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The influence of dominance and communication on resource allocation in preschool children

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AI statement:

This thesis employed *DeepWrite* solely for linguistic refinement. The tool had no influence on the scientific content, methodology, analyses, or interpretation of findings. No other generative artificial intelligence tools were used at any stage of this research.

1 Abstract

Acquiring and controlling resources is central to social dominance and shapes preschool children's social relationships. While both dominance and communication influence resource allocation, the interplay between these factors—particularly the impact of verbal and non-verbal cues within the context of dominance—remains understudied.

This Master's thesis examines how recipients' verbal and non-verbal communication affect prosocial resource allocation in preschoolers, and whether these effects are modulated by individual differences in social dominance.

Following an initial warm-up, 78 children aged three to six from Viennese kindergartens took part in the test phase. Social dominance was assessed via two resource monopolizations and teacher questionnaires. In a structured resource allocation experiment, pairs of familiar peers took turns to act as either donor or recipient. Resource distributions either benefitted the recipient or not and varied in cost for the donor and/or inequity. All communicative acts were video-recorded and coded for further analysis.

Recipients who communicated more frequently, particularly verbally, received more resources overall, with the strongest effect in the condition that resulted in equitable resource distributions without cost for the donor. However, trial by trial analyses revealed that neither the total number of the recipient's verbal utterances nor their demands, analysed specifically apart from the overall verbal output, directly influenced donor choices in a given trial. Both donors and recipients communicated more verbally than non-verbally. Dominance increased recipients' verbal communication, but not their non-verbal communication. Donor dominance had no effect on communication frequency, and there was no systematic relationship between dominance and specific communicative strategies.

Overall, verbal communicative activity by recipients promoted prosocial resource allocation in preschoolers, but communicative behaviour was shaped more strongly by interactional role (donor vs. recipient) than by social dominance. These findings underscore the context-sensitivity of prosocial behaviour in early childhood and highlight that the interaction between prosociality, social dominance, and communicative patterns is a domain worth conducting deeper research on.

Der Erwerb und die Kontrolle von Ressourcen sind zentrale Faktoren sozialer Dominanz und prägen die sozialen Beziehungen von Kindergartenkindern maßgeblich. Während sowohl Dominanz als auch Kommunikation die Verteilung von Ressourcen beeinflussen, ist das Zusammenspiel dieser beiden Faktoren – insbesondere der Einfluss verbaler und nonverbaler Signale im Kontext sozialer Dominanz – bislang wenig untersucht.

Meine Masterarbeit geht der Frage nach, wie die verbale und nonverbale Kommunikation der Empfänger die prosoziale Ressourcenverteilung unter Kindergartenkindern beeinflusst und inwieweit diese Effekte durch individuelle Unterschiede in sozialer Dominanz moduliert werden.

Nach einer Aufwärmphase nahmen 78 Kinder im Alter von drei bis sechs Jahren aus Wiener Kindergärten an der Testphase teil. Die soziale Dominanz wurde anhand von zwei Ressourcenmonopolisierungen sowie mittels Fragebögen der Betreuerinnen erfasst. In einem strukturierten Experiment zur Ressourcenverteilung agierten Paare bekannter Gleichaltriger abwechselnd als Geber oder Empfänger. Die Verteilung konnte dem Empfänger zugutekommen oder nicht und variierte hinsichtlich der Kosten für den Geber und/oder des Maßes an Ungleichheit. Sämtliche Kommunikationsakte wurden videografiert und anschließend kodiert.

Empfänger, die häufiger kommunizierten – insbesondere verbal –, erhielten insgesamt mehr Ressourcen. Der stärkste Effekt zeigte sich in der Bedingung, die eine gerechte Verteilung ohne Kosten für den Geber ermöglichte. Eine Analyse einzelner Durchgänge ergab jedoch, dass weder die Gesamtzahl der verbalen Äußerungen eines Empfängers noch dessen Forderungen (separat von der Gesamtzahl der Äußerungen betrachtet) die Entscheidungen des Gebers unmittelbar beeinflussten. Sowohl Geber als auch Empfänger kommunizierten insgesamt häufiger verbal als nonverbal. Soziale Dominanz erhöhte die verbale, nicht jedoch die nonverbale Kommunikationshäufigkeit der Empfänger. Die Dominanz der Geber hatte keinen Einfluss auf die Kommunikationsintensität, und es zeigte sich kein systematischer Zusammenhang zwischen Dominanz und spezifischen Kommunikationsstrategien.

Insgesamt begünstigte die verbale Kommunikationsaktivität der Empfänger die prosoziale Ressourcenverteilung unter Kindergartenkindern. Das Kommunikationsverhalten wurde jedoch stärker durch die jeweilige Interaktionsrolle (Geber vs. Empfänger) als durch die soziale Dominanz geprägt. Diese Ergebnisse unterstreichen die Kontextsensitivität prosozialen Verhaltens in der frühen Kindheit und verdeutlichen, dass das Zusammenspiel von Prosozialität, sozialer Dominanz und Kommunikationsmustern ein vielversprechendes Feld für weiterführende Forschung darstellt.

2 Introduction

The ability to acquire and maintain control over valuable resources—commonly referred to as social dominance—is a fundamental aspect of social life, shaping both individual fitness and the structure of social relationships within a group (Hawley, 1999; Pellegrini et al., 2007; Hawley & Geldhof, 2012). While competition for resources is a defining feature of group living, opportunities for cooperation frequently arise within the same social environments, enabling individuals to achieve mutually beneficial outcomes that would be unattainable alone (Brosnan et al., 2010; Gokcekus et al., 2021; Grueneisen & Tomasello, 2022).

Cooperation, defined as working together towards a common goal, fosters the exchange of skills and knowledge, that is fundamental to forming lasting social networks (Moll & Tomasello, 2007; Duguid et al., 2020). Humans especially excel in cooperation, frequently engaging even with non-relatives and strangers in ways that surpass other primates in complexity and sophistication (Moll & Tomasello, 2007; Bowles & Gintis, 2011). The capacity and proficiency for cooperation often depends on the ability to recognise shared goals and to navigate the interpersonal processes required to achieve them (Tomasello et al., 2012). Here, effective communication—both verbal and non-verbal—serves as a key mechanism for influencing social interactions, facilitating cooperation, and securing access to resources (Black & Hazen, 1990; Tomasello et al., 2012).

Communication not only enables the expression of desires and intentions but also transmits social norms and expectations regarding fairness and equity (Fehr & Schurtenberger, 2018; House et al., 2019). Successful communication increases the likelihood of achieving desired outcomes in social exchanges and can de-escalate potential conflicts, preserve relationships and strengthen alliances (Tomasello, 2008; Black & Hazen, 1990). Developing communicative competence is therefore a critical component of social and cognitive growth in human ontogeny, enabling children to navigate increasingly complex group dynamics with greater flexibility (Tomasello, 2008).

Recent research suggests that dominant children are not only more effective at acquiring resources but also tend to use more assertive communication styles when interacting with their peers (Sebanc et al., 2003). Resource control strategies for asserting social dominance can be broadly categorized as coercive (e.g. aggression, direct assertion) or prosocial (e.g. sharing, alliance formation); individuals may employ a flexible mix of both, which is known as bi-strategic control (Hawley, 2002; Choi et al., 2011).

However, the relationship between social dominance, communication modality (verbal vs. non-verbal), and prosocial outcomes remains underexplored. The present thesis addresses this gap

by examining how preschoolers' verbal and non-verbal cues during a resource allocation game affect prosocial choice—and how these effects are shaped by individual differences in social dominance. I tested whether more dominant children employed different communicative strategies than their less dominant peers—and whether these strategies translated into greater influence over resource distribution.

2.1 The Role of Communication in Early Social Development

Communication encompasses the exchange of information, intentions, and emotions between individuals to influence behaviour and coordinate activities (Bearison et al., 2001; Green & Rechis, 2006). In Humans this process operates through two primary modalities: verbal communication (spoken language, vocalizations) and non-verbal communication (gestures, facial expressions, body posture, eye contact) (Black & Hazen, 1990; Tomasello, 2008). Verbal channels, which enable the explicit expression of desires, solutions, and resource claims develop later in human ontogeny (Tomasello, 2008). Non-verbal cues can serve as complete communicative acts in their own right or they can complement and substitute for spoken language, conveying attitudes and intentions that may be difficult to express verbally (Tomasello, 2008). Examples include pointing to indicate interest or ownership, and gaze-following to signal attention or cooperative intent (Tomasello, 2008). This multimodal foundation proves especially critical in resource-limited contexts, where negotiation, persuasion, and cooperation determine allocation outcomes (Green & Rechis, 2006). The integration of verbal and non-verbal elements enriches communication effectiveness and facilitates mutual understanding, even when language development is incomplete (Tomasello, 2008).

During the preschool years (ages 3–6), children's communicative abilities develop rapidly, supporting increasingly complex social interactions and strategic behaviour (Grueneisen & Warneken, 2022; Moll & Tomasello, 2007; Phillips & Shonkoff, 2000). This period is marked by the emergence of theory of mind, reputation management, and the internalization of social norms (Hill & Pillow, 2006; Jensen et al., 2014). By this stage, children produce increasingly complex verbal utterances and develop the pragmatic skills necessary to adapt their communication to different contexts and interlocutors (Black & Hazen, 1990). Preschoolers use language to request, negotiate, persuade and justify actions, often relying on both verbal and non-verbal cues to achieve their social goals (Grueneisen & Warneken, 2022). These communicative competencies are crucial in situations involving competition for or cooperation over resources. In such situations, children must balance self-interest with social expectations and relational considerations (Grueneisen & Warneken, 2022). This balancing act necessitates

the sharing of information, the negotiation of roles, and the planning of collective actions — processes that, in turn, foster the development of advanced cognitive abilities (Moll & Tomasello, 2007). Engaging in such social coordination specifically influences the growth of theory of mind, symbolic reasoning, and language production, enabling children to apply these skills in increasingly creative and flexible ways (Moll & Tomasello, 2007). The Vygotskian intelligence hypothesis contextualises this development within an evolutionary framework, proposing that human cognitive advancement is deeply rooted in our capacity for cooperation and the social application of cognitive skills (Moll & Tomasello, 2007). Central to this hypothesis is the concept of shared intentionality — the ability to align goals, intentions and mental states with others — which represents a key step towards collaborative problem solving and more complex cooperative behaviours (Moll & Tomasello, 2007).

2.2 Cooperation and Prosocial Behaviour in Childhood

The capacity for cooperation emerges early in human development. Infants already coordinate their actions toward shared goals and display an emerging understanding of joint intentions, resource sharing, and role negotiation within group contexts (Brownell, Ramani & Zerwas, 2006; Warneken et al., 2006; Warneken & Tomasello, 2007). The strategies that individuals use in their cooperative interactions are strongly shaped by both cognitive development and accumulated social experience throughout ontogeny (Hartup, 1983; Moll & Tomasello, 2007; Warneken & Tomasello, 2009). Crucially, effective cooperation requires children to recognize opportunities for collaboration, represent and infer individual goals, and form joint intentions with a partner (Warneken & Rosati, 2012). Basic cooperative activities were observed as early as 14 months, when infants engaged in instrumental helping—such as retrieving out-of-reach objects or providing information through pointing—initially with adults and later with peers (Eckerman & Perterman, 2004; Warneken & Tomasello, 2007). By preschool age, typically between 3 and 5 years of age, children begin to exhibit more structured cooperative behaviours and increasingly embedded in complex social interactions (Phillips & Shonkoff, 2000).

Cooperation can take a variety of forms, differing in the balance of benefits and costs for the partners involved (Gokcekus et al., 2021). One such form is prosocial behaviour, which in evolutionary biology is defined as voluntary actions that benefit another individual while incurring little or no cost to the actor (Marshall-Pescini et al., 2016). Svetlova, Nichols and Brownell (2010) distinguish between empathic prosocial behaviour, which involves recognising and responding to others' emotional states (e.g. comforting distressed individuals), and empathic helping, which requires emotional understanding as well as the ability to infer appropriate ameliorative actions. While empathic prosocial responses reliably emerge by 24

months, empathic helping — such as bringing a blanket to someone who is cold — proved significantly more challenging for 18-month-olds (Svetlova, Nichols & Brownell, 2010). This often required adults to explicitly communicate specific needs (Svetlova, Nichols & Brownell, 2010). This progression reveals a hierarchical development: from early instrumental helping based on action understanding, through empathic prosocial responses grounded in emotional recognition, to sophisticated empathic helping that integrates emotional comprehension with contextually appropriate interventions (Grueneisen & Warneken, 2022; Moll & Tomasello, 2007). As children grow, their prosocial behaviour becomes increasingly complex and selective, paralleling their advancements in cognitive and social abilities (Grueneisen & Warneken, 2022). By around the age of five, they begin to employ prosocial actions more strategically, actively participating in collaborative activities, choosing their social partners with greater discernment, and demonstrating improved ability to infer others' thoughts and emotions (Grueneisen & Warneken, 2022). The strategic and more self-motivated use of prosociality offers the opportunity to form collaborative relationships and networks while simultaneously pursuing self-promoting goals (Grueneisen & Warneken, 2022). Children aged 5 to 6 become more aware of how they are perceived by others and actively shape their social image. They also begin to plan further ahead, strategically fostering positive perceptions to increase the likelihood of receiving favours in future interactions (Grueneisen & Warneken, 2022).

Prosocial acts themselves can serve as a means of communication, signalling positive intentions and fostering and regulating social relationships (Guinote et al., 2015). By engaging in them, individuals—whether intentionally or not—can influence how they are perceived by observers and potential cooperation partners. This, in turn, shapes their reputation and impacts future collaborative decisions. Moreover, prosociality and enhanced reputation can help mitigate social threats, which can be particularly beneficial for individuals of lower status, as it allows them to improve their standing, gain support, and strengthen coalition formation (Guinote et al., 2015).

2.3 Social Norms and Prosocial Decisions

Building on this, children's cooperative and prosocial strategies do not develop in a social vacuum but are increasingly shaped by norms and moral expectations, which structure interactions, regulate behaviour, and guide decision-making (Grüneisen & Tomasello, 2022). These norms act as implicit or explicit guidelines, teaching children how to behave appropriately within their social environment (Grüneisen & Tomasello, 2022). In dyadic

decision-making contexts, such as resource control experiments, children's choices gradually come to resemble those of adults (House et al., 2013).

Moral constructs form a core component of what is often referred to as moral development, which encompasses the roles of cognition, behaviour, and emotion in decision-making processes (Eisenberg, Fabes, & Spinrad, 2006; Hawley & Geldhof, 2012). However, as Hawley & Geldhof (2012) highlight, the presence of moral knowledge does not always translate into moral behaviour, especially in emotionally or socially complex contexts. Still research shows, also in practical experimental settings, that around the age of 3-4 years, children begin to demonstrate internalised rule-compliant behaviour, responding to social norms even in the absence of external enforcement (Kochanska, Aksan, & Koenig, 1995). Blake and McAuliffe (2011) add further information on this age group regarding equity concern. Disadvantageous inequity aversion refers to children rejecting offers where they receive less than a peer, while advantageous inequity aversion describes the rejection of offers where they would benefit more than others, for the sake of fairness (Blake & McAuliffe, 2011). Young children, even as young as 4 or 5 years old, often reject offers that leave them with less than a peer, likely driven by a self-protective bias against being exploited, shaped by evolutionary pressures (Blake & McAuliffe, 2011).

Older children become more attuned to normative information, adapting their sharing behaviour to the cultural norms of their environment (Chen Zeng, Cheng & Henrich, 2022; Grüneisen & Warneken, 2022). Harbaugh et al. (2003) found that children's preference for fairness increases steadily from around age 7 through adolescence, up to 18 years of age. The rejection of advantageous inequity – so giving up a better deal for the sake of fairness – also tends to emerge later, around age 8, than the previously mentioned disadvantageous inequity aversion (Blake & McAuliffe, 2011). At this stage, children begin to articulate fairness as a guiding principle in their decisions, even at a personal cost (Blake & McAuliffe, 2011). Comments such as "I wanted it to be fair" in Blake and McAuliffe's (2011) study reflect an internalised social norm of fairness that applies not only to oneself but also to others.

Moreover, this shift towards fairness reasoning often coincides with the development of reputation awareness (Blake & McAuliffe, 2011). Around the age of 6-8 years, children begin to consider how their actions affect how others perceive them (Hill & Pillow, 2006). In public settings, such as the inequity game, older children may refuse advantageous offers in order to signal fairness to observers, even if they would accept such offers in private (Blake & McAuliffe, 2011). However, reputational concerns alone do not fully explain children's responses - particularly their early rejection of disadvantageous offers (Blake & McAuliffe,

2011). The later emerging rejections of advantageous inequity reflect a more generalised and principled understanding of fairness, shaped by both cognitive maturation and social experience (Blake & McAuliffe, 2011).

2.4 Social Dominance in Childhood

Beyond shaping social relationships, prosociality plays a key role in resource acquisition (Hawley, 1999). Hawley (1999) considers prosociality within the theoretical framework of resource control theory. The latter views human behaviour as an evolutionary strategy that has evolved to compete for limited resources within the social group (Hawley, 2014). The ability to control resources through either coercive or prosocial behaviour is referred to as social dominance (Hawley, 2002). Dominance interactions have been argued to be distinct from social status or hierarchical rank within the group or from general aggression, which occur independently of direct competition over resources (Pellegrini, 2008). These phenomena are embedded in broader group dynamics and social networks, reflecting a hierarchy that is more complex than single or repeated dyadic encounters over resource control (Pellegrini, 2008). Interactions where social dominance is at play still influence the social relationship of the interaction parties as they do take place within the social environment (Hawley, 2002). The effectiveness and social acceptability of different dominance strategies, however, varies considerably across developmental stages and cultural contexts (Charafeddine et al., 2016; Henrich, Heine & Norenzayan, 2010).

Social dominance emerges early in development, becoming evident in toddlers and significantly influencing dyadic contest outcomes (Pellegrini, 2008). During these early years, children demonstrate remarkable tolerance for coercive and aggressive behaviours until approximately age six, creating a developmental window where such strategies carry fewer social penalties (Hawley, 1999). The superior ability of dominant children to control resources establishes them as valuable social partners, conferring significant advantages in peer perception and social positioning (Hawley, 1999). This generates a cascade of social benefits: preschoolers demonstrate preferential affiliation with dominant peers, actively seeking to imitate and learn from them while rating them as more likeable than less dominant counterparts (Hawley, 1999; Roseth et al., 2007). Crucially, social dominance correlates strongly with perceived competence, positioning dominant children as knowledgeable role models within peer groups (Hawley, 1999).

The relationship between dominance strategies and social outcomes becomes more nuanced with age (Hawley, 2014). While purely coercive approaches may potentially damage social status in certain contexts, strategic application—particularly when combined with prosocial

skills—can enhance social influence and peer acceptance (Hawley, 2014). This bi-strategic control approach, integrating both coercive and prosocial elements, proves increasingly sophisticated as children navigate complex social dynamics into adolescence and adulthood (Hawley, 2014). Empirical evidence reveals that coercive dominance is not consistently linked to peer disliking, contrary to common assumptions (Hawley & Bower, 2018). Studies with American adolescents (Hawley, Little, & Card, 2007) and preschoolers (Hawley & Geldhof, 2012) found no strong correlation between coercive behaviour and peer rejection. Remarkably, German preschool samples demonstrated positive associations between coercive dominance and peer liking, highlighting how cultural contexts shape strategy perception and acceptance (Hawley, 2002; Roseth et al., 2011). These findings suggest that dominance strategy effectiveness depends on developmental timing, cultural norms, and strategic sophistication rather than strategy type alone, warranting further cross-cultural investigation (Hawley & Bower, 2018).

2.5 The Current Study

The current body of research emphasises the importance of considering both verbal and non-verbal communication when analysing resource allocation experiments, highlighting that statements about fairness and equality can have a significant impact on negotiation dynamics. Communication in resource allocation serves multiple functions. First, it acts as a tool for coordinating the actions of individuals competing or cooperating over limited resources. Clear communication reduces misunderstandings and conflicts by allowing participants to negotiate roles, take turns, and agree on fair shares (Green & Rechis, 2006; Grueneisen & Tomasello, 2022). Second, communication plays a normative role by transmitting social rules and expectations regarding fairness, equity, and cooperation that guide behaviour within groups (Grueneisen & Tomasello, 2022). Normative statements—such as “that’s not fair” or “we should share”—help regulate behaviour and reinforce social norms (Grueneisen & Tomasello, 2022).

This Master’s thesis aimed to answer the following questions: How do a recipient’s verbal and non-verbal communication cues influence a donor’s prosocial behaviour? And does children’s communication depend on the social dominance of the participants? Throughout the conducted resource allocation game, children were allowed to communicate freely, allowing for the observation of both verbal and non-verbal cues.

I formulated the following hypotheses and predictions:

H1a): The more recipients communicate, the more stickers they end up receiving.

H1b): Trial by trial, recipient communication for a particular box will lead to an increased probability that the donor will choose the communicated box in this trial.

H1c): Dominance interacts with the effects in H1b in that more dominant recipients are better able to influence the donor's choices than less dominant recipients.

H2): More dominant individuals - both donors and recipients - will communicate more verbally and non-verbally than less dominant individuals.

H3): More dominant individuals - both donors and recipients - will use more demand statements and protest statements than less dominant individuals. Less dominant individuals - both donors and recipients - will use more verbal normative statements than more dominant individuals.

3 Methods

The methods used in this Master's thesis focused on two main aspects: 1) Assessing social dominance within dyadic relationships and 2) Analysing decision-making and communication during a resource allocation experiment. Data were collected using several approaches: two resource monopolizations to assess social dominance; a questionnaire on social dominance completed by at least one pedagogical staff member from each kindergarten group; and a structured resource allocation experiment, during which both verbal and non-verbal communication were recorded and analysed. Before the test phase, the children completed a warm-up designed to familiarize them with the resource allocation experiment and to assess their understanding of the setup, which they had to pass in order to proceed.

3.1 Participants

A total of 100 children aged three to six years were recruited from four kindergartens, operated by Kinderfreunde Wien, between October 2023 and September 2024. The sample included 55 girls ($M_{\text{age}} = 57.15$ months, $SD_{\text{age}} = 11.56$) and 45 boys ($M_{\text{age}} = 60.96$ months, $SD_{\text{age}} = 11.91$), giving an overall mean age of 58.86 months ($SD = 11.81$) — approximately five years.

The legal guardians of all participating children gave their written informed consent. All procedures were carried out in accordance with the Declaration of Helsinki and had been approved by the ethics committee of the University of Vienna (Ref. No. 00992) and the respective childcare institutions.

3.2 Experimental setup

Two female experimenters conducted all tests and the warm-up. One experimenter actively led the session by explaining the tasks, guiding the procedures, and interacting with the children. The second experimenter took on an observational role; recording the children's decisions

during the warm-up, resource monopolizations and the resource allocation experiment. The active experimenter's instructions during the experiment were loosely standardized to ensure that all children received a consistent explanation of the experimental setup and procedure.

The warm-ups, the resource monopolizations and the resource allocation experiment all took place in a separated room within the respective kindergarten and were video recorded using two cameras. Both cameras included audio capture to document verbal interactions during the resource allocation experiment.

The apparatus (see Figure 1) for the resource allocation experiment was placed on a table, and additional barriers were arranged as needed to ensure that donors could not physically reach the recipient's side. It was composed of two wooden boxes, each measuring 84 cm by 20 cm, mounted side-by-side on a wooden base (100 × 80 cm). Transparent Plexiglas lids covered the tops of the boxes, allowing children to view but not directly access the rewards—colourful stickers—inside.



Figure 1 Apparatus for the resource allocation experiment (e.g. prosocial condition).

In front of each box, on the donor's side, was a slot for inserting a green plastic coin (see Figure 2). When a coin was inserted, a hidden mechanism—controlled remotely by the observing experimenter—lifted the lid of the corresponding box, granting access to the stickers inside. The mechanical system was concealed within an opaque central unit that also physically separated the donor and recipient compartments. During each trial, the donor received one coin and could choose to open only one box. Prior to the decision, the experimenter clearly displayed the stickers assigned to each box and also clearly explained the distributions verbally, placing them visibly in the compartments, always starting with the right box. The apparatus was placed on a

table, and additional barriers were arranged as needed to ensure that donors could not physically reach the recipient's side.

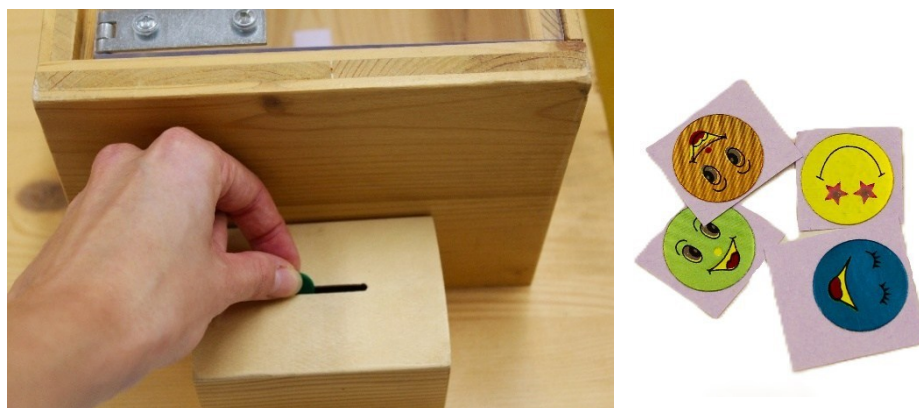


Figure 2 Examples of coin insertion and used stickers.

3.3 Warm-up

During the warm-up phase, the barrier between the two sides was removed, allowing the child to collect stickers from both compartments of the selected box.

The Warm-up consisted of 18 trials separated into an explanation phase (2 trials), a knowledge probe (10 trials) and a familiarization phase (6 trials).

Prior to the explanation trials, children were informed that the boxes could be opened using a coin and were instructed to open each side of the box once to observe the effect of inserting the coin. During the two explanation trials, the children were familiarized with the concept of unequal rewards in the two the boxes. One box contained 3 stickers on the donor side and none on the recipient side (3/0), whereas the other box contained 1 sticker on the donor side and none on the recipient side (1/0).

Following this explanation phase, they could freely choose which side of the box to open. The 10 trials of the knowledge probe comprised various distributions of stickers that were placed systematically on the donor and/or the recipient side. One choice always resulted in more stickers for the participant (e.g (1/1) vs. (1/0)). The child had to consider the stickers on both the donor and the recipient side to make the correct choice.

The familiarization phase incorporated the same sticker distributions that were used later in the test phase—prosocial, costly, and envy configurations (two trials each). However, unlike in the test phase, children in the familiarization phase were allowed to access both sides of the selected box, ensuring they understood the reward structure without the constraint of one-sided access. Children were required to reach a minimum accuracy threshold in the knowledge probe in order to proceed to the test phase. Performance was evaluated across 10 trials: a full pass was awarded for 9 or 10 correct responses, reflecting performance significantly above chance level; a

qualified pass was given for 6 to 8 correct responses, indicating success in more than half of the trials; and a fail was assigned for 5 or fewer correct responses, corresponding to success in only half or fewer of the trials. In total, 78 out of the 100 children participated in the test phase ($n = 78$): 50 achieved a full pass (0–1 errors in the warm-up) and 28 a qualified pass (2–4 errors). However, 22 children did not meet this criterion—having chosen the less profitable option five times or more—and were therefore excluded from the subsequent testing phase.

Of the 100 children (55 female, 45 male) tested in the warm-up phase, 11 of 55 females (20.0 %) and 11 of 45 males (24.4%) failed. There was no significant association between sex and failure rates, as determined by Pearson's chi-squared test ($\chi^2(1) = 0.085, p = 0.771$). Females made an average of 1.96 errors ($Mdn = 1.0, SD = 2.12$), while males made 2.38 errors ($Mdn = 2.0, SD = 2.27$). As the data were not normally distributed, the difference in error counts between females and males was tested using a Mann-Whitney U-test. The result was not statistically significant ($W = 1121, n(f/m) = 55/45, p = 0.409$).

Children aged 3–4 years made significantly more errors in the warm-up ($M = 2.83, Mdn = 2.0, SD = 2.29$) than those aged 5 years and older ($M = 1.38, Mdn = 1, SD = 1.79$; Mann-Whitney U test: $W = 775, n(old/young) = 47/53, p < 0.001$). Consistently age was negatively correlated with warm-up errors (Spearman's $\rho = -0.40, p < 0.001$), indicating that younger children made more mistakes and were less likely to pass the warm-up phase.

The children that passed the warm-up were paired into dyads of two, always with familiar partners from the same kindergarten group or from the same combined group during the summer break. A total of 44 dyads were formed; however, 11 of these were unable to complete a role reversal due to children leaving the kindergarten during the data collection period, or due to imbalanced group sizes within the respective kindergarten group. A total of 77 sessions were conducted, each comprising two resource monopolizations—one before and one after the recourse allocation experiment—as well as the resource allocation experiment itself.

3.4 Resource Monopolization

The first resource monopolization, based on Grueneisen and Tomasello's (2022) dominance test, measured dominance by first access and duration of access of a desired toy. In this study, either a kaleidoscope or a handheld water ring toss game (see Figure 1) was used as the contested item, with the order of presentation counterbalanced across participants.



Figure 3 Toys used in Monopolization 1.

First, the active experimenter showed the children the toy and demonstrated how to use it briefly. She then placed it on the ground between the two children and gave them three minutes (180 s) to play with it, after which she took it back.

After the resource allocation experiment, the children participated in a second monopolization: the crayon task (Staub & Sherk, 1970). The active experimenter gave each child the same colouring picture (either a sun or an apple, which were counterbalanced). She then placed one functional and one non-functional crayon in the centre between the children and gave them permission to colour in for three minutes (180 s). Once again, the first child to access the functional crayon and the duration of their access were measured.

The second experimenter recorded which child accessed the toy or functional crayon first. The duration of access for each child was later determined through video analysis in BORIS (v. 8.21.8, 5 October 2023). In both resource monopolisations, the first child to access the crayon (Child 1 or Child 2) and the duration of their access could have been used as measures of dominance.

3.5 Resource Allocation Experiment

The arrangement of rewards was balanced across trials to prevent side biases.

Each session consisted of 18 consecutive trials, split equally among three reward distribution conditions: a prosocial distribution (1/1 vs. 1/0), a costly sharing distribution (1/1 vs. 2/0), and an envy distribution (1/2 vs. 1/1). After the first session, children swapped roles, with donors becoming recipients and vice versa. To reduce the impact of learning, dyads that were tested twice (in Sessions 1 and 2) were given a minimum of five days between each session.

The verbal and non-verbal cues, during the resource allocation experiment were separately recorded for each child (donor and recipient), for each trial, in relation to their categories. All were coded and analysed in Solomon Coder (version beta 19.08.02). Non-verbal

communication was defined as gestures signalling a desired choice (pointing, putting the hand on the desired box, etc.) or a clear change of position towards a specific box.

Verbal cues were systematically categorized into distinct types of statements for both donors and recipients (see Table 1 and for examples Table 14 in the appendix). Each cue was additionally coded for its directionality, i.e., whether it was addressed to the experimenter, the donor, or the recipient. Additionally, it was noted whether a gesture or statement referred to the speaker's profitable or nonprofitable box — that is, the box containing more stickers for the individual in question — or if their communicative behaviour was not directed towards a specific box, in which case it was coded as neutral. Statements in which children expressed a demand or preference for a specific distribution, protested a previously stated choice, or made normative statements referencing fairness or equity concerns were categorized in accordance with the scheme used by Grueneisen and Tomasello (2022). Based on observations during the warm-up phase—where children frequently made predictions about upcoming distributions, compared their received stickers with those of others, or commented on the alternative box—prediction and comparison statements were also established as major categories in the analysis of verbal behaviour. Off-topic utterances, unrelated to the resource allocation task, were likewise included, as they already appeared frequently in the warm-up sessions.

In addition, Laugh was introduced as a separate statement type, following findings by House et al. (2012), who showed that children were more likely to share in prosocial games when trials in which donors laughed during their choice were excluded. Deference was also added as a category, capturing instances in which a child independently offered a profitable choice to the other participant or volunteered to give away one of their own stickers. Whenever an utterance could not be clearly assigned to any predefined category, was unrelated to the experimental context, or was inaudible in the audio recordings, it was coded accordingly.

During data collection, an unanticipated behaviour was observed: children occasionally engaged in external agreements, meaning they redistributed stickers outside the parameters of the resource allocation task and thereby altered the originally proposed distribution. These agreements were coded post hoc as an additional category, even though they were not strictly verbal, to capture all instances in which children modified the allocation after a compartment of the box was opened. Any verbal statements made immediately before or after such agreements—i.e., when children chose to redistribute stickers—were also coded and analysed separately to capture the context and motivation for these actions.

All verbal and non-verbal categories were quantified as frequencies, reflecting how often each type of statement or behaviour occurred.

Table1
Categories of verbal communication

Donor	Recipient
Demand (profitable/nonprofitable/neutral)	
Protest (profitable/nonprofitable/neutral)	
Prediction (profitable/nonprofitable/neutral)	
Normative (profitable/nonprofitable/neutral)	
Comparison (profitable/nonprofitable/neutral)	
Laugh	
Nontopic	
Deference	
Nonaudible	
Nonassignable	
	Extortion
External Agreement	

3.6 Teacher Questionnaire

At least one teacher in each kindergarten group rated each child's dominance using a questionnaire, both for dominance as a trait and dyadic compared to each child in the group. The questionnaire comprised two sections. In the first, teachers evaluated whether the target child would be able to assert themselves in a hypothetical conflict over a desirable toy, specifically whether the child would ultimately succeed in obtaining it. This judgment was made for every possible dyadic combination with the other participating children of the same kindergarten group (e.g., “Would Child 1 prevail against Child 2?”), with response options of “Yes,” “No,” or “Cannot say.”

The second section addressed trait ratings. Teachers evaluated four statements—“assertive,” “dominant,” “stands up for themselves,” and “tells others what to do”—using continuous visual analogue scales (VAS), adopting the items used by Pellegrini et al. (2007). Each response was indicated by placing a mark along the line between the two anchors (“Does not apply at all” to

“Applies very much”). The position of the mark was measured in millimetres and then expressed in relation to the total line length, yielding quasi-metric trait scores. The questionnaire was part of a larger study, but the corresponding data were not analysed for this Master's thesis. Therefore, the results of the questionnaire are not reported here.

3.7 Statistical Analyses

All statistical analyses were conducted in R (Version 4.2.2) and the significance level was set at $p \leq 0.05$.

To assess social dominance in the resource monopolizations, the consistency of first access to the resource across sessions and monopolizations was evaluated using exact binomial tests, comparing the observed proportion of “same child” cases to the expected chance level of 50%. Confidence intervals (95%) were calculated for all proportions.

Within each monopolization, the relationship between first access and duration of access was analysed using Wilcoxon tests, comparing the duration of access between the child who accessed the toy first and the other child.

To quantify individual differences in resource access, Delta values of Monopolization 1 were calculated for each dyad, and the correlation of Delta values between Session 1 and Session 2 was assessed using Spearman's rank correlation coefficient.

To compare the likelihood of making a profitable decision across the three experimental conditions (prosocial, envy and costly), a Cochran's Q test for related samples was performed. For each dyad and session, the outcome was coded as binary (1 = at least one profitable decision in the condition; 0 = none). The test was performed using the `cochran.qtest` function from the `RVAideMemoire` package in R, for all dyads and their respective sessions.

When the overall test was significant, pairwise McNemar tests (prosocial vs. envy; prosocial vs. costly; and envy vs. costly) were conducted, with Holm correction applied for multiple comparisons.

Dyad 32, Session 2 was excluded from further analysis due to a camera malfunction causing missing communication data.

The following statement types were summed across trials, separately for donors and recipients, for the analysis of communication behaviours: Choice, Protest, Prediction, Normative, Comparison, Laugh, Nontopic and Deference. Normality was assessed using Shapiro–Wilk tests, but none of the variables met the assumption (all $p < .05$). Therefore, non-parametric Wilcoxon tests were used to compare (a) the frequency of communicative acts between donors and recipients, (b) profitable versus nonprofitable utterances within each role, (c) gesture

frequency between donors and recipients, and (d) gestures directed at profitable versus nonprofitable boxes.

To test hypothesis H1a, Spearman rank correlation coefficients were calculated to assess the association between recipients' overall communication frequency and their sticker gain. Recipient verbal communication was quantified as total verbal utterances (including Demand (profitable), Protest (profitable), Prediction (profitable), Normative, Comparison, Laugh, Nontopic and Deference, Nonaudible, Nonassignable, Extortion), excluding Laughter. Recipient proficiency was measured as profitable sticker allocations received overall and within each condition (prosocial, costly, envy).

The influence of recipient communication on donor choice was analysed trial by trial (H1b). Chi-squared tests of independence with Yates' continuity correction were used to examine the association between recipients' profitable demands and donor decisions, as well as between recipients' total verbal utterances (again including Demand (profitable), Protest (profitable), Prediction (profitable), Normative, Comparison, Laugh, Nontopic, Deference, Nonaudible, Nonassignable and Extortion) and donor decisions.

To address H1c, the relationship between Delta Recipient (from Monopolization 1, Session 1) and recipients' success rate—calculated as the proportion of Demands followed by a profitable donor decision (profitable decisions after Demands / total Demands $\times$ 100)—was examined using Spearman rank correlation.

To examine the relationship between social dominance and the frequency of communication (H2), both verbal and nonverbal communicative acts were analysed separately for donors and recipients. For each participant, the total number of verbal utterances (excluding laughter) and gestures was extracted and transformed into long format, resulting in two observations per individual (one for verbal, one for gesture).

Generalized estimating equations (GEE) with a Poisson family were used to model the count data, accounting for repeated measures within dyads. The main predictors were dominance (Delta Donor or Delta Recipient of Monopolization 1 Session 1) and communication type (verbal or gesture), including their interaction. This approach allowed to test whether dominance was associated with overall communication frequency, whether this association differed by communication modality, and whether there was a general quantitative difference between verbal and nonverbal communication. All analyses were conducted in R using the geepack package. Model fit was assessed using Wald statistics, and significance was set at $p < 0.05$.

Associations between individual dominance scores and the frequency of Demand, Protest, and Normative statements for both donors and recipients (H3) were examined using Spearman rank correlations.

Finally, because some children redistributed stickers outside the parameters of the resource allocation experiment ($n = 10$), a post-hoc exploratory analysis was conducted. All verbal statements before and after these external agreements, in which children chose to redistribute stickers after a box compartment was opened, were analysed separately. This analysis examined whether recipients' communication influenced redistribution and whether specific communicative patterns emerged. To test for symmetry in the distribution of statements before and after the agreements, a Bowker test was applied. Additionally, a McNemar test assessed whether the distribution of speaker roles (donor vs. recipient) changed significantly within dyads, allowing conclusions about which child may have influenced or initiated the agreement.

4 Results

A total of 77 sessions were conducted with 44 dyads, categorized as either male, female, or mixed sex, and as old (both children aged 5–6 years), young (both aged 3–4 years), or mixed age (one younger and one older child) (see Figure 4). Although sex and age were intended to be counterbalanced, this was not achieved. Chi-squared tests confirmed significant deviations from an even distribution across age groups ($\chi^2 = 36.09$, $df = 4$, $p < 0.001$) and sex groups ($\chi^2 = 29.93$, $df = 4$, $p < 0.001$). As slightly more female children participated, they were overrepresented in the test phase (38.96% of sessions; see Fig. 4). Conversely, younger children were underrepresented (20.78% of sessions; see Fig. 4), as more of them failed the warm-up.

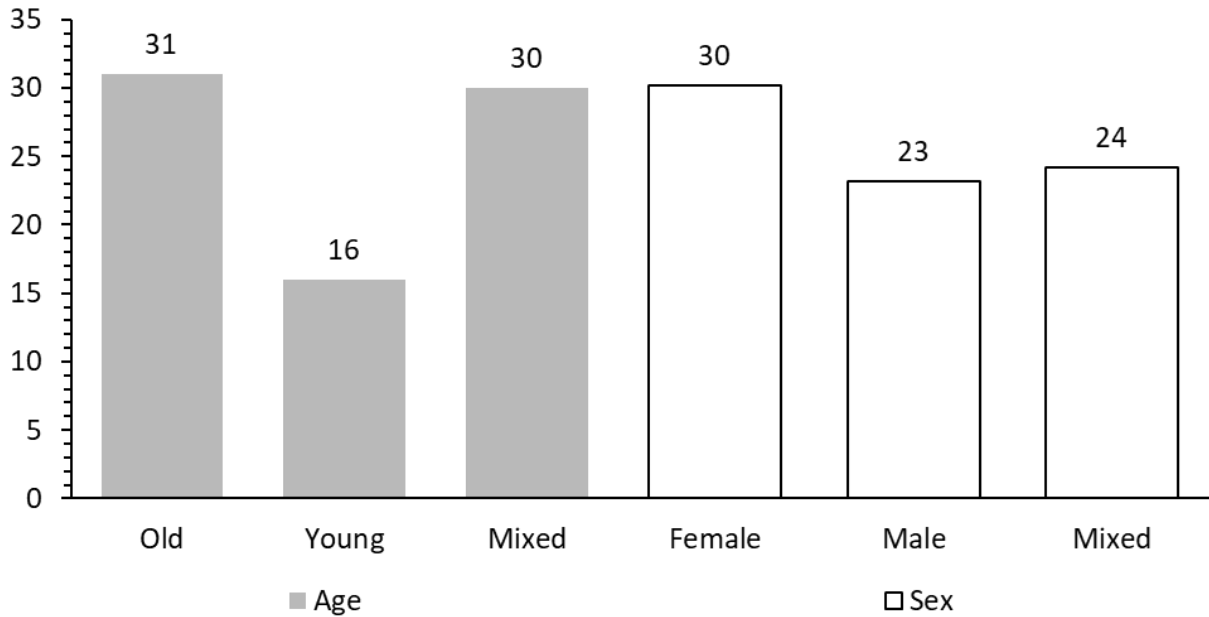


Figure 4 Description of age and sex distribution within test sessions ($n = 77$).

4.1 Social Dominance in the Resource Monopolization

Consistency of first access across the two resource competition tasks and the two sessions was examined by assessing whether the same child obtained the toy and the pencil first (see Table 2). In neither of the two sessions was the first access consistently attained by the same child across the two resource competition tasks (Session 1: $p = 0.880$, 95 % confidence interval [0.32, 0.63]; Session 2: $p = 0.728$, 95 % CI [0.36, 0.72]).

Table 2

Comparison of first access between Monopolization 1 (Toy) and Monopolization 2 (Pencil) within Session 1 and Session 2

	First Access Monopolization 1 vs. Monopolization 2	
	Session 1	Session 2
Same child	21 (47.77 %)	18 (54.55 %)
Different child	23 (52.27 %)	15 (45.45 %)

When comparing first access in Monopolization 1 across sessions, the same child had first access to the toy in 19 out of 32 cases in Session 1 and Session 2 ($p = 0.377$, 95 % CI [0.41, 0.76]). Overall, there were only 3 out of 32 cases (9.38 %) in which the same child had first access in all four monopolizations. Consequently, first access does not appear to be a reliable indicator of stable dominance differences between the children.

Within Monopolization 1, first access was related to the duration of access: In both Session 1 ($V = 567$, $n = 39$, $p = 0.014$; Fig. 5) and Session 2 ($V = 386$, $n = 31$, $p = 0.008$; Fig. 6) the child who had first accessed the toy retained it for a significantly longer duration.

In contrast, Monopolization 2 showed no significant association in either Session 1 ($V = 388$, $n = 38$, $p = 0.805$; Fig. 15 in appendix) or Session 2 ($V = 260$, $n = 28$, $p = 0.198$; Fig. 16 in appendix) (Additional Figures to compare First access and duration of access between Sessions are presented in the appendix; Figures 13&14). These results suggest that social dominance measures from Monopolization 1 are more suitable than those from Monopolization 2; therefore, the following analyses focus on Monopolization 1.

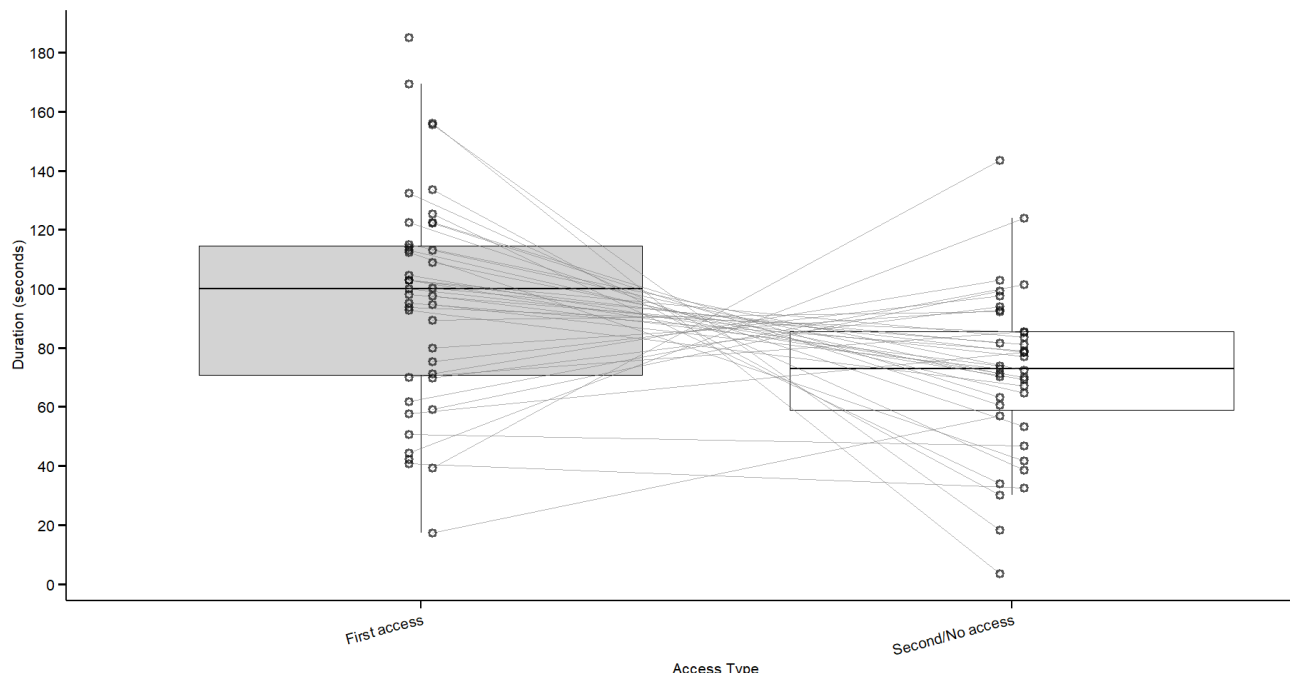


Figure 5 Comparison of access type and access duration in Monopolization 1, Session 1. Each circle represents a child; lines connect children belonging to the same dyad.

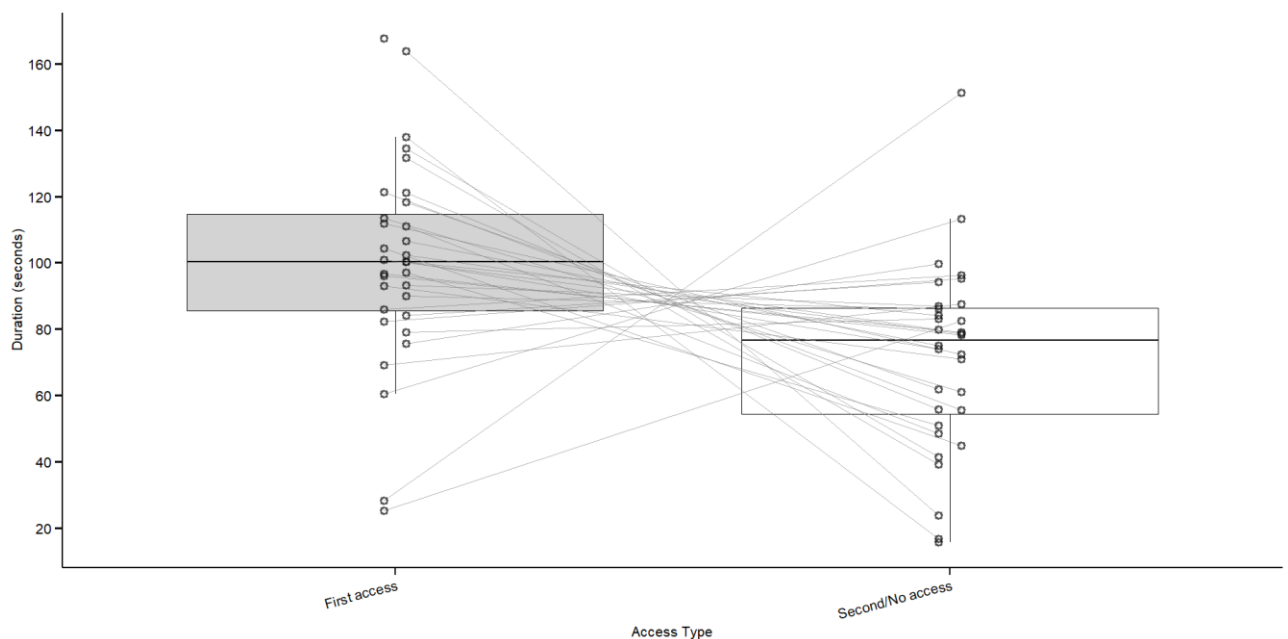


Figure 6 Comparison of access type and access duration in Monopolization 1, Session 2. Each circle represents a child; lines connect children belonging to the same dyad.

Examining the duration of access in the two children within a dyad reveals that there is a large variation in how long each of the children had access to the object (see Figure 7). In some cases, one child had predominant access to the object, whereas in others both children shared access for similar amounts of time.

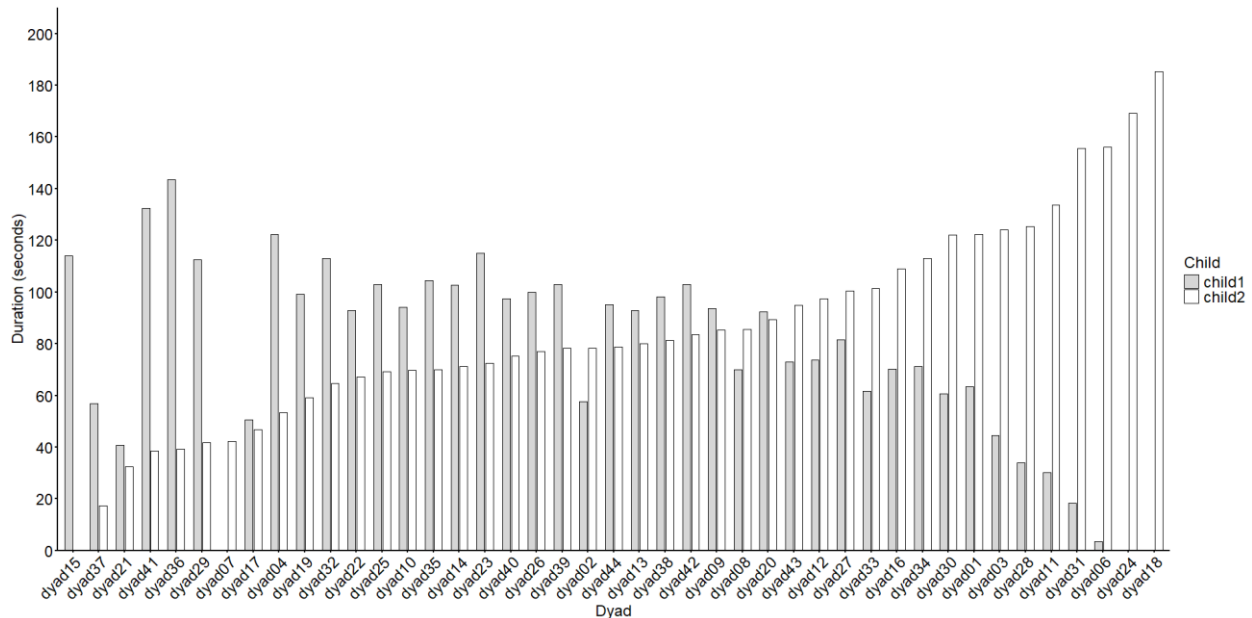


Figure 7 Duration of access in Monopolization 1, Session 1. Grey bars indicate the possession duration of Child 1, and white bars that of Child 2. Bars are sorted in ascending order according to the possession duration of Child 2.

Accordingly, I calculated the Delta value of Monopolization 1, as a continuous measure capturing more nuanced information on social dominance. Supported by the positive relationship between first access and duration of access in Monopolization 1, I concluded that this Delta value provides the most suitable indicator of social dominance (see Table 13 in the appendix). Comparison of the Delta values in Monopolization 1 between Session 1 and Session 2 showed a significant positive relationship ($r = 0.4$, $p = 0.032$; see Fig. 8).

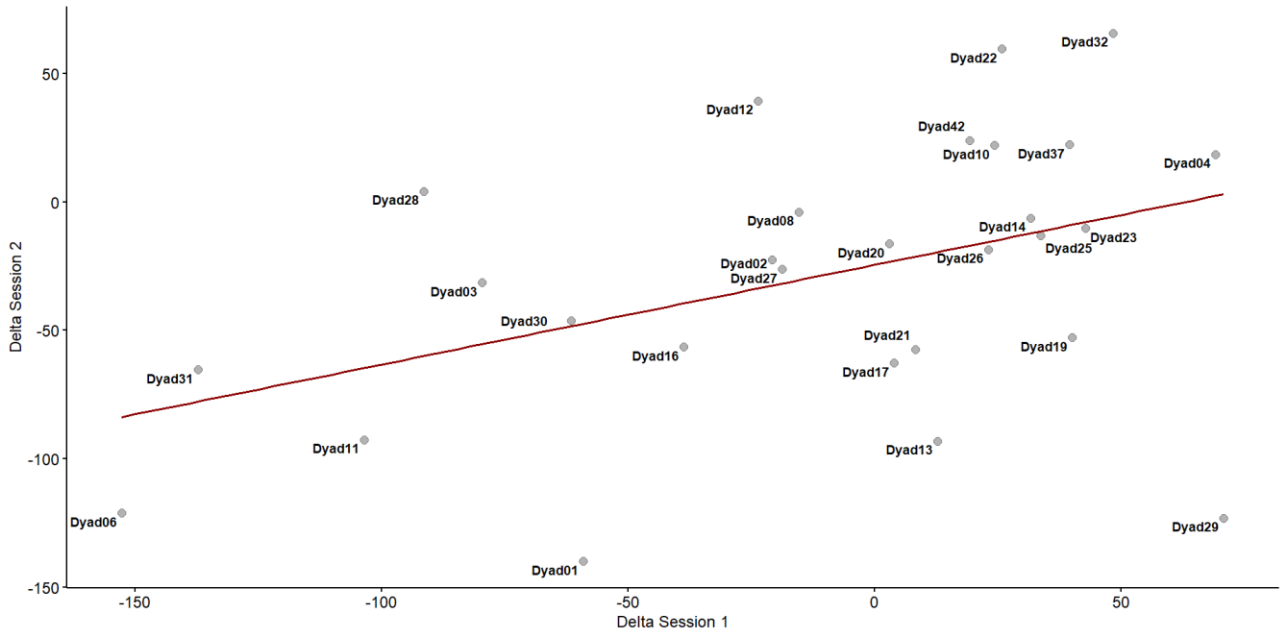


Figure 8 Scatterplot of Delta values for Session 1 and Delta values for Session 2 in Monopolization 1. Each dot represents a dyad. The red line indicates the statistical relationship between the two variables.

4.2 Choices in the Resource Allocation Experiment

Table 3 shows the donors' choices of distributions in the resource allocation experiment that were profitable for the recipient, across the three conditions (prosocial, envy, and costly). It also shows whether the donors chose an equal distribution or an unequal one.

Table 3

Share of profitable decisions for the recipient in each condition

	Condition		
	Prosocial	Costly	Envy
Profitable decision	207 (31,94 %)	141 (21,76 %)	133 (20,52 %)
Equal distribution (1/1)	207 (31, 94 %)	141 (21, 76 %)	515 (79,48 %)

Cochran's Q test revealed a significant difference in the probability of making a profitable decision (for the recipient) across conditions ($Q(2, n = 76) = 9.69, p = 0.008$). Estimated probabilities were 0.84 in the prosocial, 0.68 in the envy, and 0.64 in the costly condition. Post-hoc McNemar tests with Holm correction indicated that the probability was significantly higher in the prosocial condition than in the envy ($p = 0.011$) and costly ($p = 0.050$) conditions, with no significant difference between envy and costly ($p = 0.719$).

4.3 Descriptive Analysis of Children's Communication

All data on non-verbal communication are presented in Table 4. Recipients used significantly more gestures, than donors ($V = 250.5, n = 76, p < 0.001$), and their gestures were more often

directed toward the more profitable box than the less profitable one ($V = 908, n = 76, p < 0.010$). By contrast, donors' gestures were not significantly more often directed toward their own profitable box ($V = 383, n = 76, p = 0.139$).

Table 4

Type of gestures summed across all participants, displayed for donors and recipients, respectively

	Gestures	
	Donor	Recipient
Profitable	83	264
Non profitable	71	115
Neutral	2	4
Sum	156	383

The total number of communicative statement types is presented in Table 5 below. Recipients made significantly more protest statements than donors ($V = 21.5, n = 76, p < 0.001$). Donors laughed significantly more than recipients ($V = 292.5, n = 76, p < 0.001$) and used more deference statements ($V = 122.5, n = 76, p < 0.010$). Recipient demands ($V = 562, n = 76, p < 0.001$) and protests ($V = 373.5, n = 76, p < 0.001$) were significantly more often directed to the box containing the profitable distribution than to the box containing the nonprofitable distribution. Furthermore, the recipients predicted significantly more often that the donor would choose a self-serving distribution in the next trial(s) than a distribution that would be profitable for the recipient ($V = 7.5, n = 76, p = 0.011$).

Furthermore, donors showed a significantly higher likelihood of demanding the profitable box compared to the nonprofitable one ($V = 522.5, n = 76, p < 0.001$). Donor protests were also significantly more profitable, than nonprofitable regarding the distribution of stickers in the signalled compartment ($V = 45, n = 76, p < 0.010$).

Table 5

Comparison of verbal communication between donors and recipients

	Donor		Recipient
	3607	Sum Verbal (without laugh)	3326
		Demand	
Overall	203		162
Profitable	140		149

Nonprofitable	55		13
Neutral	8		0
Overall	24	Protest	117
Profitable	23		115
Nonprofitable	0		1
Neutral	1		1
Overall	49	Prediction	122
Profitable	19		14
Nonprofitable	26		91
Neutral	4		17
	31	Normative	44
	1177	Comparison	1011
	70	Laugh	2
	1997	Nontopic	1757
	27	Deference	3
	92	Nonaudible	84
	7	Nonassignable	15
		Extortion	11

To examine whether communicative behaviour changed around instances of sticker redistribution outside the regular allocation procedure, I compared verbal statements made before and after the external agreement. No significant pattern of change was observed ($\chi^2(21, n = 10) = 8, p = 0.995$; see Table 6).

Recipients and donors were equally likely to make a verbal statement before the external agreement, with only one instance being a demand from the recipient, indicating no clear influence of either role in initiating the sticker redistribution (see Table 7). Consistently, the McNemar test, which assessed whether the distribution of speaker roles (Donor vs. Recipient) changed after the agreement, revealed no significant differences ($\chi^2(1, n = 10) = 0.00, p = 1.000$), suggesting no systematic shifts in roles across dyads.

Table 6
Verbal statements prior and after external agreements

Verbal statement prior	Verbal statement after				
	Laugh	Nonaudible	Comparison	Non topic	Non assignable
Demand (profitable)	1	0	0	0	2
Deference	0	0	0	1	0
Comparison	0	1	0	0	0
Non topic	0	0	1	2	0
Non assignable	0	0	0	2	0

Table 7
Comparison of the role in verbal statements in relation to external agreements

	Donor	Recipient
Verbal statement prior	5	5
Verbal statement after	4	6

4.4 H1a) The more recipients communicate, the more stickers they end up receiving

The recipients' overall verbal communication—including Demands, Protests, Predictions, Normative statements, Comparisons, Nontopic statements, Deference statements, Nonaudible statements, Nonassignable statements, and Extortion statements—was significantly and positively correlated with the number of times they received the profitable reward distribution ($\rho = 0.29, p = 0.010$; Fig. 9). When taking the individual conditions (prosocial, costly, envy) of the resource allocation experiment into account, there was a positive correlation between the number of recipient communication bouts and the number profitable choices made by the donor in the prosocial condition ($\rho = 0.42, p < 0.001$; Fig. 10). In contrast, the correlation between recipient's total number of communication bouts and the number of donor's profitable choices was not significant in either the costly sharing condition ($\rho = 0.20, p = 0.083$) or the envy condition ($\rho = -0.02, p = 0.856$).

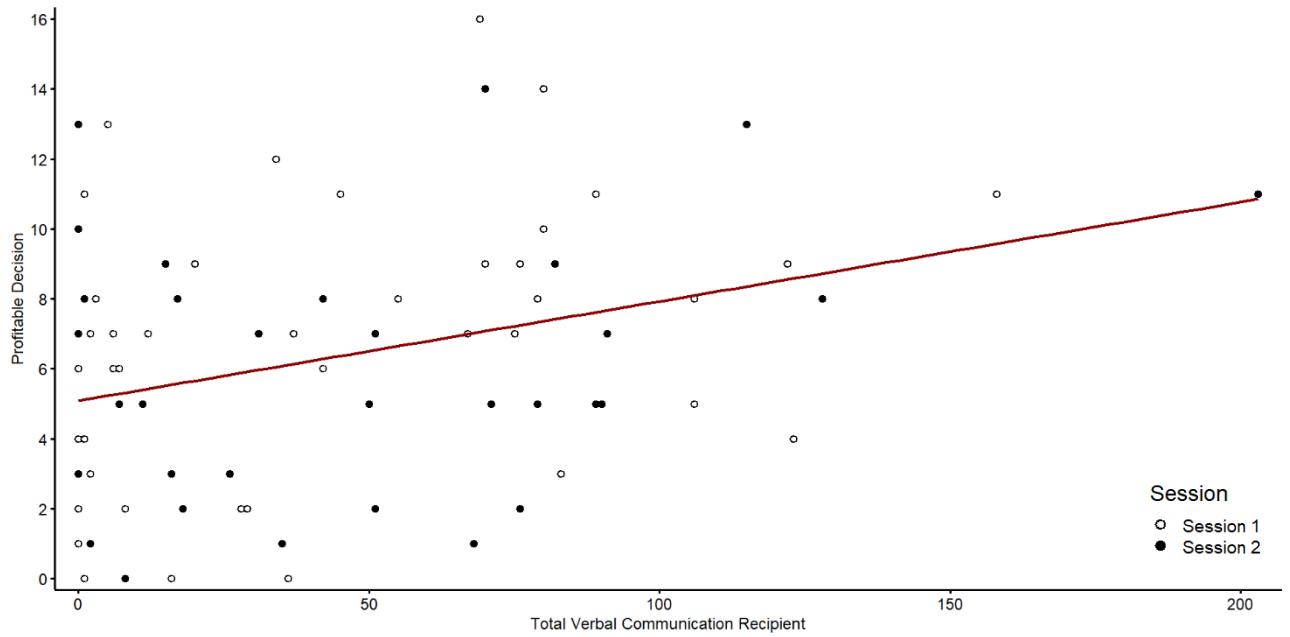


Figure 9 Scatterplot of recipients' total verbal communication and profitable decision-making in the resource allocation experiment. Empty (white) dots denote data points from Session 1, and filled (black) dots denote data points from Session 2. The red line indicates the statistical relationship between the two variables.

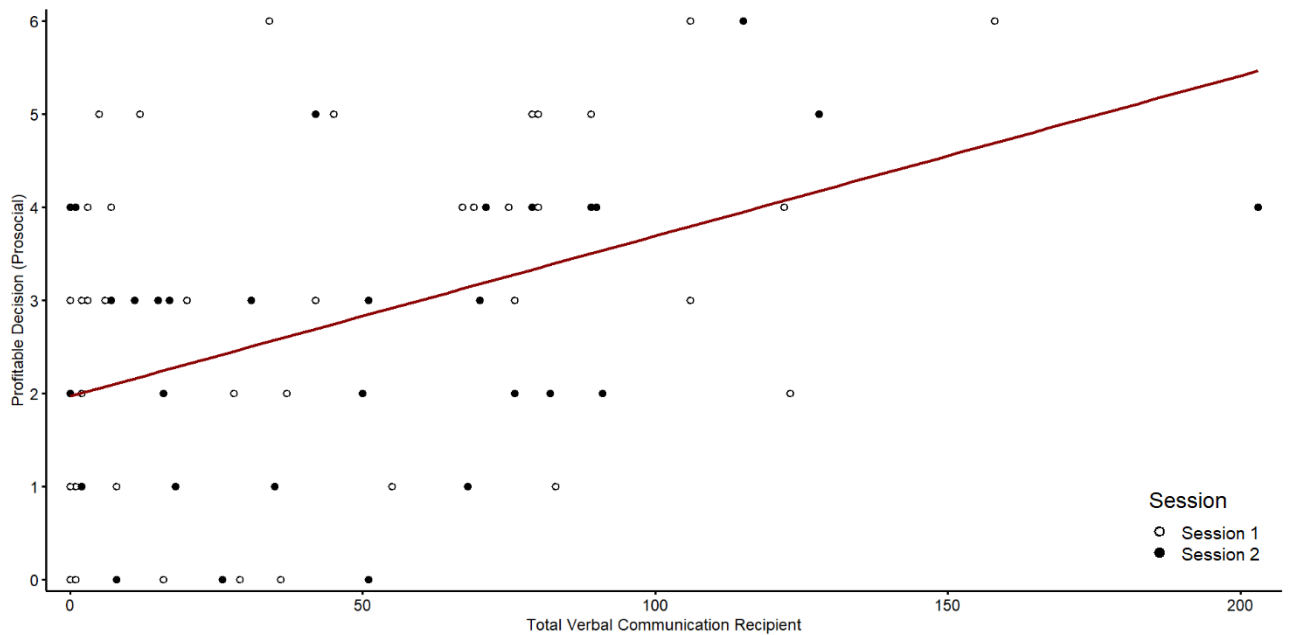


Figure 10 Scatterplot of recipients' total verbal communication and profitable decision-making in the prosocial condition of the resource allocation experiment. Empty (white) dots denote data points from Session 1, and filled (black) dots denote data points from Session 2. The red line indicates the statistical relationship between the two variables.

4.5 H1b) Trial by trial, recipient communication for a particular box will lead to an increased probability that the donor will choose the communicated box

When recipients' Demands, Protests, and Predictions towards the profitable resource distribution as well as the Normative, Comparison, Deference, Extortion, Nontopic, Nonassignable, and Nonaudible categories were included (67 out of 76 sessions, 88.16%), the chi-squared test showed no statistically significant association between the recipient's communication and the donor's decision to choose the profitable box ($\chi^2(1, n = 1367) = 1.21, p = 0.271$). Instances in which overall communication and recipients' profitable decisions coincided are presented in Table 8.

In 32 out of 76 sessions (42.11%), the recipient communicated at least one Demand for profitable distribution. Table 9 shows the cases in which the Demand also led to a profitable decision for the recipient. The chi-squared test revealed a non-significant trend between the recipient's communicated Demand and the donor's decision to select the profitable box ($\chi^2(1, n = 1367) = 3.12, p = 0.078$).

These results do not fully support hypothesis H1b, which predicts that, trial by trial, recipient communication increases the likelihood of a corresponding donor decision (for the chi-squared results for each recipient, see Tables 15 and 16 in the Appendix).

Table 8

Connection between recipients' overall communication and donors' decision in the resource allocation paradigm. "Profitable decision" indicates outcomes advantageous to the recipient

	Communication	No verbal communication
Profitable decision	351	195
Nonprofitable decision	503	319

Table 9

Connection between recipients' Demand and donors' decision in the resource allocation paradigm. "Profitable decision" indicates outcomes advantageous to the recipient.

	Demand	No Demand
Profitable decision	54	492
Nonprofitable decision	58	763

4.6 H1c) Dominance interacts with the effects in H1b in that more dominant recipients are better able to influence the donor's choices than less dominant recipients

There was no significant correlation between recipient dominance (Delta Recipient) and success rate (profitable decisions after Demands / total Demands $\times$ 100) ($\rho = 0.25$, $p = 0.172$; Fig. 11).

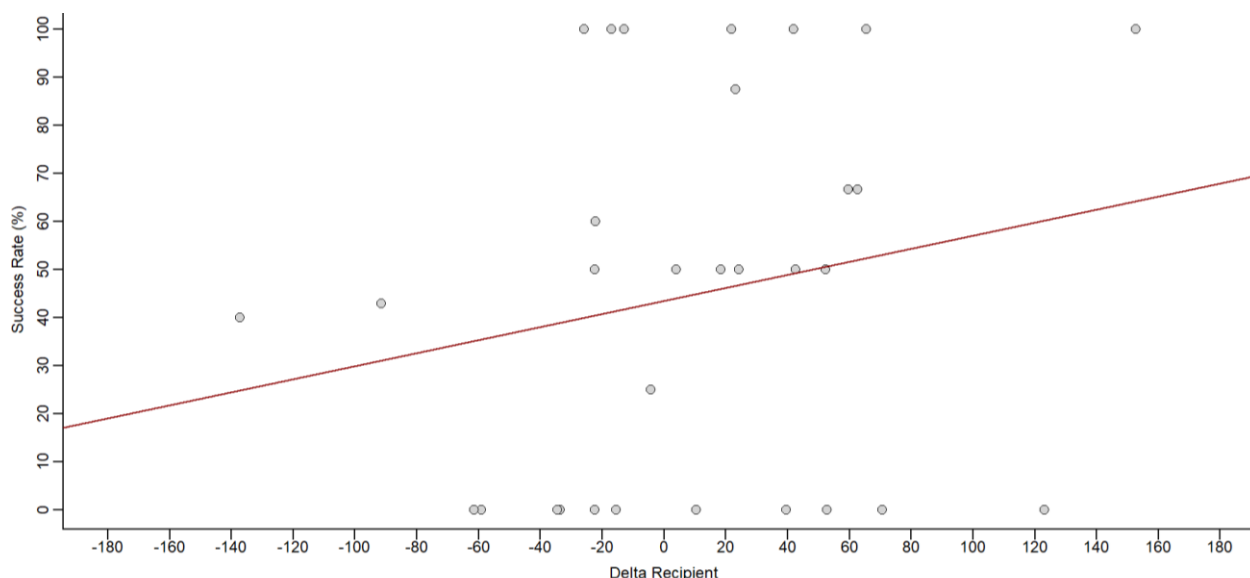


Figure 11 Scatterplot of recipients' dominance (Delta Recipient) and success rate. Each dot represents a child. The red line indicates the statistical relationship between the two variables.

4.7 H2) More dominant individuals - both donors and recipients - will communicate more verbally and non-verbally than less dominant individuals

Verbal communication was quantitatively much more frequent than nonverbal gestures (see Table 10). Donor dominance had no significant effect on the frequency of communication nor did the interaction between donor dominance and communication type (GEE, Poisson family; Table 10).

Table 10

Summary Table: GEE Results Donor

Predictor	Estimate	Std. Error	p-value	Interpretation
Intercept	3.844	0.154	<0.001	—

Predictor	Estimate	Std. Error	<i>p</i> -value	Interpretation
Scale (Delta Donor)	0.027	0.083	0.745	No main effect
Communication Type Gesture	-3.091	0.183	<0.001	Verbal > Gesture
Scale (Delta Donor): Communication Type Gesture	0.056	0.108	0.604	No interaction effect

GEE analysis of recipient communication revealed a complex, modality-dependent relationship with dominance status. In line with donor communication recipients predominantly used verbal communication, with gestural communication representing a minor part of their overall communication repertoire (see Table 11). Although no significant main effect of recipient dominance (Delta Recipient) was observed for overall communication (GEE, Poisson family; Table 11), a significant dominance $\times$ communication type interaction indicated differential effects across communication modalities. Specifically, there was a positive association between dominance (Delta Recipient) and the frequency of verbal communication, whereas no such association was found for gestural communication (see Figure 12).

Table 11

Summary Table: GEE Results Recipient

Predictor	Estimate	Std. Error	<i>p</i> -value	Interpretation
Intercept	3.76	0.161	<0.001	——
Scale (Delta Recipient)	0.136	0.106	0.200	No main effect
Communication Type Gesture	-2.149	0.160	<0.001	Verbal > Gesture
Scale (Delta Recipient): Communication Type Gesture	-0.245	0.097	0.012	Effect of Delta Recipient differs between verbal communication and gestures

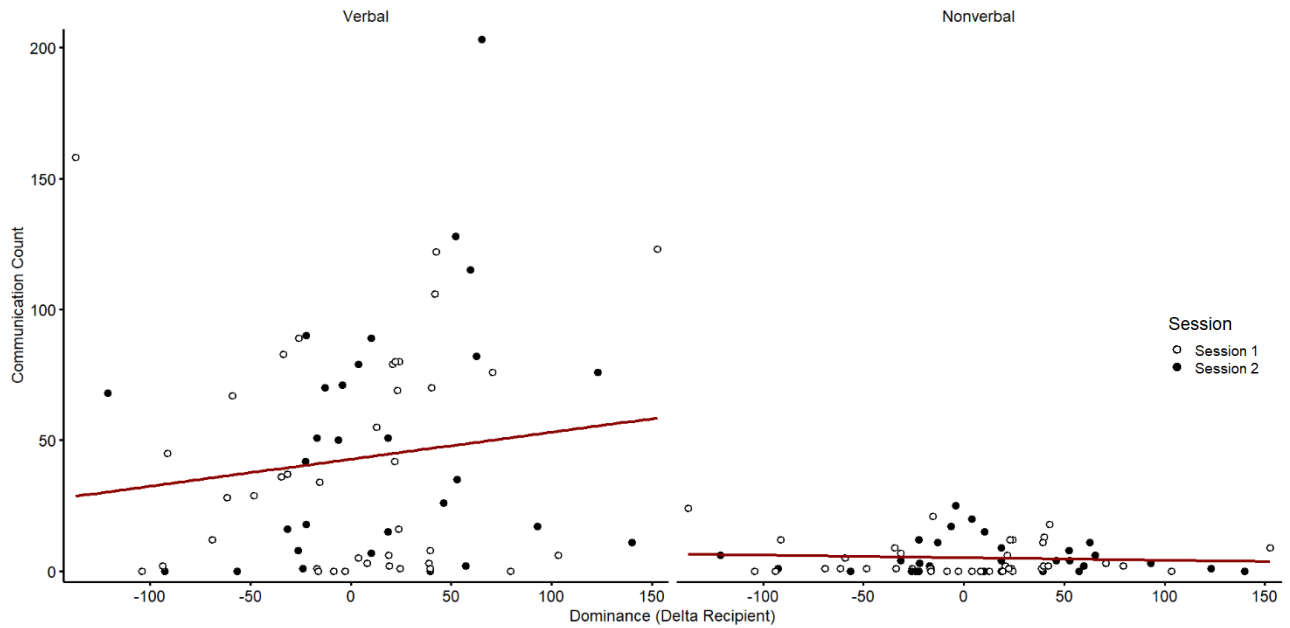


Figure 12 Visualization of the interaction between recipient dominance (Delta Recipient) and communication type.

4.8 H3) More dominant individuals - both donors and recipients - will use more demand statements and protest statements than less dominant individuals. Less dominant individuals - both donors and recipients - will use more verbal normative statements than more dominant individuals

Table 12 provides descriptive statistics for demands, protests and normative statements, with the data separated according to donors and recipients, respectively. However, the frequency of these three statement types was not correlated with the dominance of either recipients or donors (see Table 13).

Table 12

Descriptive statistic sum, mean and SD for demand, protest and normative statements for donors and recipients respectively

	Demand			Protest			Normative		
	Sum	Mean	SD	Sum	Mean	SD	Sum	Mean	SD
Donor	203	2.67	4.51	24	0.32	1.16	31	0.41	1.10
Recipient	162	2.13	3.87	117	1.54	3.48	44	0.58	2.17

Table 13

Results of Spearman Correlations between statement type and dominance

	Demand		Protest		Normative	
	<i>Rho</i> (ρ)	<i>p</i>	<i>Rho</i> (ρ)	<i>p</i>	<i>Rho</i> (ρ)	<i>p</i>
Donor	0.08	0.52	0.06	0.64	0.04	0.72
Recipient	0.01	0.93	0.14	0.25	0.08	0.52

5 Discussion

The present study investigated how verbal and non-verbal cues from recipients influence the prosocial behaviour of preschool children in resource allocation, and how this influence depends on the social dominance of the participants. The results revealed both expected and unexpected patterns between communication, prosocial behaviour, and dominance. Consistent with hypothesis H1a, recipients who communicated more frequently received more stickers overall, indicating that communication can effectively promote prosocial choices—especially in situations where prosocial and equality motives align. However, contrary to H1b, trial by trial analyses revealed no significant effect; recipient communication did not reliably influence donor decisions at the level of individual trials. For H1c, dominance was not associated with greater success in influencing donors' decisions, as measured by the proportion of profitable donor choices following recipient demands. Regarding H2, there was no significant main effect of recipient dominance on overall communication frequency. Instead, a significant interaction emerged: the effect of dominance depended on the communication modality, with dominance shaping the pattern rather than the quantity of communicative behaviour. For H3, no systematic differences were found in the use of demands, protests, or normative statements between more and less dominant individuals. Instead, recipients as a group produced more protests and demands, while donors were more likely to laugh or defer.

5.1 Access Duration as a Measure of Social Dominance

To assess social dominance, both first access and duration of access were considered within the monopolizations. However, data from Monopolization 2 were excluded from the main analysis, as outcomes in this task were likely influenced by prior experience with Monopolization 1 and the resource allocation experiment, introducing additional variability and potential carry-over effects. Furthermore, children's behaviour in Session 2 may have been shaped by their experiences and interactions in Session 1. Therefore, Monopolization 1 in Session 1 was

selected as the most reliable indicator of social dominance, as this measure was least affected by prior experimental manipulation and thus provided the most stable and unbiased assessment of dominance within the dyads.

However, first access in Monopolization 1 in Session 1 did not prove to be a valid indicator of persistent dominance relationships among preschoolers. This indicates either that dominance was not strongly pronounced in this sample or that the chosen methods were insufficiently sensitive. This discrepancy may stem from the experimental design, the dyadic nature of the tasks, or contextual factors such as task novelty and peer familiarity, but it may also reflect genuine variability in how dominance emerges across settings.

A more nuanced perspective emerged from the analysis of access duration (Delta values) within dyads: as a continuous measure, Delta values provided richer information about individual differences in resource control. The significant correlation of Delta values between Session 1 and Session 2 suggests that sustained access may capture more stable aspects of social dominance than first access. Notably, in many dyads both children exhibited similar access durations in Monopolization 1, Session 1, indicating that dominance was often balanced or ambiguous. This pattern suggests that neutral or unclear dominance relationships were common in preschool peer interactions in this sample, rather than clear hierarchical structures. This contrasts with previous findings that early childhood groups often display identifiable and relatively stable hierarchies (Hawley, 1999; Pellegrini, 2008; Grueneisen & Tomasello, 2022). The current results highlight that dominance in early childhood may be highly context-dependent, shaped by situational factors such as daily variability, task design, and the immediate social environment (Pellegrini et al., 2007; Hawley & Geldhof, 2012). The frequent occurrence of dyads with comparable access times, and the variability in first access across monopolizations and sessions suggest that dominance was fluid and repeatedly renegotiated, rather than fixed or easily captured by the behavioural markers used.

Consistent with Hawley's (1999, 2002) work, these findings support the view that dominance in early childhood is dynamic rather than static. Children continuously adapt their strategies to the social environment, peer group composition, and available resources, drawing flexibly on both coercive and prosocial means of resource control (Hawley 1999; 2002). Dominance hierarchies at this age are therefore less linear and stable than in older groups (Hawley 1999; 2002). Moreover, the presence of adult observers can alter how dominance is expressed, often by suppressing overt coercion and encouraging prosocial strategies (Cañigüeral & Hamilton, 2019; Li & Zhao, 2019). Under such conditions, more dominant children may be more inclined to share toys, resulting in a more balanced display of dominance.

Notably, Charafeddine et al. (2016) demonstrated that children's evaluations of dominant behaviours and their allocation decisions vary across cultural contexts. Thus, the observed ambiguity and fluidity may reflect developmental and methodological factors, as well as differences in how dominance is enacted and sanctioned within cultural environments (Charafeddine et al., 2016; Hawley, 1999). As the cultural background of the participants in the present study was not systematically recorded, this remains a possible confounding factor influencing both the expression and perception of dominance.

For future research, it would be interesting to make more naturalistic observations of peer interactions in everyday settings, which may better capture the dynamic, context-sensitive, and culturally embedded nature of early dominance hierarchies. Collecting detailed demographic and cultural information would also allow for more nuanced analyses of how individual, situational, and cultural factors jointly shape social dominance in early childhood.

5.2 Connection between Communication and Donors' Choice

Consistent with hypothesis H1a, recipients who communicated more frequently received more stickers overall. This finding aligns with prior research emphasising communication as a powerful tool for influencing peers and coordinating social interactions (Tomasello, 2008). Interestingly, the effect was most pronounced in the prosocial (1/1 vs. 1/0) condition, where donor and recipient shared equal benefits, but absent in the envy (1/2 vs. 1/1) and costly (1/1 vs. 2/0) conditions. This pattern suggests that the effectiveness of communication may hinge on the alignment between prosocial and equality motives. In the prosocial condition, the other-benefitting choice (1/1) coincided with the equal-payoff option, creating convergent incentives that could have amplified the influence of recipient communication. In the costly condition, by contrast, the other-benefitting option (1/1) still ensured equal outcomes, but donors also faced the competing temptation of maximizing their personal payoff (2/0), which may have reduced their responsiveness to recipient appeals. Most notably, in the envy condition, the other-benefitting choice (1/1) conflicted with equality concerns, as donors who chose the alternative (1/2) would leave recipients with a lower payoff. This motivational conflict may explain why communication failed to influence donor behaviour when prosocial and equality considerations conflicted. Furthermore, this suggests that communication is most effective when the donor's self-interest is not at risk, which is consistent with developmental findings indicating that fairness-based reasoning and reciprocity play a stronger role in contexts of equality (Blake & McAuliffe, 2011; Corbit et al., 2017). Specifically, Blake and McAuliffe (2011) demonstrated that children's willingness to act on fairness norms—such as rejecting unequal allocations—is most pronounced when both parties receive equal benefits, as in the 1/1 prosocial condition. In

contrast, when faced with advantageous or disadvantageous inequity—paralleling the costly and envy conditions—children’s decisions are more strongly driven by self-interest, and fairness-based reasoning is less likely to guide their behaviour (Blake & McAuliffe, 2011). Their results show that younger children are primarily averse to disadvantageous inequity, but it is not until around the age of eight that they begin to reject advantageous inequity as well (e.g. a costly condition), indicating a shift towards a more generalised and impartial sense of fairness (Blake & McAuliffe, 2011). This developmental trajectory suggests that children are more sensitive to fairness and responsive to communicative cues in situations where equal outcomes are possible, but less so when equal sharing would require personal sacrifice. Considering the age group of the sample, the present findings are consistent with this pattern: Donors were way more likely to opt for equal distributions in the envy condition (79,48 %) than in the costly condition (21,76 %), where they were more likely to choose inequality when facing advantageous inequity. These findings suggest that, in preschool age, peer communication alone is not sufficient to counteract children’s self-interested tendencies, echoing prior evidence that fairness-based reasoning only gradually strengthens across development (Blake & McAuliffe, 2011).

In contrast to H1a, H1b was not supported. When all verbal statements (excluding Laughter) were included in the trial by trial analyses, recipient communication did not significantly influence donor choices. However, when the analysis was restricted to recipients’ profitable demands, a non-significant trend emerged, indicating that such demands might increase the likelihood of donors selecting the communicated option. This discrepancy—between the overall effect of recipient communication on outcomes observed in H1a and the lack of significant trial-level effects in H1b—suggests that the persuasive impact of communication may not reside in isolated utterances. Instead, the persuasive effect of communication seems to be shaped by broader interactional dynamics that unfold over repeated exchanges, or by quantitative features of verbal statements—such as their frequency or intensity—that are not captured in the H1b analysis, where the variable "profitable Demands" was treated as binary. Such quantitative aspects of communication could also act as a proxy for underlying relational factors—such as friendship quality or peer affiliation—which some studies have linked to prosocial behaviour (Engelmann, Haux & Herrmann, 2019; Moore, 2009), though the evidence remains mixed (Horn et al., 2018).

It is also important to note that, although fairness-related statements were included in the general analysis of all verbal communication for H1b, the present analysis did not specifically examine whether such normative utterances, when considered in isolation, increased the

likelihood that donors would choose the communicated box. Future research should directly test whether explicit appeals to fairness norms are more persuasive than other forms of communication in influencing allocation decisions. Donors may have resisted overt demands, instead relying on their own preferences or internalized fairness considerations. This raises an important open question: how do children balance external communicative cues with their intrinsic sense of fairness when making prosocial choices? Clarifying whether recipient demands reinforce or undermine donors' autonomous fairness motivations would provide valuable insight into the interplay between social influence and normative reasoning in early childhood.

5.3 The Role of Dominance in Communication

Recipient dominance was not associated with greater success in influencing donor decisions, as measured by the success rate (i.e. profitable decisions made in response to demands divided by the total number of demands). Correlation analysis revealed no significant effects. As the measurement of influence relied on trial-level effects, this result is consistent with the lack of a significant effect observed for H1b. Recipients' influence on donor choices did not appear to be effective on a trial by trial basis, regardless of either dominance status or communicated demands. It should be emphasized, however, that the success rate in H1c was calculated solely based on the occurrence of recipients' profitable demands, not on the total number of verbal statements made by recipients. The latter was already found to be non-significant in H1b. Still this finding contrasts with predictions from resource control theory (Hawley, 2002), which posits that dominant individuals should be more effective in shaping resource allocation.

Partial support for H2 was found, but the pattern was more nuanced than initially hypothesized. Specifically, there was no significant main effect of recipient dominance (Delta Recipient in Monopolization 1 Session 1) on overall communication frequency. Instead, the GEE analysis revealed a significant interaction between dominance and communication type: the relationship between dominance and communication depended on the modality. More dominant recipients did not generally communicate more overall, but their dominance was differentially expressed depending on whether they used verbal or gestural communication. This suggests that dominance shapes not the quantity, but the modality of communicative behaviour.

It should also be noted, however, that verbal communication was easier to reliably record and categorize, while more subtle non-verbal cues—such as gaze following or facial expressions—were not systematically captured in the present study. As a result, the potential role of nuanced non-verbal behaviours in expressing or mediating dominance may have been underestimated,

representing a limitation of the current measurement approach (Grueneisen & Tomasello, 2022; Keltner et al., 2008).

For donors, neither dominance nor its interaction with communication type was related to communication frequency, suggesting that the expression and impact of dominance may be asymmetrical and role-dependent within the context of the task. Dominant donors may exert their dominance primarily through their control over resource distribution, utilizing their decision-making power rather than increased verbalization. In contrast, dominant recipients—lacking direct influence over the allocation process—may rely more heavily on verbal communication to express their dominance within the interaction.

Hypothesis H3, which predicted systematic differences in the use of demands, protests, and normative statements between more and less dominant individuals, was not supported. Dominance was unrelated to the frequency of any specific verbal category. Instead, recipients as a group produced more protests and demands, whereas donors were more likely to laugh or defer. Similarly, Grueneisen and Tomasello (2022) found in their study that more dominant recipients were no more likely than their less dominant peers to issue orders or to protest. These results contrast with those of Sebanc et al. (2003), who found that dominant preschoolers issued more commands and demands than their lower-ranking peers. However, it is important to note that Sebanc et al.'s findings were based on naturalistic observations of children's behaviour during competitive interactions over valuable resources rather than a structured resource allocation experiment. Differences in study design and data collection methods may therefore account for the divergent patterns observed.

Taken together, these findings indicate that communicative roles are shaped more by task position (donor versus recipient) than by individual dominance status. While recipients were generally more likely than donors to express demands and protests, there was no evidence that dominance status systematically influenced the frequency of these verbal strategies. Instead, the GEE results revealed that dominance effects were modality-specific, with dominance interacting with communication type rather than exerting a uniform main effect. This suggests that recipients, lacking direct control over resource allocation, may rely on particular communicative modalities to influence donor decisions, whereas donors, who already possess structural power, do not necessarily express dominance through increased verbalization.

The absence of a significant difference in the use of normative statements between recipients and donors, or between more and less dominant individuals, is unexpected. However, it is important to note that normative statements were the verbal category observed least frequently out of the three that were analysed in more detail. This low base rate may have limited the

statistical power to detect meaningful differences, suggesting that future research with larger samples or more targeted elicitation of normative language may be necessary to clarify potential role- or status-related effects in the use of normative statements during resource allocation interactions.

5.4 Limitations

Despite these insights, several other limitations must be acknowledged. The sample was somewhat skewed toward older children (5–6 years) and girls due to unequal participation and attrition during the warm-up phase, which may limit the generalizability of the findings across age and gender.

The assessment of social dominance was based on two resource monopolizations; however, the reliability between first access and duration of access was low. Moreover, in many dyads, the duration of access was similar for both individuals, suggesting more subtle or indistinct dominance relationships that are difficult to capture. Incorporating questionnaire-based assessments would have provided a more robust, multi-method approach to measuring social dominance, but this was not feasible due to the time and workload constraints of the present Master's thesis (Grueneisen & Tomasello, 2022).

Moreover, subtle non-verbal cues such as gaze direction or facial expressions were not systematically coded, potentially underestimating their role in social interactions (Keltner et al., 2008). The structured experimental environment may have further constrained the natural expression of dominance and communicative strategies, as the presence of adult experimenters could have inhibited overt displays of dominance or altered children's typical behaviour patterns (Cañigual & Hamilton, 2019; Li & Zhao, 2019). Finally, the cultural background of participants was not systematically recorded or analysed. Given evidence that cultural norms shape both dominance expression and resource allocation strategies, this represents a potential confound (House et al., 2019).

Future research should address these limitations in ecological validity by employing more naturalistic methods to observe peer interactions related to social dominance in everyday settings, while systematically collecting demographic and cultural information to facilitate cross-cultural comparisons (Henrich, Heine & Norenzayan, 2010). As Warneken and Rosati (2012) note, real-world social contexts rarely present children with clearly defined choices or explicit outcomes, as experimental tasks do. Instead, children must first identify opportunities for interaction and then respond appropriately to potential partners, highlighting the complexity of everyday social decision-making (Warneken & Rosati, 2012).

It would also be valuable to expand coding schemes to include a broader range of non-verbal behaviours and to investigate longitudinal trajectories assessing how early communicative and dominance strategies predict later social outcomes such as peer acceptance or leadership.

5.5 Conclusion and Theoretical Implications

With respect to the research questions, recipients' overall verbal communication positively influenced donors' choices in the resource allocation paradigm, particularly by increasing the likelihood of prosocial decisions. However, dominance was not associated with a general increase in verbal communication among donors or recipients. Instead, in the latter, the effect of dominance depended on the type of communication, as indicated by a significant interaction between dominance status and communication modality. Importantly, dominance was not linked to greater success in influencing donors' decisions on a trial by trial basis.

Building on the theoretical framework outlined in the introduction, the results highlight the central role of communication in how children navigate their social world. In line with the Vygotskian intelligence hypothesis, the ability to express intentions, negotiate, and coordinate actions emerges as a key mechanism through which children manage both competition and cooperation (Moll & Tomasello, 2007). The finding that overall communicative activity was linked to greater resource acquisition—particularly under equitable, low-cost conditions—suggests that communicative competence is not just supportive but actively drives prosocial outcomes.

A crucial aspect highlighted by this research is the context-sensitivity of prosocial actions in resource allocation (Blake & Rand, 2010; Charafeddine et al., 2016). As described by Blake and McAuliffe (2011) and Blake and Rand (2010), children's willingness to act fairly or share resources is modulated by the perceived costs and benefits to themselves. The finding that communication was most effective in the prosocial (1/1 vs. 1/0) condition, but not when self-interest was threatened, aligns with developmental models suggesting that fairness-based reasoning is strongest when it does not require personal sacrifice. Children's fairness and sharing decisions are guided not only by normative concerns but also by strategic considerations about costs, reciprocity, and reputation (Blake & McAuliffe, 2011; House et al., 2019; Engelmann & Rapp, 2018).

The lack of a robust effect of dominance on communicative influence challenges some previous research where dominant children used more and stronger communicative cues (Seban et al., 2003). Although research on the interaction between social dominance and communicative patterns is scarce and a domain worth conducting deeper research on. Instead, the data analysed in this Master thesis suggest that dominance may be less salient in structured cooperative

contexts, or that its expression is more nuanced—potentially mediated by cultural norms, task structure, or the presence of adult observers. This underscores the importance of considering both individual traits and situational variables in models of social behaviour. Additionally, while this study did not directly measure reputation effects, the frequent use of communicative acts—especially by recipients—may reflect an early form of social signalling aimed at influencing peer perceptions and future interactions (Black & Hazen, 1990; Grueneisen & Warneken, 2022; Warneken & Tomasello, 2009). This aligns with theories positing that prosociality is not only altruistic but also serves strategic social functions (Grueneisen & Warneken, 2022). Alternatively, although being many the choice of categories of verbal statements could have been non fitting.

Notably, there is still a striking lack of research specifically examining communication within resource allocation paradigms—particularly in combination with social dominance. Most existing studies focus either on resource allocation or on communication in isolation; very few integrate both aspects and explore their interplay in ecologically valid settings. Addressing this gap would provide critical insights into how children use communication to navigate complex social decisions about sharing and competition. Additionally, exploring how friendship quality or group dynamics interact with dominance and communication to shape prosocial behaviour would provide further valuable insights.

6 References

- Bearison, D. J., Dorval, B., LeBlanc, G., Sadow, A., & Plesa, D. (2002). Collaborative cognition : children negotiating ways of knowing. Ablex Pub.
- Black, B., & Hazen, N. L. (1990). Social Status and Patterns of Communication in Acquainted and Unacquainted Preschool Children. *Developmental Psychology*, 26(3), 379–387.
<https://doi.org/10.1037/0012-1649.26.3.379>
- Blake, P. R., & McAuliffe, K. (2011). “I had so much it didn’t seem fair”: Eight-year-olds reject two forms of inequity. *Cognition*, 120(2), 215–224.
<https://doi.org/10.1016/j.cognition.2011.04.006>
- Blake, P. R., & Rand, D. G. (2010). Currency value moderates equity preference among young children. *Evolution and Human Behavior*, 31(3), 210–218.
<https://doi.org/10.1016/j.evolhumbehav.2009.06.012>
- Bowles, S., & Gintis, H. (2011). *A cooperative species: human reciprocity and its evolution*. (Course Book, pp. xii–xii). Princeton University Press.
<https://doi.org/10.1515/9781400838837>
- Brosnan, S. F., Salwiczek, L., & Bshary, R. (2010). The interplay of cognition and cooperation. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 365(1553), 2699–2710. <https://doi.org/10.1098/rstb.2010.0154>
- Brownell, C. A., Ramani, G. B., & Zerwas, S. (2006). Becoming a Social Partner With Peers: Cooperation and Social Understanding in One- and Two-Year-Olds. *Child Development*, 77(4), 803–821. <https://doi.org/10.1111/j.1467-8624.2006.t01-1-.x-i1>
- Cañigueral, R., & Hamilton, A. F. de C. (2019). Being watched: Effects of an audience on eye gaze and prosocial behaviour. *Acta Psychologica*, 195, 50–63.
<https://doi.org/10.1016/j.actpsy.2019.02.002>

- Charafeddine, R., Mercier, H., Clément, F., Kaufmann, L., Reboul, A., & Van Der Henst, J.-B. (2016). Children's allocation of resources in social dominance situations. *Developmental Psychology*, 52(11), 1843–1857. <https://doi.org/10.1037/dev0000164>
- Chen Zeng, T., Cheng, J. T., & Henrich, J. (2022). Dominance in humans. *Philosophical Transactions of the Royal Society of London. Series B. Biological Sciences*, 377(1845), 20200451. <https://doi.org/10.1098/rstb.2020.0451>
- Choi, J., Johnson, D. W., & Johnson, R. (2011). The Roots of Social Dominance: Aggression, Prosocial Behavior, and Social Interdependence. *The Journal of Educational Research*, 104(6), 442–454. <https://doi.org/10.1080/00220671.2010.514689>
- Corbit, J., McAuliffe, K., Callaghan, T. C., Blake, P. R., & Warneken, F. (2017). Children's collaboration induces fairness rather than generosity. *Cognition*, 168, 344–356. <https://doi.org/10.1016/j.cognition.2017.07.006>
- Duguid, S., Wyman, E., Grueneisen, S., & Tomasello, M. (2020). The strategies used by chimpanzees (*Pan troglodytes*) and children (*Homo sapiens*) to solve a simple coordination problem. *Journal of Comparative Psychology*, 134(4), 401–411. <https://doi.org/10.1037/com0000220>
- Eckerman, C. O., & Peterman, K. (2004). Peers and infant social/communicative development. In A. Fogel & G. Bremner (Eds.), *Blackwell handbook of infant development* (pp. 326–350). Blackwell Publishing Ltd. <https://doi.org/10.1002/9780470996348.ch12>
- Eisenberg, N., Fabes, R. A., & Spinrad, T. L. (2006). Prosocial Development. In N. Eisenberg (Ed.), *Handbook of Child Psychology* (6th ed., Vol. 3, pp. 646–718). Wiley
- Engelmann, J. M., Haux, L. M., & Herrmann, E. (2019). Helping in young children and chimpanzees shows partiality towards friends. *Evolution and Human Behavior*, 40(3), 292–300. <https://doi.org/10.1016/j.evolhumbehav.2019.01.003>

- Engelmann, J. M., & Rapp, D. J. (2018). The influence of reputational concerns on children's prosociality. *Current Opinion in Psychology*, 20, 92–95.
<https://doi.org/10.1016/j.copsyc.2017.08.024>
- Fehr, E., & Schurtenberger, I. (2018). Normative foundations of human cooperation. *Nature Human Behaviour*, 2(7), 458–468. <https://doi.org/10.1038/s41562-018-0385-5>
- Gokcekus, S., Cole, E. F., Sheldon, B. C., & Firth, J. A. (2021). Exploring the causes and consequences of cooperative behaviour in wild animal populations using a social network approach. *Biological Reviews*, 96(5), 2355–2372. <https://doi.org/10.1111/brv.12757>
- Green, V. A., & Rechis, R. (2006). Children's cooperative and competitive interactions in limited resource situations: A literature review. *Journal of Applied Developmental Psychology*, 27(1), 42–59. <https://doi.org/10.1016/j.appdev.2005.12.002>
- Grueneisen, S., & Tomasello, M. (2022). How fairness and dominance guide young children's bargaining decisions. *Child Development*, 93(5), 1318–1333.
<https://doi.org/10.1111/cdev.13757>
- Grueneisen, S., & Warneken, F. (2022). The development of prosocial behavior—From sympathy to strategy. *Current Opinion in Psychology*, 43, 323–328.
<https://doi.org/10.1016/j.copsyc.2021.08.005>
- Guinote, A., Cotzia, I., Sandhu, S., & Siwa, P. (2015). Social status modulates prosocial behavior and egalitarianism in preschool children and adults. *Proceedings of the National Academy of Sciences*, 112(3), 731–736. <https://doi.org/10.1073/pnas.1414550112>
- Harbaugh, W. T., Krause, K., & Liday, S. G. (2003). Bargaining by children. *Journal of Economic Behavior & Organization*, 51(2), 179–195. [https://doi.org/10.1016/S0167-2681\(02\)00098-8](https://doi.org/10.1016/S0167-2681(02)00098-8)
- Hartup, W. W. (1983). Peer relations. In E. M. Hetherington (Ed.), *Handbook of child psychology* (Vol. 4, pp. 103–196). New York: Wiley.
- Hawley, P. H. (1999). The Ontogenesis of Social Dominance: A Strategy-Based Evolutionary Perspective. *Developmental Review*, 19(1), 97–132. <https://doi.org/10.1006/drev.1998.0470>

- Hawley, P. H. (2002). Social dominance and prosocial and coercive strategies of resource control in preschoolers. *International Journal of Behavioral Development*, 26(2), 167–176.
<https://doi.org/10.1080/01650250042000726>
- Hawley, P. H. (2014). Evolution, Prosocial Behavior, and Altruism. In *Prosocial Development*. Oxford University Press. <https://doi.org/10.1093/acprof:oso/9780199964772.003.0003>
- Hawley, P. H., & Bower, A. R. (2018). Evolution and Peer Relations. In *Handbook of Peer Interactions, Relationships, and Groups*. New York: The Guilford Press, 2018. Disponível em: William M. Bukowski; Brett Laursen; Kenneth H. Rubin.
- Hawley, P. H., Little, T. D., & Card, N. A. (2007). The allure of a mean friend: Relationship quality and processes of aggressive adolescents with prosocial skills. *International Journal of Behavioral Development*, 31(2), 170–180. <https://doi.org/10.1177/0165025407074630>
- Hawley, P. H., & John Geldhof, G. (2012). Preschoolers' social dominance, moral cognition, and moral behavior: An evolutionary perspective. *Journal of Experimental Child Psychology*, 112(1), 18–35. <https://doi.org/10.1016/j.jecp.2011.10.004>
- Henrich, J., Heine, S. J., & Norenzayan, A. (2010). The weirdest people in the world? *The Behavioral and Brain Sciences*, 33(2–3), 61–83.
<https://doi.org/10.1017/S0140525X0999152X>
- Hill, V., & Pillow, B. H. (2006). Children's Understanding of Reputations. *The Journal of Genetic Psychology*, 167(2), 137–157. <https://doi.org/10.3200/GNTP.167.2.137-157>
- Horn, L., Hungerländer, N. A., Windhager, S., Bugnyar, T., & Massen, J. J. M. (2018). Social status and prenatal testosterone exposure assessed via second-to-fourth digit ratio affect 6–9-year-old children's prosocial choices. *Scientific Reports*, 8(1), 9198.
<https://doi.org/10.1038/s41598-018-27468-0>
- House, B. R., Henrich, J., Brosnan, S. F., & Silk, J. B. (2012). The ontogeny of human prosociality: behavioral experiments with children aged 3 to 8. *Evolution and Human Behavior*, 33(4), 291–308. <https://doi.org/10.1016/j.evolhumbehav.2011.10.007>

- House, B. R., Kanngiesser, P., Barrett, H. C., Broesch, T., Cebioglu, S., Crittenden, A. N., Erut, A., Lew-Levy, S., Sebastian-Enesco, C., Smith, A. M., Yilmaz, S., & Silk, J. B. (2019). Universal norm psychology leads to societal diversity in prosocial behaviour and development. *Nature Human Behaviour*, 4(1), 36–44. <https://doi.org/10.1038/s41562-019-0734-z>
- Jensen, K., Vaish, A., & Schmidt, M. F. H. (2014). The emergence of human prosociality: Aligning with others through feelings, concerns, and norms. *Frontiers in Psychology*, 5. <https://doi.org/10.3389/fpsyg.2014.00822>
- Keltner, D., Van Kleef, G. A., Chen, S., Kraus, M. W., & Zanna, M. P. (2008). A Reciprocal Influence Model of Social Power: Emerging Principles and Lines of Inquiry. In *Advances in Experimental Social Psychology* (Vol. 40, pp. 151–192). Elsevier Science & Technology. [https://doi.org/10.1016/S0065-2601\(07\)00003-2](https://doi.org/10.1016/S0065-2601(07)00003-2)
- Kochanska, G., Aksan, N., & Koenig, A. L. (1995). A Longitudinal Study of the Roots of Preschoolers' Conscience: Committed Compliance and Emerging Internalization. *Child Development*, 66(6), 1752–1769. <https://doi.org/10.2307/1131908>
- Li, Y., & Zhao, M. (2019). Effects of the presence of others on prosocial behavior: Perceived face as mediator. *Asian Journal of Social Psychology*, 22(2), 193–202. <https://doi.org/10.1111/ajsp.12358>
- Marshall-Pescini, S., Dale, R., Quervel-Chaumette, M., & Range, F. (2016). Critical issues in experimental studies of prosociality in non-human species. *Animal Cognition*, 19(4), 679–705. <https://doi.org/10.1007/s10071-016-0973-6>
- Moll, H., & Tomasello, M. (2007). Cooperation and human cognition: The Vygotskian intelligence hypothesis. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 362(1480), 639–648. <https://doi.org/10.1098/rstb.2006.2000>
- Moore, C. (2009). Fairness in Children's Resource Allocation Depends on the Recipient. *Psychological Science*, 20(8), 944–948. <https://doi.org/10.1111/j.1467-9280.2009.02378.x>

- Pellegrini, A. (2008). The roles of aggressive and affiliative behaviors in resource control: A behavioral ecological perspective. *Developmental Review*, 28(4), 461–487.
<https://doi.org/10.1016/j.dr.2008.03.001>
- Pellegrini, A. D., Roseth, C. J., Mliner, S., Bohn, C. M., Van Ryzin, M., Vance, N., Cheatham, C. L., & Tarullo, A. (2007). Social dominance in preschool classrooms. *Journal of Comparative Psychology*, 121(1), 54–64. <https://doi.org/10.1037/0735-7036.121.1.54>
- Phillips, D. A., & Shonkoff, J. P. (2000). *From Neurons to Neighborhoods: The Science of Early Childhood Development* (1st ed.). National Academies Press. <https://doi.org/10.17226/9824>
- Roseth, C. J., Pellegrini, A. D., Bohn, C. M., Van Ryzin, M., & Vance, N. (2007). Preschoolers' aggression, affiliation, and social dominance relationships: An observational, longitudinal study. *Journal of School Psychology*, 45(5), 479–497.
<https://doi.org/10.1016/j.jsp.2007.02.008>
- Roseth, C. J., Pellegrini, A. D., Dupuis, D. N., Bohn, C. M., Hickey, M. C., Hilk, C. L., & Peshkam, A. (2011). Preschoolers' Bistrategic Resource Control, Reconciliation, and Peer Regard. *Social Development (Oxford, England)*, 20(1), 185–211.
<https://doi.org/10.1111/j.1467-9507.2010.00579.x>
- Sebanc, A. M., Pierce, S. L., Cheatham, C. L., & Gunnar, M. R. (2003). Gendered Social Worlds in Preschool: Dominance, Peer Acceptance and Assertive Social Skills in Boys' and Girls' Peer Groups. *Social Development (Oxford, England)*, 12(1), 91–106.
<https://doi.org/10.1111/1467-9507.00223>
- Shantz, C. U. (1987). Conflicts between Children. *Child Development*, 58(2), 283–305.
<https://doi.org/10.2307/1130507>
- Staub, E., & Sherk, L. (1970). Need for Approval, Children's Sharing Behavior, and Reciprocity in Sharing. *Child Development*, 41(1), 243–252. <https://doi.org/10.2307/1127403>

- Svetlova, M., Nichols, S. R., & Brownell, C. A. (2010). Toddlers' Prosocial Behavior: From Instrumental to Empathic to Altruistic Helping. *Child Development*, 81(6), 1814–1827. <https://doi.org/10.1111/j.1467-8624.2010.01512.x>
- Tomasello, M. (2008). *Origins of Human Communication* (1st ed., Vol. 2008). The MIT Press. <https://doi.org/10.7551/mitpress/7551.001.0001>
- Tomasello, M., Melis, A. P., Tennie, C., Wyman, E., & Herrmann, E. (2012). Two Key Steps in the Evolution of Human Cooperation: The Interdependence Hypothesis. *Current Anthropology*, 53(6), 673–692. <https://doi.org/10.1086/668207>
- Warneken, F. (2015). Precocious Prosociality: Why Do Young Children Help? *Child Development Perspectives*, 9(1), 1–6. <https://doi.org/10.1111/cdep.12101>
- Warneken, F., Chen, F., & Tomasello, M. (2006). Cooperative Activities in Young Children and Chimpanzees. *Child Development*, 77(3), 640–663. <https://doi.org/10.1111/j.1467-8624.2006.00895.x>
- Warneken, F., & Rosati, A. G. (2012). Early social cognition: How psychological mechanisms can inform models of decision making. In P. Hammerstein & J. R. Stevens (Eds.), *Evolution and the mechanisms of decision making* (pp. 151–166). MIT Press.
- Warneken, F., & Tomasello, M. (2007). Helping and Cooperation at 14 Months of Age. *Infancy*, 11(3), 271–294. <https://doi.org/10.1111/j.1532-7078.2007.tb00227.x>
- Warneken, F., & Tomasello, M. (2009). Varieties of altruism in children and chimpanzees. *Trends in Cognitive Sciences*, 13(9), 397–402. <https://doi.org/10.1016/j.tics.2009.06.008>
- West, S. A., El Mouden, C., & Gardner, A. (2011). Sixteen common misconceptions about the evolution of cooperation in humans. *Evolution and Human Behavior*, 32(4), 231–262. <https://doi.org/10.1016/j.evolhumbehav.2010.08.001>

7 Appendices

7.1 Appendix A: Supplementary Tables

Table 13

Access duration of Monopolization 1 and respective Delta-values

Dyad	Session 1			Session 2		
	Child 1 access duration	Child 2 access duration	Delta 1	Child 1 access duration	Child 2 access duration	Delta 2
dyad01	63.307	122.379	-59.072	23.756	163.779	- 140.023
dyad02	57.595	78.368	-20.773	79.932	102.352	-22.420
dyad03	44.418	124.012	-79.594	75.061	106.479	-31.418
dyad04	122.379	53.286	69.093	96.689	78.157	18.532
dyad05	NA	NA	NA	113.411	60.998	52.413
dyad06	3.466	156.110	-152.644	16.672	137.892	- 121.220
dyad07	NA	42.311	NA	NA	15.610	NA
dyad08	70.060	85.470	-15.410	86.134	90.003	-3.869
dyad09	93.658	85.274	8.384	NA	NA	NA
dyad10	94.044	69.771	24.273	92.964	70.875	22.089
dyad11	30.158	133.659	-103.501	39.132	131.719	-92.587
dyad12	73.809	97.520	-23.711	111.777	72.372	39.405
dyad13	92.775	79.999	12.776	41.337	134.425	-93.088
dyad14	102.815	71.211	31.604	86.974	93.232	-6.258
dyad15	113.897	NA	NA	94.275	84.179	10.096
dyad16	70.152	108.888	-38.736	61.859	118.337	-56.478
dyad17	50.680	46.760	3.920	48.363	111.088	-62.725
dyad18	NA	185.160	NA	167.757	NA	NA
dyad19	99.160	59.080	40.080	60.474	113.291	-52.817
dyad20	92.280	89.400	2.880	84.000	100.318	-16.318
dyad21	40.760	32.480	8.280	25.101	82.434	-57.333

dyad22	92.840	67.080	25.760	104.408	44.757	59.651
dyad23	115.080	72.400	42.680	85.917	96.242	-10.325
dyad24	NA	169.280	NA	96.002	78.962	17.040
dyad25	102.960	69.320	33.640	82.204	95.157	-12.953
dyad26	69.113	87.602	-18.489	NA	NA	NA
dyad27	81.560	100.320	-18.760	73.928	100.189	-26.261
dyad28	33.920	125.320	-91.400	83.153	78.968	4.185
dyad29	112.440	41.680	70.760	28.204	151.320	- 123.116
dyad30	60.680	122.200	-61.520	50.883	97.068	-46.185
dyad31	18.243	155.516	-137.273	55.678	121.080	-65.402
dyad32	113.041	64.679	48.362	121.327	55.559	65.768
dyad33	61.679	101.401	-39.722	NA	NA	NA
dyad34	71.166	113.056	-41.890	NA	NA	NA
dyad35	104.496	70.004	34.492	NA	NA	NA
dyad36	143.490	39.288	104.202	NA	NA	NA
dyad37	56.906	17.401	39.505	100.913	78.565	22.348
dyad38	98.157	81.241	16.916	NA	NA	NA
dyad39	102.839	78.357	24.482	NA	NA	NA
dyad40	97.490	75.228	22.262	NA	NA	NA
dyad41	132.357	38.520	93.837	NA	NA	NA
dyad42	102.837	83.634	19.203	99.590	75.605	23.985
dyad43	72.960	94.762	-21.802	NA	NA	NA
dyad44	95.158	78.843	16.315	NA	NA	NA

Table 14
Ethogram verbal communication

Button	Explanation and examples
Start	One frame before Trial 1.
Stop	Closing the apparatus or verbally ending the game signals the end of trial 18.
Trial	The experimenter 1 communicates the start of the first and next trial e.g. "Nächste Runde" (transl. "next round").
Verbal statement	Words spoken by one of the children. If there is a gap of 0.5 seconds between words, they are categorised as separate events (Foster et al., 2000).
Laugh	Donor or Recipients laugh 3 s before or after a side of the apparatus was opened.
Non topic	Statements unrelated to the resource allocation experiment
Demand	Child demands a certain sticker distribution. E.g. Donor: „Jetzt legst du aber zwei zu ihr und einen zu mir.“ (transl. "Now, put two with her and one with me."). Recipient: "Jetzt solltest du mal die [Box aufmachen]." (transl. „Now you should open this box.“).
Protest	Child is objecting to a certain sticker distribution. E.g. Donor: "Warum immer zwei bei der [...]?" (transl. "Why always two for [...]?"). Recipient: "Und jetzt willst du dass ich keinen bekomme!" (transl. "And now you want me not to get any!").
Prediction	Child is predicting a certain decision before the apparatus is opened. E.g. Donor: „Das nächste mal dann aber wieder fair!" (transl. „Next time, I'll choose fairly!"). Recipient: „Du nimmst immer die!" (transl. "You always take that one!").
Normative	The child is expressing a value judgement (e.g. regarding fairness or justice). E.g. Donor: "Weil da hat jeder von uns eins" (transl. „Because we both get one."). Recipient: "Du willst da immer hinein, weil wir da beide gleich viel kriegen" (transl. „You always want to go in there because we both get the same.").
Comparison	The child is comparing their sticker distribution with that of the other child. E.g. Donor: „Ich habe zwei!" (transl. „I have two!"). Recipient: „Ach jetzt habe ich keines bekommen." (transl. „Oh, now I haven't got one.").
Extortion	The recipient tries to secure a more profitable distribution from the donor by putting them under emotional pressure. E.g. Recipient: „[...]und wenn nicht, dann bin ich nicht mehr dein Freund!" (transl. "[...] and if not, then I'm no longer your friend.").

Table 15

Connection between recipients' profitable demands and donors' decisions in the resource allocation paradigm. "Profitable" indicates outcomes advantageous to the recipient. χ^2 per recipient: 44 children did not make any demands directed towards the profitable box and are therefore excluded from the table.

Recipient_ID	Demand & Profitable	Demand & Nonprofitable	No Demand & Profitable	No Demand & Nonprofitable	$\chi^2(p)$
1_1	0	1	13	4	0,610
2_2	1	1	11	5	1
5_2	2	2	10	4	0,841
6_1	1	0	5	12	0,716
8_1	0	3	6	9	0,502
8_2	1	1	8	8	1
10_1	4	4	4	6	1
10_2	3	2	5	7	0,875
17_2	4	2	5	7	0,617
18_2	2	6	5	5	0,552
19_2	0	1	1	16	1
22_1	1	0	10	7	1
22_2	2	1	11	4	1
23_1	1	1	8	8	1
23_2	0	1	5	12	1
24_2	1	0	6	11	0,815
25_1	0	2	3	13	1
25_2	7	0	7	4	0,220
26_1	7	1	9	1	1
26_2	1	1	1	15	0,507
28_1	3	4	8	3	0,440
28_2	3	9	2	4	1
29_1	0	1	9	8	1
29_2	0	3	2	13	1
30_1	0	2	2	14	1
31_1	4	6	7	1	0,117
31_2	3	0	8	7	0,387
34_1	2	0	6	10	0,356
35_1	0	1	0	17	NA
37_1	0	1	2	15	1
37_2	0	1	2	15	1
43_1	1	0	5	12	0,7

Table 16

Connection between recipients' overall communication and donors' decisions in the resource allocation paradigm. "Profitable" indicates outcomes advantageous to the recipient. χ^2 per recipient: 4 Recipients did not communicate at all and are therefore excluded from the table.

Recipient_ID	Communication & Profitable	Communication & Nonprofitable	No Communication & Profitable	No Communication & Nonprofitable	$\chi^2(p)$
1_1	12	5	1	0	1
1_2	11	6	0	1	0.815
2_1	9	9	0	0	NaN
2_2	11	5	1	1	1
3_1	0	1	6	11	1.00
3_2	7	5	2	4	0.617
4_1	5	6	4	3	1
4_2	7	8	2	1	1
5_1	1	1	7	9	1.00
5_2	11	6	1	0	1.00
6_1	6	12	0	0	NaN
6_2	5	11	2	0	0.267
7_1	8	6	3	1	0.948
7_2	12	5	1	0	1
8_1	3	9	3	3	0.596
8_2	8	9	1	0	1
9_1	0	1	8	9	1
10_1	7	10	1	0	0.908
10_2	8	9	0	1	1
11_1	0	5	9	4	0.035
11_2	0	1	12	5	0.716
12_1	2	8	4	4	0.402
13_1	1	15	1	1	0.507
13_2	4	7	2	5	1
14_1	5	8	2	3	1
14_2	5	11	0	2	0.926
15_1	5	2	5	6	0.552
15_2	1	3	8	6	0.571
16_1	2	1	10	5	1
17_1	3	1	10	4	1
17_2	8	9	1	0	1
18_1	5	13	0	0	NaN
18_2	7	11	0	0	NaN
19_1	9	9	0	0	NaN
19_2	0	13	1	4	0.610
20_1	1	0	3	14	0.492
21_1	0	2	8	8	0.557
21_2	0	2	1	15	1.00
22_1	11	6	0	1	0.815

22_2	13	5	0	0	NaN
23_1	9	9	0	0	NaN
23_2	5	13	0	0	NaN
24_1	7	10	0	1	1
24_2	6	11	1	0	0.815
25_1	3	15	0	0	NaN
25_2	13	4	1	0	1.00
26_1	16	2	0	0	NaN
26_2	2	15	0	1	1.00
27_1	3	3	4	8	0.864
27_2	0	7	0	11	NaN
28_1	6	7	5	0	0.119
28_2	5	13	0	0	NaN
29_1	8	9	1	0	1
29_2	2	16	0	0	NaN
30_1	2	12	0	15	1
30_2	2	10	1	4	1
31_1	11	7	0	5	NaN
31_2	11	7	0	0	NaN
32_1	1	12	1	0	1
33_1	1	1	3	4	0.920
34_1	8	9	0	13	1
35_1	0	15	0	1	NaN
37_1	0	4	2	17	1
37_2	1	10	1	12	1.00
38_1	1	0	10	6	1
39_1	0	1	0	7	NaN
40_1	9	8	1	0	1
41_1	0	3	3	12	1
42_1	0	1	7	10	1
42_2	0	1	8	9	1
43_1	6	11	0	1	1.00
44_1	0	1	6	11	1.00

7.2 Appendix B: Additional Figures

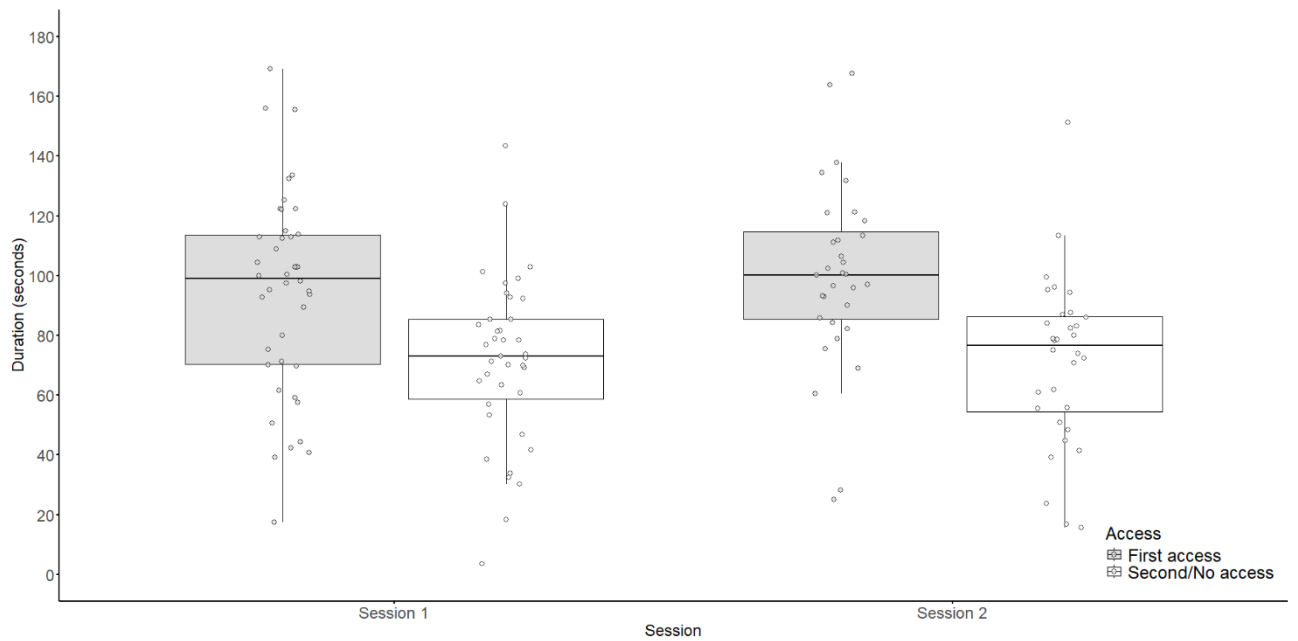


Figure 13 Comparison between access type and access duration in Monopolization 1. Each circle represents a child.

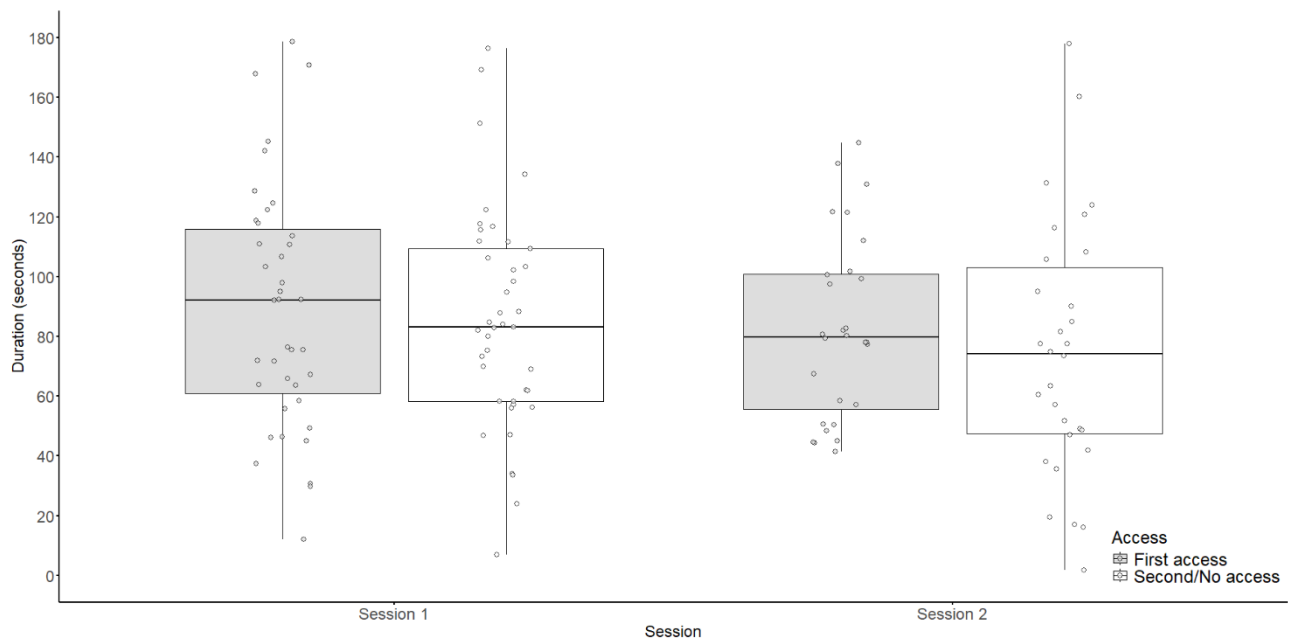


Figure 14 Comparison between access type and access duration in Monopolization 2. Each circle represents a child.

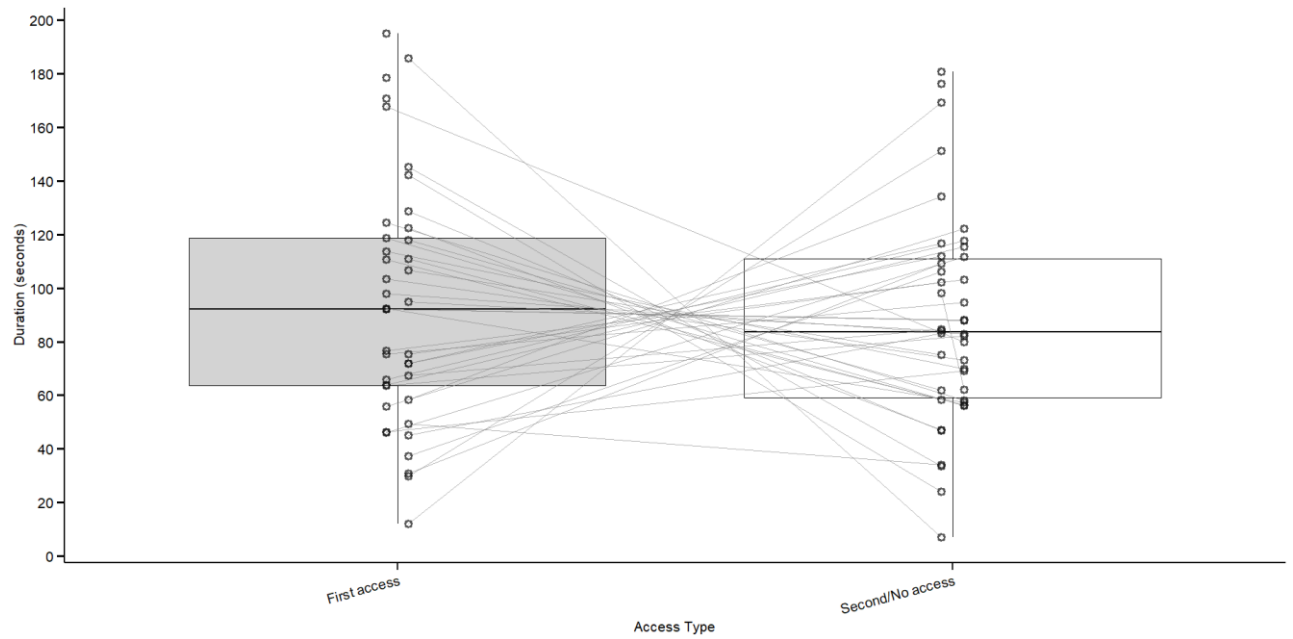


Figure 15 Comparison of access type and access duration in Monopolization 2, Session 1. Each circle represents a child; lines connect children belonging to the same dyad.

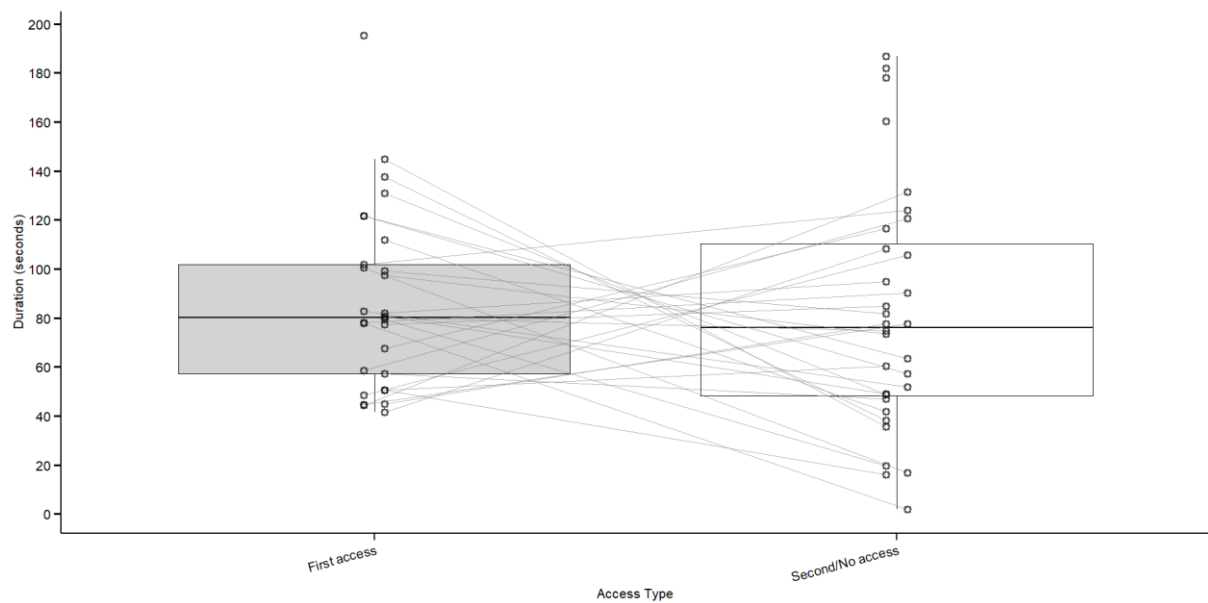


Figure 16 Comparison of access type and access duration in Monopolization 2, Session 2. Each circle represents a child; lines connect children belonging to the same dyad.