



Collaboration fails to promote sharing behavior but both collaborative and parallel play boost friendship in young children aged 4 to 6

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ABSTRACT

Prosocial behaviors like collaboration and sharing are key to early childhood development. This study examined how collaboration, sex, and friendship influence sharing and perceived friendship among 48 dyads (96 children) aged 4–6. Participants were recruited from primary schools and paired into same-sex or cross-sex dyads. They were randomly assigned to either a collaborative or parallel play condition involving a cheese board game. In the collaborative condition, children worked together on one board, whereas in the parallel condition, they played individually on separate boards. After the game, children faced unequal rewards hidden under cups—one child received three candies (“lucky”), the other one candy (“unlucky”). Children then had the opportunity to share their rewards during a one-minute period without adult supervision. Friendship levels were assessed using a visual scale before and after the game. Children shared rarely, and contrary to our predictions, sharing behavior was not affected by collaboration, sex, dyad composition, or friendship level. However, both collaborative and parallel play led to increases in friendship ratings, suggesting that engaging in a shared activity and spending time with a peer may be associated with more positive evaluations of the relationship. No differences emerged between collaborative and parallel play in terms of this increase. The study highlights that prosocial sharing is sensitive to task design and social context, especially perceptions of ownership, while collaborative and parallel play may foster emotional bonds rather than generosity. These findings emphasize the importance of social tasks and positive social experiences in promoting prosocial development in early childhood.

Introduction

Prosocial behaviors encompass a set of voluntary actions intended to benefit others (Dunfield, 2014). They are essential for social interactions and play a fundamental role in child development. These behaviors emerge early in life and shape children's ability to navigate relationships and group dynamics. Recent research has highlighted that children's prosocial behaviors evolve from being primarily sympathy-based to becoming more strategic as they grow older (Grüneisen & Warneken, 2022). This development reflects children's increasing ability to use prosocial acts to achieve ulterior goals, such as improving their reputation or eliciting reciprocity. In

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this study, we focus specifically on two forms of prosocial behavior: sharing and collaboration. Sharing entails voluntarily giving up resources, making it a more complex and sometimes costly prosocial act than collaboration, as it requires the ability to recognize unequal distribution of resources, the motivation to see equality restored, and the ability to overcome a desire to monopolize resources (Dunfield, 2014; Eisenberg & Mussen, 1989; Messer et al., 2017; Tomasello, 2009). In contrast, collaboration involves working together toward a common goal, requiring coordination, mutual effort, and the ability to share ideas, materials, or simply a shared purpose (Melis & Warneken, 2016). It facilitates problem-solving, enhances social cohesion, and strengthens interpersonal bonds. While collaboration benefits all parties involved, sharing often involves an imbalance, as one child relinquishes something valuable for the benefit of another. The costs associated with sharing may be mitigated when it follows collaborative work, as individuals may be more willing to incur these costs in light of the benefits gained through collaboration. Such collaboration not only strengthens social bonds but also provides opportunities for children to practice relinquishing resources (e.g., through compromise) in pursuit of a common goal (Hamann et al., 2011). Understanding how these behaviors develop and what factors influence them provides key insights into early social cognition and moral reasoning.

In this vein, this article is organized around two main thematic research axes. The first focuses on the effects of various factors on sharing behavior, including collaboration, sex, and peer relationship (i.e. dyad composition and friendship). The second examines the links between collaborative activity and friendship, as well as the effects of dyad sex composition (same-sex vs. cross-sex) and the status of being the 'lucky' child (receiving more rewards) on the perception of friendship.

Effect of collaboration on sharing

The impact of collaboration on sharing has been extensively examined in developmental psychology. By collaborating to achieve a common goal, children engage in essential social skills, such as flexibility, acceptance of others' ideas, and the ability to compromise (Malti et al., 2016). Numerous studies have demonstrated positive links between collaboration and sharing. Hamann et al. (2011) demonstrated that three-year-old children who engaged in a collaborative task were more likely to share equitably with a real partner afterward compared to those who performed a parallel task. Similar findings were reported by Warneken et al. (2011), who observed that collaboration fosters a sense of fairness, leading children to distribute rewards more equally with a real partner. These results suggest that collaborative activities strengthen children's awareness of social norms and mutual obligations, reinforcing prosocial decision-making. Additionally, Melis et al. (2013) found that children who worked in a collaborative way with a puppet were more likely to share rewards than those who completed tasks individually, highlighting the importance of social engagement in fostering generosity. Furthermore, repeated collaborative interactions appear to strengthen prosocial tendencies over time, as children become accustomed to mutual exchange and fairness (Warneken & Tomasello, 2007). This dynamic may be influenced by two crucial factors that were not examined in previous studies: sex and friendship relationships among children.

Effect of sex on sharing

Indeed, a significant factor influencing prosocial behavior in children is sex. A meta-analysis has shown that girls tend to engage in prosocial behaviors, including sharing, more frequently than boys (Fabes & Eisenberg, 1998). Girls are often more attuned to social and emotional cues, which may enhance their inclination toward empathy-driven sharing. In contrast, boys may exhibit a stronger preference for competitive interactions, which can sometimes reduce their willingness to share resources (Eisenberg et al., 2013). However, the literature on sex differences in sharing remains inconsistent. Some studies suggest that boys can be just as generous as girls, particularly when engaging in collaborative tasks; however, these findings appear to be culturally dependent (Wan et al., 2019). Indeed, Wan et al. (2019) demonstrated that, in contrast to Western children –among whom girls tend to be more generous than boys– Chinese boys shared more stickers with unfamiliar peers than Chinese girls. This finding suggests that sex differences in generosity are, at least in part, shaped by cultural factors. Other findings confirm that boys' sharing behaviors are more context-dependent, influenced by factors such as group dynamics and the presence of social norms (House et al., 2023). Additionally, research by Birch and Billman (1986) found that girls tend to share more with their friends (i.e. sharing food) than with acquaintances, whereas boys do not always differentiate between close and casual peers in their prosocial actions. Finally, Fabes and Eisenberg (1998) noted that observed sex differences in prosocial behavior may have been influenced by measurement biases, including item content favoring girls or variations in assessment contexts (naturalistic vs. experimental settings).

Overall, while sex appears to influence children's prosocial behavior, particularly in sharing, these differences are influenced by other variables. They are shaped by contextual factors such as culture, social norms, experimental condition and the nature of peer relationships, highlighting the need to consider multiple interacting influences when examining sharing in children.

Building on this multifaceted perspective, it is also important to consider how specific characteristics of peer interactions, particularly the sex of the sharing partner, may further shape children's sharing behavior. Indeed, beyond general sex differences, the composition of the dyad itself can influence how children respond to situations involving fairness and resource distribution. Recent research by van Wingerden et al. (2024) further highlights the complexity of sex differences in fairness and sharing behavior. Their study, involving children aged 3 to 8, found that girls were more likely to reduce advantageous inequity with a real peer partner, while both boys and girls were more averse to male recipients receiving more than them. Notably, older girls tolerated disadvantageous inequity more when the allocation favored other girls rather than boys. In contrast, boys aged 7–8 exhibited a spite gap, preferring to maximize their own advantage over fairness, particularly in male-male interactions. These findings suggest that sex-related fairness preferences evolve with age and are influenced by the social context of interactions. However, while these studies provide valuable insights into sex-based fairness preferences, they do not fully account for the role of social relationships, such as friendships, in shaping

sharing behavior.

Effect of peer relationships on sharing: considering the friendship

Friendship is defined as a relationship marked by mutual positive regard that transcends specific places or moments in time (Asher et al., 1996). This close link entails three main features: proximity (i.e. being physically together, playing and spending time), prosocial interactions (i.e. sharing resources, secrets, care for each other, helping one another, loyalty), similarity (i.e., demographic and individual-level similarity, like attitudes, values and experiences) (Afshordi & Liberman, 2021). Given this definition of friendship, which emphasizes the prosocial nature of interactions, friendship may play a role in shaping prosocial behavior, influencing how children interact and share with their peers; however, empirical findings in the literature remain mixed.

Indeed, some studies have reported that friendship fosters emotional closeness and social bonding, which in turn promotes collaboration and generosity (Güroğlu, 2022). Among 4- to 5-year-olds, friendship is characterized by shared interests, mutual support, and a greater tendency to share with friends than with acquaintances or strangers (Fujisawa et al., 2008; Lenz & Paulus, 2021; Olson & Spelke, 2008). Reciprocity also seems to play a key role in this process, as children who have previously received prosocial acts from friends are more likely to reciprocate them in future interactions (Warneken & Tomasello, 2006). Furthermore, the strength of friendship appears to influence sharing behavior, with closer friends demonstrating higher levels of generosity and fairness (Paulus et al., 2020). Expanding on this idea, a recent study by Katerkamp and Horn (2025) investigated preschoolers' prosocial behavior in group settings, focusing on the effects of dominance, popularity, and friendship. Their findings suggest that friendship is an important predictor of prosocial actions, as children were more likely to share and help their friends than non-friends.

However, while some research report that friendship appears to encourage prosociality, others do not find such an effect, and these inconsistencies may be related to sex differences and experimental context. Indeed, some studies suggest that girls are more likely to share with friends, whereas boys may display competitive tendencies that sometimes suppress prosocial behavior within friendships (Berndt, 1981). Moreover, importantly, the effects of friendship on prosocial behavior can depend heavily on the experimental context. Research has shown that studies using artificial tasks or indirect measures (e.g., pictures of potential friend and stranger (Lenz & Paulus, 2021), puppets and evaluating a protagonist's actions (Paulus et al., 2020) often reveal positive friendship effects, whereas studies involving direct interactions with real familiar peers in dyads often failed to find preferential sharing with friends (Berndt, 1981; Horn et al., 2024; Messer et al., 2017). This highlights that children's prosocial behavior is sensitive not only to social relationships but also to the realism and social configuration of the situation in which it is measured.

To summarize, on the one hand, these findings underscore the potential role of friendship in shaping prosocial behavior; on the other hand, they also raise important questions about how sex dynamics intersect with these social bonds. Given the distinct ways in which friendship and sex each shape social interactions, it becomes essential to examine how their interplay influences early expressions of fairness, sharing, and collaboration.

Effect of collaboration on friendship

Few studies have examined causal links between collaborative play and friendship development in preschoolers (Beazidou & Botsoglou, 2024). Most existing research is correlational: in older children and adolescents (mean age 11.7), aggression predicted more negative (e.g., conflicts, betrayal, talking negatively about the friend to others) and fewer positive friendships (e.g., companionship, reliable alliance). Withdrawal was linked to less positive friendships, and prosocial behavior was associated with more positive and less negative friendships (Dryburgh et al., 2022). In younger children (ages 3–5), cooperation, social play, and friendship-sustaining skills were positively associated with peer acceptance and friendship, based on teacher reports and observations (Beazidou & Botsoglou, 2024). Cooperative pretend play at age four predicted smoother communication, fewer conflicts, and more responsive, friendly interactions (Dunn & Hughes, 2001). Reciprocal friendships at ages three and four were also strongly linked to positive peer behaviors such as sharing, helping, and encouragement (Coelho et al., 2017).

However, it is important to note that all of these studies are correlational and do not allow for the identification of causal relationships. The originality of our research lies in its attempt to provide preliminary evidence of causal effects, investigating whether collaborative play may contribute to the development of preschool friendships and moreover highlighting different variables that contribute to the development of friendship in early social interactions.

Effect of dyad sex composition (same-sex or cross-sex) on friendship

One important dimension of this interplay concerns the nature of same- and cross-sex friendships. As noted by Howes (1988), young children initially form both types of friendships, but over time tend to increasingly gravitate toward same-sex peers. In early toddlerhood (12–23 months), a significant proportion of children maintain cross-sex friendships, but these friendships become less frequent as children grow older. By late toddlerhood (2–3 years), the number of cross-sex friendships declines, and by the preschool years (4–6 years), same-sex friendships predominate. This shift is likely driven by a growing awareness of sex norms, as well as differences in play styles and socialization patterns. Importantly, children who maintain cross-sex friendships often exhibit greater social competence, suggesting that the dynamics of friendship may moderate fairness and sharing behaviors (Howes, 1988).

Influence of the 'lucky' child status on friendship perception

Previous research on children's collaboration and sharing has essentially relied on resource-allocation paradigms in which children are required to decide how to distribute rewards. These paradigms are often decontextualized, insofar as children are supervised by an experimenter and asked to make an individual decision about allocating resources to an absent social partner, a puppet, or to individuals who are present but unfamiliar to them (e.g., the experimenter), generally without having engaged in any prior joint activity involving shared effort with the sharing partner (e.g. Brownell et al., 2009; Shi et al., 2024). Among these, interactive collaboration tasks have played a central role to advancing our understanding of children's sharing by moving beyond individual decision-making and embedding sharing decisions within joint action. A particularly influential line of research is that of Warneken et al. (2011), who adapted collaborative problem-solving paradigms to investigate sharing in young children. Children coordinate their actions to obtain rewards, which are then distributed symmetrically, allowing researchers to examine sharing behavior following equitable joint effort. For instance, in their study, spatial manipulations such as clumped versus dispersed reward distributions were used to vary access to resources. In the clumped condition, all rewards are located in a single position, which may allow for more uneven access depending on children's actions and positioning. In contrast, the dispersed condition distributes rewards across two locations, promoting more equal access. Importantly, these manipulations primarily affect spatial constraints and coordination demands rather than introducing an explicit social inequality between partners.

More recently, Kim et al. (2023) introduced a distribution and sharing paradigm involving familiar preschooler dyads, in which children receive an initially unequal allocation of resources (e.g., 1 vs. 4 stickers), followed by an opportunity for free sharing. This paradigm represents an important advance by examining children's cognitive, emotional, and behavioral responses to inequality experienced within a real interaction with a familiar partner. However, in this design, the inequality is entirely imposed by the experimenter and made highly salient prior to the sharing phase (e.g., through explicit counting and repeated questions about fairness and emotions). As a result, sharing decisions occur after an explicit induction of normative reflection, which may influence observed behaviors. Moreover, children do not contribute to the acquisition of the resources, limiting the examination of sharing within a joint action context.

Beyond these paradigms, research has also begun to consider how inequality experiences may influence children's affective and relational evaluations of social partners. In particular, being in an advantaged ("lucky") position may not only affect sharing behavior but also shape how children perceive their relationship with their partner. It is possible that being in an advantaged position is associated with positive emotions, such as joy, which may strengthen social bonds (Arnett, 2023; Kim et al., 2023; Prosen & Smrtnik Vitulić, 2018; Sander, 2025). On the one hand, possessing more resources – even without sharing – may elicit positive emotions in young children, as preschoolers often judge norm violations as emotionally positive for the violator, who satisfies a selfish desire (Gummerum et al., 2016). Young children (under six) are particularly reluctant to share desirable items (Kogut, 2012), suggesting that extra resources may inherently generate positive emotions and encourage social engagement. On the other hand, not sharing may also evoke emotions such as guilt or empathic concern, potentially motivating reparative behavior and fostering relational closeness (Paulus & Moore, 2017; Scaffidi Abbate et al., 2022). Furthermore, sharing itself may generate positive emotions: children anticipate feeling happy when sharing (Paulus & Moore, 2017), and voluntary sharing is associated with increased happiness (Wu et al., 2017). Older children (8–10 years) even report greater satisfaction from giving than younger ones (Kogut, 2012). Taken together, being in a "lucky" position may influence perceived relationship quality, regardless of whether sharing occurs.

The present study

Building on this literature, the present study introduces a novel experimental paradigm, the cheese board game, designed to examine sharing behavior and friendship perceptions within a real-time collaborative context involving an unequal reward distribution. In contrast to Warneken et al. (2011), where resources are jointly obtained and typically distributed equally, and to Kim et al. (2023), where inequality is externally imposed and made salient prior to any decision, the present study introduces an experimentally induced asymmetry in resource allocation after a shared activity. Children encounter an unequal distribution (1 vs. 3 candies) with the child receiving three candies hereafter referred to as the "lucky child", within the interaction context and are given a minimal instruction, without any explicit induction of fairness norms or prior questioning. This allows for the observation of spontaneous sharing behavior, unprecedented by direct normative activation. The design therefore combines real-time peer interaction, discovery of inequality, and minimal decision constraints, providing an ecologically valid context for studying sharing. In addition, the present paradigm examines the social consequences of such inequality experiences, particularly from the perspective of the "lucky child". While prosocial behavior such as sharing benefits not only others but also the actor (Curry et al., 2018; Hui et al., 2020), less is known about how being in an advantaged position influences perceived relationship quality (i.e. friendship) following a collaborative activity.

Accordingly, the present study aimed to investigate how collaboration, sex, dyad sex composition, and friendship influence sharing behavior in children aged 4 to 6 years. Based on previous findings showing that joint action can promote fairness and prosociality (Hamann et al., 2011; Warneken et al., 2011), we predicted that children in the collaborative condition would be more likely to share than children in the parallel condition. In addition, based on prior literature suggesting higher prosocial tendencies among girls and within same-sex peer relationships (Fabes & Eisenberg, 1998; Birch & Billman, 1986; van Wingerden et al., 2024), we predicted that sharing would be more frequent among girls, within same-sex dyads, and when friendship ratings were higher. Regarding friendship ratings, our primary interest concerned changes in friendship perceptions from before to after the activity. Based on previous research linking shared play experiences and friendship quality (Beazidou & Botsoglou, 2024; Coelho et al., 2017), we predicted that friendship ratings would increase after the activity, particularly in the collaborative condition. We also expected overall higher friendship ratings

in same-sex dyads than in cross-sex dyads, consistent with prior developmental literature on peer preferences during early childhood (Howes, 1988). Finally, analyses involving the distinction between lucky and unlucky children were exploratory and intended to examine whether occupying different positions within the unequal reward distribution context was associated with changes in perceived friendship. By examining these factors, this study contributes to a deeper understanding of early childhood social development and the mechanisms that foster prosociality and interpersonal bonds.

Method

Participants

A total of 96 children (48 girls and 48 boys), aged between 4 and 6 years ($M = 5.1$ years, $SD = 0.7$), participated in this study. All participants were enrolled in public primary schools in Geneva (Switzerland). The sample included children from first grade ($N = 40$), second grade ($N = 52$), and mixed first- and second-grade classes ($N = 4$). The study received approval from the Ethics Committee of the University of Geneva and the Department of Public Instruction (DIP). Informed consent forms were distributed to all legal parents before the study commenced. No exclusion criteria were established, except for cases where parents declined video recording or data usage for research purposes. Data collection spanned from April 2022 to April 2023.

Materials

Cheese board game

This experimental task involved a wooden board ($100\text{ cm} \times 60\text{ cm}$) featuring 16 holes of varying sizes. A string mechanism allowed participants to navigate a ball towards the final hole, with the objective of guiding it successfully to the top without falling into other holes. The game, known as the “cheese board,” could be played individually, in which case a single child manipulated both strings simultaneously with both hands to guide the ball, or collaboratively, where two children each controlled one string. Successful completion in the real-time collaborative condition required coordination between participants, as both had to move their respective strings in a synchronized manner to guide the ball, and verbal communication was often used to coordinate actions.

Rewards

After completing the game, children were seated in front of a table where two inverted cups concealed rewards. These rewards consisted of organic, vegan candies. Teachers were consulted beforehand to ensure the absence of allergies. Each child was assigned a cup: the unlucky child received one candy, while the lucky child received three.

Friendship scale

A visual friendship assessment scale was administered before and after the game to evaluate changes in perceived friendship levels. The scale comprised five emoticons ranging from sadness to joy, color-coded from red (negative) to green (positive). The experimenter explained each level verbally, progressing from “not a friend at all” (=1) to “best friend” (=5).

Procedure

Participants were pseudo-randomly assigned to either cross-sex (boy/girl) or same-sex (boy/boy or girl/girl) dyads. This allocation was based on pre-existing school lists of students whose parents had provided consent. Dyads were then randomly assigned to one of two experimental conditions: parallel play or collaborative play (Table 1).

In the parallel play condition, each child played the cheese board game individually on separate boards. Each child manipulated both strings alone, using both hands to guide the ball through the holes to the final target. In the collaborative play condition, dyads worked together on a single board to complete the task collaboratively. Each child controlled one string, and successful completion required coordinated movements of both participants as well as communication to achieve the goal. All children were ensured to complete the game successfully. For those experiencing difficulty, the experimenter provided assistance as needed, so that all participants could finish the task successfully and leave the game “feeling satisfied.” The whole experiment was videotaped for subsequent analysis.

Upon arrival, one experimenter separately assessed the friendship level of each child in the dyad to prevent mutual influence. The

Table 1
Distribution of children across experimental parameters (dyad sex composition, sex, condition).

Dyad sex composition	Sex	Condition	
		Parallel	Collaboration
Same-sex	Girl/girl	6 dyads	6 dyads
	Boy/boy	6 dyads	6 dyads
Cross-sex	Girl/boy	6 dyads	6 dyads
	Boy/girl	6 dyads	6 dyads

Note: the capital letter represents the lucky children.

experimenters then provided standardized instructions for the game, corresponding to the assigned condition. After completing the game, the unlucky child was seated in front of the cup containing one candy, and the lucky child in front of the cup containing three candies. The two children sat face to face, allowing them to see both each other and the rewards placed directly in front of them. Before leaving the room, the experimenters informed the children that they could lift the cups to discover their rewards. No additional instruction was given regarding what they should do during the minute without adult supervision. The experimenters then briefly exited the room for one minute, allowing the children to decide independently whether to share their candies. Upon re-entering the room, they discreetly verified whether sharing had occurred; this observation was not made explicit to the children. Subsequently, they reassessed the friendship scale for each child individually. If no sharing had taken place, the experimenter with the unlucky child adjusted the reward distribution to ensure fairness after the friendship assessment.

Statistical analysis

To investigate how experimental condition and individual or dyadic characteristics predicted children's sharing behavior, a hierarchical binary logistic regression was conducted. This stepwise modeling approach was chosen to reflect theoretical assumptions about the relative importance of predictors: the experimental condition was entered first, based on prior evidence of its central role, followed by individual and relational characteristics (dyad sex composition, sex, and friendship level). The hierarchical approach allowed for testing the incremental predictive value of each block while controlling for previously entered variables. The outcome variable (sharing) was binary (yes = 1, no = 0), and predictors included both categorical and continuous variables. The analysis was initially designed as a three-step hierarchical logistic regression. Step 1 included the main effect of condition (collaboration vs. parallel play). Step 2 added dyad sex composition (same-sex vs. cross-sex), sex of the lucky child (girl vs. boy), and friendship level assessed by the lucky child. A third step including interaction terms between condition and the other predictors was initially planned for exploratory purposes. However, diagnostic checks indicated that the events-per-variable ratio ($EPV = 1.86$) for this model was insufficient to support reliable estimation. Although all models converged successfully in SPSS, with estimation stopping after four iterations when parameter changes fell below the .001 criterion and no convergence warnings issued, the interaction step nevertheless showed signs of instability, reflected in large standard errors and very wide confidence intervals. Consequently, the interaction model was not retained for interpretation, and inference focused on the first two steps including main effects only. Model diagnostics were conducted for the retained models. The events-per-variable ratio was 13.0 for Step 1 and 3.25 for Step 2. Variance inflation factors (VIFs), computed for all predictors in an auxiliary regression model, ranged from 1.003 to 1.190, indicating no evidence of problematic multicollinearity. The logistic regression was conducted using SPSS (version 29), with the enter method for each block. Friendship level was mean-centered prior to interaction term creation to reduce multicollinearity and ease interpretation. Model fit was assessed using likelihood ratio chi-square tests, and effect sizes were reported as odds ratios (Exp(B)) with 95 % confidence intervals.

In addition, to further explore the potential effects of individual and dyadic factors, complementary post-hoc analyses were performed. Chi-squared tests were specified to examine differences in sharing behavior between dyad sex compositions (same-sex vs. cross-sex) and between the sex of the lucky child (girl vs. boy). A Mann-Whitney *U* test was performed to compare friendship ratings between children who shared and those who did not. These post-hoc tests were included to provide a more fine-grained investigation of possible effects that might not be detected in the hierarchical regression due to limited cell sizes or low power.

We also aimed to compare the change in friendship levels before and after the game, depending on the condition, the dyad sex composition, and the sex of the child evaluating the friendship with their playmate. To verify the comparability of the experimental conditions prior to the main analyses, Mann-Whitney *U* tests were conducted on baseline friendship ratings, comparing the collaboration and parallel conditions separately for lucky and unlucky children. Two separate analyses were therefore conducted: one for the change in friendship ratings as reported by the lucky child, and another for the unlucky child. To this end, we performed mixed-design ANOVAs with the condition (collaboration vs. parallel play), the dyad sex composition (same-sex vs. cross-sex), and the sex of the child evaluating the friendship (girl vs. boy) as between-subjects factors, and the time of the friendship evaluation (before the game vs. after the game) as a within-subject factor. The primary research question concerned changes in friendship ratings over time, particularly whether these changes differed as a function of experimental condition. Accordingly, effects involving time were considered central to the hypotheses. Main effects of condition, sex, and dyad composition were nevertheless retained because these effects are estimated simultaneously within the ANOVA framework and were interpreted descriptively rather than as evidence of treatment-related change over time. Although friendship ratings were collected using a 5-point scale and are therefore ordinal in nature, they were treated as approximately continuous in the present analyses. This choice is consistent with methodological recommendations suggesting that individual rating items with five or more response categories can be analyzed using parametric methods (e.g. Harpe, 2015). To examine the robustness of this analytical choice, alternative models treating the outcome as ordinal were also explored. However, given the limited sample size, sparse data across factor combinations, and the resulting estimation instability (e.g., very large standard errors and non-interpretable parameter estimates), these models were not retained for interpretation. Therefore, the mixed-design ANOVA was used as a pragmatic and interpretable approach. Assumptions for the mixed-design ANOVAs were checked and were generally acceptable: residuals were approximately normally distributed, homogeneity of variance was mostly supported (with one exception showing a significant Levene's test for post-game ratings of the unlucky child, $p = .011$, though group sizes were balanced), and Box's *M* tests were non-significant. No influential outliers were detected, and cell sizes were balanced across conditions. As the within-subject factor had only two levels, the assumption of sphericity was inherently satisfied. To further assess the robustness of the findings, complementary non-parametric analyses were conducted. Wilcoxon signed-rank tests were used to examine pre-post changes in friendship ratings separately for lucky and unlucky children. In addition, Mann-Whitney *U* tests were conducted on change scores to examine whether these changes differed between experimental conditions.

In addition, to assess whether friendship ratings were mutual within dyads, Spearman correlation analyses were conducted between the friendship ratings of the two children in each dyad, both before and after the game.

Finally, to examine whether receiving resources influenced changes in friendship ratings, we computed a change score for each unlucky child by subtracting the pre-game friendship rating from the post-game rating. We then compared these change scores between unlucky children who received resources and those who did not receive resources using a Mann–Whitney *U* test. The significance threshold was set at $p < .05$.

Results

Sharing behavior

The results showed that thirty-five children did not share (72.9 %) compared to thirteen who shared (27.1 %). Importantly, sharing was only expected from the lucky children, who had received more resources and were thus in a position to compensate for the induced advantageous inequity. In addition, none of the unlucky children gave their single candy to the lucky child; all retained their own reward. Table 2 presents the percentage of children who shared rewards across dyad sex compositions, sex, and experimental conditions. In addition, a boxplot illustrating the relationship between friendship ratings and sharing behavior is presented in Fig. 1.

To investigate how experimental condition and individual or dyadic characteristics predicted children's sharing behavior, a hierarchical binary logistic regression was conducted (Table 3). Given the limited number of sharing events observed in the sample, analyses focused on models including main effects only. In the first step, the model including only condition did not significantly predict sharing behavior. The odds of sharing were slightly higher in the collaboration, but this effect was not statistically significant. Indeed, among those who shared their reward, six were in the parallel condition and seven were in the collaborative condition. In the second step, adding dyad sex composition, sex, and friendship level did not significantly improve the model. None of the predictors showed a significant main effect, and the explained variance remained minimal (*Nagelkerke* $R^2 = .01$). Overall, the logistic regression analyses did not yield significant predictors of sharing behavior.

To further explore potential effects of individual and dyadic factors, post-hoc analyses were conducted. Chi-squared tests revealed no significant differences in sharing between same-sex and cross-sex dyads, $\chi^2(1) = 0.105$, $p = .745$, nor between boys and girls, $\chi^2(1) = 0.022$, $p = .882$. Additionally, a Mann–Whitney *U* test indicated no significant difference in friendship ratings between children who shared ($M = 3.85$, $SD = 1.21$) and those who did not ($M = 3.80$, $SD = 1.28$), $U = 231.5$, $Z = 0.097$, $p = .922$. These complementary analyses converge with the regression results, suggesting that neither dyad sex composition, sex, nor friendship level was associated with sharing behavior in this sample.

Change in friendship levels before and after the game

Descriptive statistics for friendship ratings are presented in Table 4, and the results of the mixed-design ANOVAs are reported in Table 5.

Preliminary analyses were conducted to verify that friendship ratings before the activity did not differ systematically across experimental conditions. Mann–Whitney *U* tests revealed no significant baseline differences between the collaboration and parallel conditions for either lucky children ($U = 230.5$, $p = .214$) or unlucky children ($U = 286$, $p = .983$). These results support the assumption that the random assignment procedure did not produce systematic pre-existing differences between conditions.

For the lucky children, the ANOVA revealed a significant main effect of dyad sex composition. Specifically, lucky children in same-sex dyads rated their friendships with same-sex peers more positively ($M = 4.3$, $SD = 0.2$) than with cross-sex peers ($M = 3.6$, $SD = 0.2$). This effect was supported by a complementary Mann–Whitney *U* test conducted on average friendship ratings across time points ($U = 189$, $Z = -2.10$, $p = .036$). There was also a significant main effect of time, indicating that lucky children perceived their friendships more positively after the game ($M = 4.1$, $SD = 1.2$) compared to before the game ($M = 3.8$, $SD = 1.2$). A complementary Wilcoxon signed-rank test confirmed this increase ($Z = 1.97$, $p = .048$). Moreover, the ANOVA revealed a significant interaction between time and condition. Post hoc analyses indicated that this effect was driven by the collaboration condition. Lucky children in the collaboration group reported higher friendship ratings after the game (before: $M = 3.6$, $SD = 1.3$; after: $M = 4.2$, $SD = 1.2$; $p = .004$), whereas friendship ratings in the parallel play condition remained relatively stable over time (before: $M = 4$, $SD = 1.2$; after: $M = 4.1$, $SD = 1.2$;

Table 2

Percentage of children sharing rewards across experimental parameters (dyad sex composition, sex, condition; numbers in parentheses indicate the number of children).

Dyad sex composition	Sex	Condition		Total (N = 48)
		Parallel (N = 24)	Collaboration (N = 24)	
Same-sex (N = 24)	Girl/girl	0 % (0)	4.2 % (2)	12.5 % (6)
	Boy/boy	4.2 % (2)	4.2 % (2)	
Cross-sex (N = 24)	Girl/boy	4.2 % (2)	4.2 % (2)	14.6 % (7)
	Boy/girl	4.2 % (2)	2.1 % (1)	
Total (N = 48)		12.5 % (6)	14.6 % (7)	27.1 % (13)

Note: the capital letter represents the lucky children.

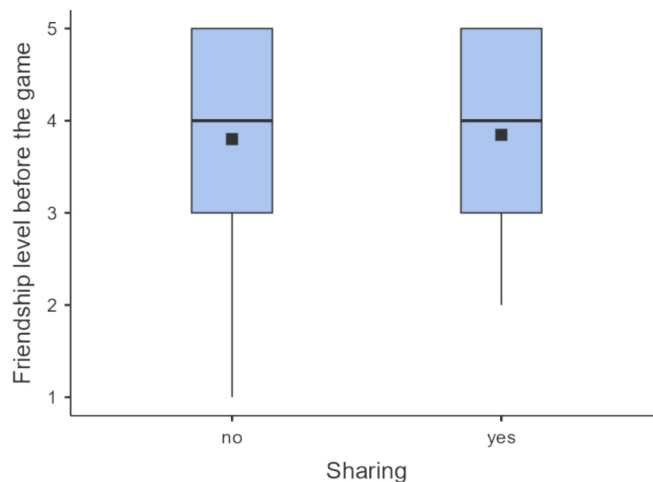


Fig. 1. Boxplots of Friendship ratings of the lucky child as a function of sharing behavior (shared: yes vs. did not share: no).

Table 3

Hierarchical logistic regression predicting sharing behavior.

Predictor	B	SE	Wald	p	Exp(B)	95 % CI for Exp(B)
Step 1						
Condition	0.21	0.65	0.11	.746	1.24	[0.35, 4.43]
Model $\chi^2(1) = 0.106, p = .745$						
Step 2						
Condition	0.26	0.67	0.15	.699	1.29	[0.35, 4.78]
Dyad Sex Composition	0.29	0.70	0.18	.673	1.34	[0.34, 5.27]
Sex	-0.11	0.65	0.03	.862	0.89	[0.25, 3.22]
Friendship	0.09	0.29	0.10	.754	1.09	[0.62, 1.92]
Model $\chi^2(4) = 0.341, p = .987$						

Table 4

Descriptive statistics of friendship ratings (means and standard deviations) provided by the lucky and unlucky children, by condition, dyad sex composition, and sex.

	Condition	Dyad sex composition	Sex	Lucky child M (SD)	Unlucky child M (SD)
Friendship level before the game	Parallel	Same-sex	boys	4.3 (1)	3.3 (1.3)
			girls	4.6 (0.5)	3.8 (0.8)
		Cross-sex	boys	3.7 (1.4)	3.2 (1.5)
			girls	3.7 (1.5)	3.5 (1)
	Collaboration	Same-sex	boys	4.2 (1.3)	3.5 (1.5)
			girls	4 (0.9)	4.2 (1.2)
		Cross-sex	boys	3.2 (1.2)	3.7 (1.2)
			girls	3 (1.7)	2.7 (1.2)
Friendship level after the game	Parallel	Same-sex	boys	4.9 (0.4)	3.7 (1.5)
			girls	3.8 (1.3)	3.8 (0.4)
		Cross-sex	boys	4 (1.3)	3 (1.4)
			girls	3.5 (1.4)	4.2 (1)
	Collaboration	Same-sex	boys	4.7 (0.8)	3.8 (1.8)
			girls	4.2 (1.2)	4.2 (1.2)
		Cross-sex	boys	3.7 (1.4)	4.7 (0.5)
			girls	4.2 (1.6)	3.2 (1.7)

$p = .937$). However, a complementary Mann–Whitney U test based on change scores (post–pre) did not reach significance ($U = 357.5$, $Z = 1.61$, $p = .107$), suggesting that this condition-specific effect should be interpreted cautiously. These results are illustrated in Fig. 2. No other main effects or interactions reached significance.

A similar ANOVA was conducted for the unlucky children. The analysis revealed a significant main effect of time, indicating that unlucky children also rated their friendships more positively after the game ($M = 3.8$, $SD = 1.3$) compared to before the game ($M = 3.4$,

Table 5

Mixed-design ANOVA results examining effects of condition, dyad sex composition, sex, and time on friendship ratings for lucky and unlucky children.

	Lucky children			Unlucky children		
	F	p	η_p^2	F	p	η_p^2
Time	4.348	.043*	.098	5.740	.021*	.125
Condition	0.279	.600	.007	0.117	.733	.003
Dyad Sex Composition	4.818	.034*	.107	1.113	.298	.027
Sex	0.367	.548	.009	0.001	.970	.000
Condition x Dyad Sex Composition	0.012	.912	.000	0.221	.641	0.006
Condition x Sex	0.122	.728	.003	2.446	.126	.058
Dyad Sex Composition x Sex	0.228	.635	.006	1.398	.244	.034
Time x Condition	4.834	.034*	.108	1.064	.308	.026
Time x Dyad Sex Composition	1.640	.208	.039	1.629	.209	.039
Time x Sex	1.993	.166	.047	0.002	.958	.000

Note. Significant effects ($p < .05$) are indicated in bold and marked with an asterisk (*).

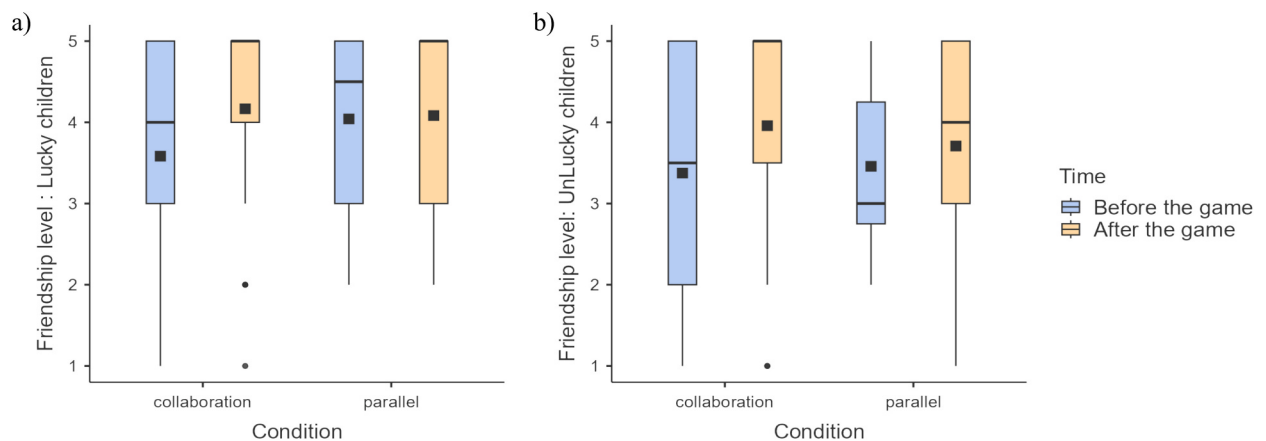


Fig. 2. Boxplots of friendship ratings before and after the game by condition: a) of the lucky children, b) of the unlucky children.

$SD = 1.3$). A complementary Wilcoxon signed-rank test confirmed this increase ($Z = 2.29$, $p = .022$). No other main effects or interactions were significant.

Correlational analyses indicated that friendship perceptions within dyads showed weak associations. Before the game, the association between lucky and unlucky children's ratings was weak and non-significant ($\rho = .192$, $p = .192$). After the game, the association increased and reached statistical significance, although it remained modest ($\rho = .299$, $p = .039$), suggesting a slight alignment in friendship ratings after the game, but no strong mutual perception overall.

Finally, a Mann–Whitney U test was conducted to examine whether receiving resources influenced changes in friendship ratings among unlucky children. The results showed no significant difference between children who received resources and those who did not ($U = 270.50$, $z = 1.08$, $p = .279$). This indicates that receiving resources from a peer did not significantly affect the change in perceived friendship after the game.

Discussion

The present study aimed to examine how collaboration, sex, dyad sex composition, and friendship influence sharing behavior in young children, as well as how these factors may affect changes in perceived friendship. We hypothesized that collaboration would promote sharing, and that sharing would be more frequent among girls, within same-sex dyads, and at higher levels of friendship. Regarding friendship ratings, we predicted that friendship perceptions would increase after the activity, particularly in the collaborative condition. Finally, analyses involving the distinction between lucky and unlucky children were exploratory and aimed to examine whether occupying different positions within the unequal reward distribution context might be associated with changes in perceived friendship.

Sharing behavior was relatively rare in the present study, with only 13 of 48 children sharing their reward with their playmate. Contrary to our initial hypotheses, the results of the present study did not reveal a significant effect of collaboration, sex, or friendship level on children's sharing behavior. While these findings should be interpreted in light of the study's sample size, they suggest that collaborative contexts may not systematically promote sharing behavior under the conditions of the present paradigm. Similarly, the absence of sex differences and the lack of association between friendship and sharing suggest that these factors may not strongly

influence sharing tendencies in this context. These findings highlight the importance of considering contextual, developmental, and methodological factors when interpreting children's prosocial behavior, and point to the need for further research to better understand the conditions under which sharing emerges in early childhood.

One possible explanation for the discrepancy between our results and prior studies concerns methodological differences, particularly the visibility and positioning of the reward. This methodological distinction may be particularly relevant in light of evidence that young children's sharing behavior is closely tied to their emerging understanding of ownership. During the second year of life, toddlers begin to distinguish what belongs to themselves versus others, but this understanding remains fragile and context-dependent (Blake & Harris, 2009; Pesowski et al., 2022). In our study, the reward was not incorporated into the collaborative task and remained hidden during the interaction. Consequently, children had no visual access to the resources while collaborating, and thus no clear sense of initial ownership or inequality. As Brownell et al. (2013) showed, 18-month-olds share mainly when guided by clear communicative cues, whereas 24-month-olds share more spontaneously once they better grasp personal versus shared possession. Similarly, Pesowski et al. (2019) found that even 2- and 3-year-olds respect others' ownership when cues are clear, but this sensitivity weakens when ownership is ambiguous. In our study, the use of individualized cups may have reinforced a perception of personal entitlement over the rewards, which could have discouraged sharing. In contrast, previous studies by Hamann et al. (2011) and Warneken et al. (2011) presented the rewards visibly from the start, making the stakes of distribution explicit. Shared visual access to resources may therefore foster a sense of joint ownership, encouraging equitable sharing, an effect that may not have been elicited in our setup. Supporting this view, Kanngiesser et al. (2019) showed that children in diverse societies generally respect ownership when the owner is present, and a proportion even do so when the owner is absent, although the strength of this respect varies across cultures. Thus, the limited sharing observed here may stem less from reduced prosocial motivation than from a context that did not activate representations of shared ownership.

Another important factor relates to the developmental stage of the participants and the educational context of the study. While Hamann et al. (2011) and Warneken et al. (2011) tested younger children (around 3 years old) in daycare settings, our participants were older (4 to 6 years old, mean age 5) and tested in a formal school environment. This difference may have influenced children's interpretation of the task and their social expectations. School-aged children are generally more sensitive to institutional rules and adult authority. The combination of individualized cups and the presence of experimenters during the collaborative task might have conveyed implicit ownership norms—that the item given by an adult to a child belongs exclusively to them and should not be shared. Thus, the limited sharing observed in the two conditions could reflect adherence to classroom norms or adult expectations rather than reduced prosocial tendencies. By contrast, younger children in more flexible daycare contexts might be less constrained by such norms and more likely to interpret collaboration as implying shared ownership. These considerations indicate that the effect of collaboration on sharing is sensitive to contextual and methodological variables, suggesting that generalizing this effect across different ages and settings remains tentative. As mentioned earlier in the introduction, various variables – such as the type of measurement used, the presence or absence of an interaction partner, whether the child is in a group or in a dyadic setting, and whether the situation occurs in an ecological context or an experimental laboratory – influence the child's prosocial behavior (Berndt, 1981; Fabes & Eisenberg, 1998; Horn et al., 2024; House et al., 2023; Lenz & Paulus, 2021; Messer et al., 2017; Paulus et al., 2020; van Wingerden et al., 2024). Our results also suggest that while schools do aim to promote prosocial behavior, including sharing, it may be important to remain attentive to implicit norms or contextual cues that could unintentionally discourage such behavior, and to ensure that sharing is consistently supported within pedagogical practices.

Secondly, the results also yielded several noteworthy insights regarding the effect of the experimental setting on the degree of friendship. Indeed, friendship ratings were higher after the activity among all children, in both conditions. This result does not align with studies that have highlighted a positive association between collaborative activity (i.e., play) and friendship (Beazidou & Botoglou, 2024; Coelho et al., 2017; Dunn & Hughes, 2001). It suggests that simply being placed in the presence of a peer during a shared activity (i.e. doing the same play) may be associated with more positive evaluations of peer relationships. Notably, this effect was observed whether the activity was carried out collaboratively or in parallel. It appears that sharing a common play experience, even without direct interaction, may contribute to the reinforcement of social ties. Play is known to elicit positive affect and enjoyment (Prosen & Smrtnik Vitulić, 2018), and these positive emotional experiences may in turn support more favorable evaluations of peer relationships (Arnett, 2023). To further examine alternative explanations, we investigated the role of resource distribution during the task. Analyses focusing on the resource manipulation indicate that among unlucky children, changes in friendship ratings did not differ depending on whether they received resources or not. This finding suggests that the observed increase in friendship does not appear to be primarily explained by the act of sharing or receiving resources, but is more likely attributable to the shared activity context itself. This interpretation is further supported by the correlational analyses. Although friendship ratings were not strongly associated within dyads prior to the activity, a weak but significant positive correlation emerged afterward. This pattern reinforces the overall increase in friendship ratings, suggesting not only higher perceived closeness following the activity, but also a slight convergence in children's evaluations of their relationship within dyads. However, this alignment remained modest, indicating that the shared experience did not lead to strongly mutually consistent perceptions.

One possible mechanism underlying these effects may lie in process of social observation and implicit coordination. Even in the parallel condition, merely engaging in the same play as a peer likely elicited processes of intentional or unintentional observation (i.e. using social gaze to emotionally check the peer's reactions). This may include imitation of how the same objects were used (fostering a shared understanding of their function; Neal et al., 2025) or of the peer's emotional reactions (e.g., enthusiasm; Gruber et al., 2022). Such shared engagement, even in a parallel form, may contribute to establishing a social connection between children through the performance of the same activity. Imitation, as established in prior research, serves important social functions in early development (Over, 2020). Children are more likely to engage in high-fidelity imitation when motivated by a desire to affiliate with others, here

realizing the same activity together or in parallel. Moreover, being imitated has been shown to elicit positive affective and social responses in young children. These social functions of imitation may contribute to the strengthening of peer bonds, even in non-collaborative (parallel) play situations. However, further research is needed to more precisely identify the mechanisms underlying this observed effect. Specifically, it remains to be tested whether the enhancement in friendship is due to the similarity of the activity being performed, or merely to the co-presence of two children in the same physical space. Future experimental designs could address this by including conditions in which children are engaged in different tasks (e.g., pretend play vs mathematics exercises) while remaining in proximity. This would allow for a more fine-grained understanding of the respective roles of task similarity and co-presence in the development of peer relationships.

After having examined effects that were common to both lucky and unlucky children separately, we next consider patterns that emerged specifically within the lucky children analyses. Although lucky children in the collaboration condition showed higher friendship ratings after the activity, this pattern was not robust across analytic approaches and was not confirmed by complementary non-parametric analyses. In addition, friendship ratings in the parallel condition were already relatively high before the activity. These findings should therefore be interpreted cautiously. Tentatively, this pattern may suggest that collaborative contexts could amplify the positive effect of shared experiences, insofar as collaboration may enhance the social meaning of the interaction when it is experienced from a position of relative advantage. However, given the inconsistency of this effect across analytical approaches, this interpretation remains speculative and requires further empirical confirmation before any firm conclusions can be drawn.

Finally, a main effect of dyad sex composition was observed in the analyses conducted for lucky children, with higher friendship ratings in same-sex dyads compared to cross-sex dyads, regardless of time. This finding is consistent with prior research highlighting the predominance of same-sex friendships in early childhood, particularly between the ages of 4 and 6 (Howes, 1988). Importantly, however, this effect reflects a stable difference between same-sex and cross-sex dyads and does not reflect a differential increase in friendship ratings over time. No significant effect of dyad sex composition emerged in the analyses conducted for unlucky children. This absence of effect should nevertheless be interpreted cautiously, as the study may have lacked sufficient statistical power to detect effects consistently across analyses.

It is important to acknowledge several statistical limitations that warrant caution in the interpretation of the present findings. Across both sets of analyses, the relatively small sample size and sparse data in some conditions constrained the complexity of the statistical models that could be reliably estimated. Complementary non-parametric analyses converged with the logistic regression results in showing no reliable associations between sharing behavior and the predictors under study, supporting the robustness of the null findings for main effects. A similar pattern emerged for friendship ratings. Mixed-design ANOVAs were used as the primary analytical approach, given their interpretability in factorial designs and their common use with Likert-type scales, while acknowledging the ordinal nature of the outcome. To assess the robustness of these results, complementary non-parametric tests were conducted, which generally converged with the ANOVA findings for the main effects of time and dyad sex composition. In contrast, interaction effects appeared less stable across analytical approaches, with some effects emerging in the ANOVA but not being consistently supported by non-parametric tests. In addition, exploratory ordinal mixed models were tested but proved unstable due to sparse cell counts and limited sample size, yielding non-interpretable or unreliable estimates. Taken together, this convergence across analytical approaches provides more confidence in the interpretation of main effects, whereas interaction effects should be considered more tentative and sensitive to modelling choices.

Overall, our findings suggest that the effect of collaboration on sharing may be less general than previously assumed and highly dependent on socio-contextual factors such as task design (Fabes & Eisenberg, 1998; Hallers-Haalboom et al., 2023; Lenz & Paulus, 2021; Messer et al., 2017) and perceived ownership (Blake & Harris, 2009; Kanngiesser et al., 2019; Pesowski et al., 2019; Pesowski et al., 2022). Collaboration does not automatically foster prosocial behavior; its impact appears task-sensitive and shaped by how children interpret the situation. In contrast, the time children spent together during the activity was associated with more positive perceptions of friendship, suggesting that shared engagement in a common experience may contribute to the development of affiliative feelings in early childhood. This underscores the value of designing educational environments that integrate emotionally positive and socially collaborative experiences to support the development of peer relationships in early childhood.

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CRedit authorship contribution statement

Fleur Lejeune: Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Sylvie Richard:** Writing – review & editing, Writing – original draft, Methodology, Conceptualization. **Edouard Gentaz:** Writing – review & editing, Writing – original draft, Methodology, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Data availability

Data will be made available on request.

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