.65, p = .02\). The hypothesis was therefore supported, with friends significantly outperforming acquaintances over the two tasks. It was also predicted that target children from friendship pairings would gain higher mean scores when completing the pizza problem alone during the post-test compared to target children from acquaintance
pairings. Results indicate that the performance of target children from friendship pairings ($M = 3.67$, $SD = 0.82$) and acquaintance pairings ($M = 3.27$, $SD = 0.88$) did not differ on the post-test, $t(28) = 1.29$, $p = .21$. Thus, this hypothesis was not supported. Scores on the post-test did not differ between friends and acquaintances.

**Interaction Processes**

**Total Amount of Interaction**

A preliminary analysis was conducted to determine whether it was necessary to control for the total amount of interaction that took place between partners, to ensure that any differences between friends and acquaintances were not simply due to higher frequencies of conversational exchanges occurring between friends. A t-test indicated that there was no significant difference in the total amount of interaction between friends ($M = 39.80$, $SD = 14.51$) and acquaintances ($M = 29.20$, $SD = 13.92$), $t(28) = 2.04$, $p = .051$. However, because the difference between means approached significance, it was of interest to examine the role of the total amount of interaction by entering it as a covariate in analyses related to the interaction hypotheses. The hypotheses were therefore tested in two ways. First, t-tests examined whether differences existed between friends and acquaintances, and then follow-up analyses were conducted to test whether significant effects were diminished after entering total amount of interaction as a covariate in ANCOVA. This was appropriate, as there are currently no empirical or theoretical grounds to determine whether the absolute or the relative frequency of process variables has the greatest impact upon the outcome of collaboration.

**Planning and Monitoring**

It was predicted that friends would have higher frequencies of planning and monitoring than acquaintances during the collaboration. Initial t-tests revealed that friends ($M = 0.60$, $SD = 0.74$) and acquaintances ($M = 0.20$, $SD = 0.41$) did not differ in terms of planning, $t(22) = 1.83$, $p = .08$. However, friends ($M = 2.40$, $SD = 1.50$) were more likely to monitor their progress on the tasks than acquaintances ($M = 1.20$, $SD = 1.15$), $t(28) = 2.46$, $p = .02$.

Results of the ANCOVA indicated that the effect of partner on monitoring was almost completely removed once the total amount of interaction was entered as a covariate, $F(2,27) = 1.60$, $p = .22$. Friends monitored their progress more often only because of the increased amount of interaction they shared. (The effect size for planning was similarly reduced in the covariate analysis, $F(2,27) = 1.03$, $p = .32$.) Thus, the hypothesis was only partially supported. Friends and acquaintances did not differ in the amount of planning they engaged in during the collaboration. The absolute frequency of monitoring behaviour differed between friends and acquaintances. However, this appeared to be due to friends having a greater overall amount of interaction.

**Co-construction**

There was no support for the notion that interaction processes related to co-construction differed between friends and acquaintances. T-tests indicated that friends did not differ from acquaintances in the frequency of task-related talk (friends $M = 23.73$, $SD = 7.34$; acquaintances $M = 19.07$, $SD = 7.84$), $t(28) = 1.68$, $p = .10$, or agreements, (friends $M = 8.47$, $SD = 6.52$; acquaintances $M = 6.20$, $SD = 2.96$), $t(19) = 1.23$, $p = .23$.

**Conflict and Conflict Resolution**
It was predicted that the frequency of disagreements with a rationale would be greater for friends than acquaintances. However, results indicated that friends (M = 2.40, SD = 1.92) did not differ from acquaintances (M = 1.40, SD = 2.35) in the number of disagreements with a rationale they engaged in, t(28) = 1.27, p = .21. Hence, there was no support for the hypothesis. It was further proposed that friends would have higher frequencies of acceptance compared to acquaintances, and the results of a t-test provide support for this notion. Friends (M = 0.80, SD = 0.68) were more likely to reach acceptance than acquaintances (M = 0.20, SD = 0.41), t(28) = 2.93, p < .01. This difference remained significant after controlling for the total amount of interaction, F(2,27) = 6.83, p = .01. Thus, analyses of both the absolute and the relative frequency of acceptance provide support for the hypothesis that friends and acquaintances would differ in the degree of acceptance they experienced during the collaboration.

**Potential Mediators**

Hierarchical multiple regression analysis was undertaken to determine whether the facilitative effects of friendship on task performance were mediated through specific types of interactions that occurred during collaboration. Spearman correlations indicated that only acceptance and type of partnership were significantly associated with task performance (see Tables 1 and 2).

**Table 1**

Spearman correlations between conflict interaction processes, the type of partnership and task performance

<table>
<thead>
<tr>
<th>Process Variables</th>
<th>Acceptance</th>
<th>Disagree (with rationale)</th>
<th>Disagree (without rationale)</th>
<th>Task Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acceptance</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Disagree (with rationale)</td>
<td>0.59**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Disagreement (without rationale)</td>
<td>0.41*</td>
<td>0.63**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Task performance</td>
<td>0.53**</td>
<td>0.09</td>
<td>0.05</td>
<td></td>
</tr>
<tr>
<td>Partnership</td>
<td>-0.49**</td>
<td>-0.40*</td>
<td>-0.23</td>
<td>-0.40*</td>
</tr>
</tbody>
</table>

*p < .05 Partner: 1 = friend

**p < .01 2 = acquaintance
Table 2

Spearman correlations between 'co-construction' and 'meta-cognitive' interaction processes, the type of partnership and task performance

<table>
<thead>
<tr>
<th>Process Variables</th>
<th>Planning</th>
<th>Monitor</th>
<th>Agreement</th>
<th>Task-Related Talk</th>
<th>Task Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planning</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Monitor</td>
<td></td>
<td>0.50**</td>
<td></td>
<td></td>
<td></td>
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<tr>
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<td></td>
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<tr>
<td>Task-Related Talk</td>
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<td>0.78**</td>
<td>0.42*</td>
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<tr>
<td>Task Performance</td>
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<tr>
<td>Partnership</td>
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<td>-0.45*</td>
<td>-0.07</td>
<td>-0.31</td>
<td>-0.40*</td>
</tr>
</tbody>
</table>

*p< .05 Partner: 1=friend

**p< .01 2=acquaintance

As acceptance was the only process variable significantly associated with performance, the regression analysis was conducted with acceptance and type of partnership as the only predictors of task performance. The test of this hypothesis took place in several steps. First, a regression in which type of partnership was entered as a predictor of task performance was completed. Results showed that type of partnership ($R^2$ change = .20, $F$ change (1,28) = 7.00, $p$ = .01) explained a significant amount of variance in task performance (20%). In a subsequent regression, acceptance was entered at the first step, and partner was entered at the second step. Acceptance accounted for 24.7% of the variance in task performance ($R^2$ change = .247, $F$ change (1,28) = 9.17, $p$ = .01). The second step revealed that friendship was not a significant predictor of task performance once the contribution of acceptance had been accounted for. The $R^2$ change in the second step indicated that friendship only accounted for 5.6% of the variance in task performance not already accounted for by acceptance. Thus as figure 1 illustrates, acceptance mediates the relationship between the type of partner in collaboration (whether friend or acquaintance) and task performance.

Figure 1.

Model showing acceptance/resolution as a mediator of the relationship between type of partnership and task performance
Effects of Familiarity

A mean familiarity score was calculated for the two partners in each dyad in order to test whether familiarity was exerting any influence over performance and the processes in which children engaged during collaboration. Low scores on the measure of familiarity indicated greater familiarity. Mean familiarity was not related to task performance ($r = -0.17$, $p=.37$). However, familiarity was associated with the amount of planning in which partners engaged ($r = -0.48$, $p=.007$), accounting for 23% of the variance in planning. Peers who knew each other better tended to engage in more frequent planning. Crucially, in relation to the results presented earlier, familiarity was not associated with acceptance ($r = -0.09$, $p=.638$), the strongest predictor of task performance.

Discussion

Overview

The present study investigated whether differences existed between pairs of friends and pairs of equally familiar acquaintances when collaborating on cognitive tasks. On the premise that an individual can know someone well and yet not consider them as a friend, the primary aim of the present study was to isolate components of friendship beyond knowing that may contribute to cognitive gains when friends work together in collaboration. By controlling familiarity between the pairs of friends and acquaintances prior to assessing performance outcomes, differences between the groups must be representative of an aspect of friendship beyond mere familiarity with the partner. Also of interest were the types of interaction processes that occurred between the partners and their relative contribution to performance on the cognitive tasks.

Results indicated that friendship facilitated performance on scientific reasoning tasks beyond merely knowing the partner better, but only in the collaboration. There was no evidence of differences in performance between the groups on the post-test. Some insight was also provided into the reasons for why friends outperform acquaintances. Friends were more likely to reach acceptance, signifying that some sort of negotiation had taken place following a disagreement, and this in turn was associated with greater performance on the tasks.

Task Performance

The first two hypotheses of the present study were related to performance outcomes. It was predicted that friends would outperform acquaintances during the collaboration and on the post-test. The results showed that while friends performed better than acquaintances on the tasks during the collaboration phase, there were no differences between the two groups on the post-test. Thus, the study provides some support for the notion that gains accrued in collaboration are a direct result of the collaborative exchange between the partners. More importantly, in relation to the primary aim of the study, it shows that friendship and not familiarity is responsible for those gains. It also replicates to some extent the results obtained by in that friends outperformed acquaintances in the collaboration.

However, it does not provide support for ideas of 'cognitive fermentation', where children privately reflect on a discussion and gain greater understanding after some time has elapsed. has suggested that expecting gains from collaboration to persist over a post-test may be unreasonable given that both the collaboration and individual post-test represent entirely different social contexts. In the context of the present study, the post-test was administered two weeks after the collaboration. This two-week period coincided with a school holiday break for the children. Perhaps it was asking too much to expect the level of performance to be maintained after such time, following only a single 5-minute collaboration period. Thus,
although there was no indication that learning during the collaboration had generalized to the post-test on this occasion, it is possible that with repeated exposure to peer collaboration more prolonged effects could result.

Interaction Processes

The predicted differences in social interaction between friends and acquaintances that were expected only eventuated for two of the process variables. Friends were more likely to monitor progress on the tasks overall, but the relative frequencies of monitoring did not differ between friends and acquaintances. This lent partial support to the hypothesis that predicted friends would engage in planning and monitoring more often than acquaintances. These results do not replicate the findings of, who found that friends were more likely to monitor and evaluate progress on the task. However, only recorded monitoring on the basis of a dichotomous yes/no scale. Therefore, the lack of overall differences noted in the present study could be a result of the greater sensitivity of the frequency measure. Additionally, found that monitoring was significantly related to task performance. While a positive correlation between monitoring and task performance was observed in the present study (rho = 0.28), this value was not significant.

Friends were also more likely to reach acceptance. This indicated that following a disagreement with a rationale, friends were more inclined to negotiate their differences and achieve resolution. As there was no difference in the frequency of disagreements with a rationale between the groups, this gives support to the notion that friends manage conflict more effectively, as demonstrated in previous research ; ; . However, friends did not disagree more often than acquaintances, nor did they engage in a higher proportion of disagreements with a rationale. This is in opposition to other research which has found friends typically engage in higher rates of conflict than acquaintances . The descriptive statistics for each of the process measures indicate that rates of conflict in the present study were fairly low. Indeed, the tasks (pizza and plant problems) did not appear to elicit the type of confrontations between partners that invited by manipulating the rules on a board game so that children had differing conceptions of how the game should be played. This, along with instructions to children to "work together" at the tasks may have lessened the amount of conflict that might otherwise have been generated.

Contrary to expectations, none of the other process variable hypotheses were supported. There were no differences in the amount of planning, task-related talk or agreements between friends and acquaintances. This is counter to previous research ; ; , which has typically found greater amounts of information sharing, affect, and cooperation occurring between friends. In explaining these results it is possible that the explicit instructions to "work together" may have contributed to both friends and acquaintances expressing generally high levels of these behaviours. An additional factor may relate to the groups being closely matched on familiarity. As the study was comprised of friends and acquaintances reasonably familiar with each other, both groups may have been relatively comfortable in working together. Any differences between the groups may therefore not be as noticeable as in previous studies where the familiarity of the partners has not been controlled, perhaps leading to familiar friends being compared to relatively unfamiliar acquaintances.

As the results indicated, evidence for acceptance acting as a mediator between the type of partner and the level of task performance was supported. Friendship only had an indirect effect on performance. That is, the results show that the increased performance of friends was a result of friends being more likely to reach acceptance compared to acquaintances when dealing with conflict, and this in turn had a facilitating effect on task performance. Therefore, it can be argued that while friendship in this instance did not explain a large amount of the variance in task performance beyond acceptance, other factors (along with
specific methods of dealing with conflict) that are inherent in friendship relations may also contribute substantially to performance gains. The level of intimacy shared between friends may result in greater displays of positive affect, which in turn may have an impact on motivation and performance. Unfortunately, these ideas could not be effectively tested in the present study.

**Classroom Implications**

This research has important implications for classroom practice. Firstly, activities suitable for peer collaboration within the school curriculum should be developed and implemented. These could include activities that foster discovery learning or the understanding of basic concepts, as ; have described. Secondly, peer collaboration between friends should not be discouraged. Teachers can freely explore alternative arrangements of peer collaboration in the knowledge that different combinations of dyads will not undermine performance. Indeed, this study replicates and extends previous research into friendship by demonstrating that friends are superior collaborators to acquaintances even when the groups are equally familiar. It is likely that for best friends, the increasing familiarity they share could produce even larger effects. This remains to be fully explored but the implications are clear. Friends deserve a chance at working together as the results may surprise the skeptics.

It is also worthwhile noting that the present study was conducted toward the end of the school year. Accordingly, children tended to know more about each other than they might have if the study had been attempted earlier. This may have increased the number of acquaintances that children at least knew something about. Friendships may also have been more stable, given that they had more time to develop. These aspects may have contributed to the study being realized: without a wide range of friendship choices and adequate knowledge of other children in the class, matching friends and acquaintances on familiarity would have been impossible.

**Limitations**

distinguish between friendship and popularity, emphasizing the need to consider each of these variables in any analysis of peer relationships. As the present study did not account for differences in peer group status existing between the children, it is possible that the wider peer network may play a role in determining how well pairs of children work together. Popular children may interact differently with peers compared to children of lower acceptance levels within the classroom. Indeed, evidence suggests that popular children use different interpersonal strategies for dealing with peers compared to their lower acceptance counterparts .

Additionally, the present study did not examine the length of time children had been friends or investigate the properties of friendship that children perceive as important. indicates that not all friendships are the same. suggest that the quality of friendship relations may mediate between friendship and social or cognitive aspects of development. Assessing both the quality and stability of friendships may therefore be an important component in accurately investigating the influence of friendship .

The co-constructive measures utilized in the study were limited to the extent that while task-related talk reflected a general sharing of information, it was a fairly broad construct. The category encompassed questions, explanations, and miscellaneous statements related to the task. Consequently, children could be working largely independently of each other and still record instances of task-related talk. For the other categories this was less of an issue because they required for the most part some connection with the partner (i.e. in order to agree, disagree or plan a strategy). As a measure of co-construction, task-related talk was
therefore of limited value. Moreover, non-verbal behaviours were not analysed in the study and so important aspects of cooperation, such as looking, smiling and being attentive to the partner were not considered. Given that the affective quality of friendship may be an important determinant of success in task-coordination amongst peers, this may have been a telling limitation of the co-constructive measures.

Summary and Conclusions

When considering the results in light of previous research into friendship and peer collaboration, it should be acknowledged that the present study differed from past efforts in that its major aim was to examine the impact of friendship on cognitive task performance between peers who were equally familiar. If friends continued to outperform acquaintances once the familiarity of the partners had been controlled for, there was evidence that aspects of friendship beyond knowing contributed to performance outcomes. Where other studies have failed to determine whether performance is enhanced through the greater amount of knowledge shared between friends, or via the bond of friendship itself, the present study demonstrates that the affiliative nature of friendship alone contributes to performance gains on scientific reasoning tasks.

The opportunity for research in the area of friendship and peer learning is enormous. Researchers are only just beginning to understand the specific processes that occur in interactions with peers. Friendship is coming to be realized as a dynamic rather than static entity, moving through cycles of formation, development and maintenance, and these are currently poorly understood. Understanding more about the nature of friendship can help in determining which features of friendship contribute to learning. The present study suggests that one of these features is the manner in which friends deal with conflict.

In summary, the present study provides some insight into the importance of conflict resolution in successful peer exchange. Friends were more likely to reach acceptance and therefore tended to do better at the tasks. This suggests that peer collaboration may be most effective when children are encouraged to share their opinions in a climate that promotes the coordination of viewpoints, but at the same time motivates children to think critically about proposals and solutions to problems. Friendship may be the perfect vehicle for such an enterprise because of the mutual reciprocity that friends share, allowing them to voice an opinion and work through differences collectively, in the knowledge that the relationship will endure.

References


