The Effect of Collaboration on Children’s Sharing

by

John Corbit

M.A. (Psychology) Concordia University, 2014
B.A. (Honors, Psychology) Saint Francis Xavier University, 2012
B.Sc. (Psychology) Dalhousie University, 2009

Thesis Submitted in Partial Fulfillment of the
Requirements for the Degree of
Doctor of Philosophy

in the
Department of Psychology
Faculty of Arts and Social Sciences

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SIMON FRASER UNIVERSITY
Summer 2018

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Approval

Name: John Corbit
Degree: Doctor of Philosophy (Department of Psychology)
Title: The Effect of Collaboration on Children's Sharing

Examining Committee: Chair: Kate Slaney
Associate Professor

Tanya Broesch
Senior Supervisor
Assistant Professor

Jeremy I. M. Carpendale
Supervisor
Professor

Erik Kimbrough
Supervisor
Associate Professor

Martin Bouchard
Internal Examiner
Associate Professor
Criminology

Andy Baron
External Examiner
Associate Professor
Psychology Department
UBC

Date Defended/Approved: June 18, 2018
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Abstract

Three-year-olds divide collaboratively earned resources equally, suggesting that fairness concerns emerge much earlier in ontogeny than previously believed (Hamann et al., 2011; Warneken et al., 2011). The aim of this dissertation was to understand the psychological mechanisms underlying children’s precocious egalitarian sharing of collaboratively earned resources. Study 1 provided evidence that collaboration results in a strong sense of fairness, not observed under individual work conditions. Furthermore, the findings support the view that this sense of fairness is driven by equity over generous or prosocial motives. Study 2 showed that collaboration produced an overall increase in sharing, but that increased equitable sharing was only found when children shared the resources they had earned through collaboration. Study 3 found that children considered equity to be fair from a third party evaluation regardless of how others earned resources (i.e., collaboratively, individually). However, they showed a greater motivation to intervene against normative violations when resources were earned collaboratively. This convergent evidence suggests that collaboration is indeed a special context for the development of fairness.

**Keywords**: collaboration; equity; fairness; generosity; prosociality; cooperation
Acknowledgments

My deep gratitude goes to the hundreds of children and their parents who volunteered their time as participants in this series of studies, without you, none of this would have been possible.

I would like to thank my supervisory committee, whose diversity of expertise challenged me to consider questions of development from a multi-disciplinary perspective. Thanks to Dr. Erik Kimbrough, who always provided thoughtful and diligent feedback on my work, and who generously met with me on many occasions that always led to engaging conversations. Thanks to Dr. Jeremy Carpendale, who encouraged me to challenge the status quo in developmental psychology, and taught me not to shy away from the complexity inherent in systems of development. Thanks to Dr. Tanya Broesch, who as my senior supervisor guided me through my four years at SFU, and challenged me to develop my skills as a writer.

Thanks to my inspirational collaborators, Dr. Felix Warneken, Dr. Katie McAuliffe, and Dr. Peter Blake, whose mentorship, guidance and friendship over the past four years has been indispensable to my growth as a developmental scientist. Our long term collaboration over many projects has been the highlight of my academic career, and I feel truly honored to be a member of this team.

Most of all, I thank my family who supported, guided and provided me with the foundation without which this work would not have been possible. To my father, Dr. John D. Corbit, who instilled in me a core of critical thinking and deep respect for the scientific process. To my mother, Dr. Tara Callaghan, who has been an inspiration from the beginning, but whose generosity and support during this process has earned my
enduring gratitude. To my wife, Lauren Corbit, whose tireless support and personal ambition is an inspiration. It is not easy completing a graduate degree with a young family, but with you it’s been a pleasure. To our children, John and Olive, who taught me about time management, but more importantly inspired me to be a better person, and who have been, and will be, my greatest teachers on the processes of human development.
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List of Acronyms

AI      Advantageous inequity aversion
DI      Disadvantageous inequity aversion
TPP     Third party punishment
Chapter 1.

General Introduction

One of the most striking features of human societies is our tendency to cooperate with others, often at a significant personal cost. For cooperation to be maintained in a society, cooperators have to find ways to distribute resources that are mutually satisfactory. Thus, when considered as a way of distributing resources that satisfies the claims of everyone with a stake, fairness is a key component of cooperative success within human societies. To understand the psychological foundations of fairness it is essential to investigate the developmental processes that shape its emergence. Examining the emergence of fairness throughout ontogeny will elucidate the complex interaction between the psychological foundations and social experience that gives rise to this hallmark of human cooperation. Collaboration is a component of early social experience hypothesized to serve as a foundation for the development of fairness (Tomasello, Melis, Tennie, Wyman, Herrmann, 2012). The goal of this dissertation will be to answer the question of whether collaboration fosters a concern for fairness, and if so, to investigate the psychological processes that nurture this concern.

1.1. The Development of Fairness

Fairness is a complex concept that can be applied across many social domains. For instance, if you have been waiting in line at a community well and I cut in front of you, all things being equal, most casual observers would say that was not fair.
Alternatively, if you were waiting in line after filling two jugs and were going back for a third, we might decide it was fair for me to fill up my first jug because I am in greater need. Similarly, if I am a 70-year-old grandparent and you are a strapping teenager, provided we live in a gerontocracy, you may choose to forfeit your position in line in deference to my status. Finally, if I contributed the labor and resources to dig this well so that members of our community would no longer need to walk five miles each day to get water, we might agree that it was fair for me to fill my bucket first. The simple principle of first come first serve in turn taking becomes immensely complicated when considering the multifaceted nature of everyday social interactions. The studies presented in this dissertation focus on fairness concerns within the domain of distributive justice, a domain that examines how resources are shared in order to balance the stake of every recipient. Analogous to the example of turn taking at the well, and with all things being equal (i.e., similar need, merit, status), equality is the standard of fairness in the domain of distributive justice. Indeed, equality provides an objective benchmark upon which the study of the developmental origins of fairness can be built (McAuliffe, Blake, Steinbeis, & Warneken 2017).

The foundations of fairness may have their roots in infancy. Early in the second year of life, infants show surprise when resources are not shared equally between two puppets (Geraci & Surian, 2011; Schmidt & Sommerville, 2011; Sloan, Baillargeon, & Premack, 2012). Fairness expectations appear to become more nuanced in the second year of life, with toddlers showing an expectation that distributions should be made in proportion to work effort (Sloane et al., 2012). Schmidt and Sommerville (2011) found that 15-month-olds’ expectations for sharing between puppets predicted their willingness
to share a preferred toy with an experimenter. While this link between fairness expectation and sharing behavior supports claims that fairness has roots in infancy, the relation between infants’ understanding of fairness and children’s later fairness behavior is not yet well understood.

The emergence of equal sharing behavior from early to middle childhood has been studied extensively using the dictator game, in which children are given windfall resources (i.e., resources that are not earned) and the option to share some of those resources with an anonymous peer. Children younger than 5 years tend to keep most of the resources, but in the 5-to-8 years age range they become more likely to split resources equally between themselves and a peer (Benenson, Pascoe & Radmore, 2007; Blake, Corbit, Callaghan, & Warneken, 2016; Blake & Rand, 2010; Gummerum, Hanoch, Keller, Parsons & Hummel, 2010; Rochat et al., 2009; Smith, Blake, & Harris, 2013). The pattern of increased sharing during middle childhood is robust and appears consistently across societies, with some variability in the amount of resources shared (Blake et al., 2016; Cowell, Lee, Malcolm-Smith, Selcuk, Zhou, & Decety, 2017; Decety, Cowell, Lee, Mahasneh, Malcolm-Smith, Selcuk, & Zhou, 2015; Rao & Stewart, 1999). Researchers also use binary choice procedures to measure children’s sharing. Typically, in these tasks children are presented with two possible resource distributions between themselves and a peer and asked to decide which distribution they chose. Findings from binary choice tasks indicate that young children (3-5 years) typically choose a payoff that benefits them, whereas children between 5-to-8 years are more likely to pay a cost to choose an option that also benefits a peer (Fehr, Bernhard, & Rockenbach, 2008; House, Henrich, Brosnan, & Silk, 2012; House et al., 2013; Moore, 2009). Thus, across different
measures of resource distribution a common theme of sharing is found. Children tend to keep most resources for themselves in early childhood and begin to share equally beginning around middle childhood (i.e., 5-8 years of age).

One interpretive issue across studies in which children are given resources and asked to share is discerning the motivation that underlies their sharing behavior. For instance, when children give away resources and establish equality as a consequence, a generous or prosocial motive (i.e., giving to another) is confounded with a fairness motive (i.e., achieve equal outcomes) because the only way in which a child can move towards equality is to give one of their own resources to a partner (Blake, McAuliffe, & Warneken, 2014). Researchers have begun to investigate inequity aversion in children in order to differentiate between these motivational factors. Inequity aversion, defined as a willingness to sacrifice rewards to create greater equality, is considered to be an essential component of human fairness (Brosnan & de Waal, 2014; Dawes, Fowler, Johnson, McElreath, & Smirnov, 2007; Fehr & Schmidt, 1999; Loewenstein, Tomson, & Bazerman, 1989). Importantly, inequity aversion takes two forms, disadvantageous inequity aversion (DI) and advantageous inequity aversion (AI) (Blake & McAuliffe, 2011; Brosnan & de Waal, 2014). DI is expressed in cases where individuals pay a cost to prevent a peer from receiving more (e.g., reject the offer of 1 for self and 4 for other). By contrast, AI involves sacrificing resources when the individual receives more than a peer (e.g., reject the offer of 4 for self and 1 for other). AI demonstrates a strong concern for equality that is extended to others and not only the self. Studies with children point to different developmental trajectories of these types of inequity aversion. In US samples, DI emerges around 4 years of age and AI emerges by 8 years of age (Blake & McAuliffe,
with a one-year delay in the onset of both DI and AI in Canada (Blake, McAuliffe, et al., 2015). Thus, it appears that children’s earliest sense of fairness is self-focused, with young children only rejecting inequality when they are at a disadvantage (DI). Later in development, this concern is extended to include others such that older children reject allocations that would benefit themselves more than a peer (AI) showing what appears to be a generalized concern for equality. The cause of children’s shift from a personal to interpersonal sense of fairness remains an open question.

Punishment of unfair behaviors is another way cooperation is maintained in large-scale societies (Fehr & Fischbacher, 2003; Henrich et al., 2005; 2010; Raihani, Thornton, & Bshary, 2012). Interest in the enforcement of fairness norms has led to the study of third party punishment, a paradigm where participants receive the opportunity to sanction others who have violated a fairness norm but whose actions are of no consequence to the participant. In studies with children, punishment is typically done through giving children the option to remove resources of the unfair player. Third party punishment (TPP) of unequal sharing demonstrates a normative (i.e., generalized and agent-neutral) concern for equality. Children engage in TPP of unequal sharing by 6 years of age, even when punishment comes at the cost of personal resources (Jordan, McAuliffe, & Warneken, 2014; McAuliffe, Jordan, & Warneken, 2015; Robbins & Rochat, 2011)

To summarize, the roots of fairness may be present early in ontogeny, evidenced in studies where infants show an expectation that resources should be shared equally. However, the nature of the relation between fairness expectation in infancy and fairness behavior in childhood remains unclear. Studies of children’s fairness behavior indicate
that children’s earliest sense of fairness is self-focused, with 4-year-old children typically keeping more resources for themselves and rejecting inequality only when they are disadvantaged. Later, during middle childhood (5-8 years of age), fairness concerns are extended to include others, as when children engage in costly third party punishment of unequal sharing and begin to share equally themselves. Additionally, by 8 years of age children reject inequality even when it places them at a relative advantage to a peer (i.e., AI), demonstrating what appears to be a more general concern for equality that extends beyond the self to include others.

1.2. The Influence of Collaboration on Fairness

Critically, the aforementioned studies all involved windfall gains, in which children are given resources and can decide how they should be distributed. However, an important aspect of determining fair resource distributions is how the resources are obtained in the first place. Collaborating to earn resources may be an important context where fairness concerns are particularly pronounced because of the state of interdependence created between collaborators. If one party is not happy because resources are distributed unfairly, then they are not likely to continue engaging in the collaborative activity. Dissatisfaction between collaborators is a problem as the interdependent nature of collaboration means that a breakdown in partner engagement leads to a failure in reaching collaborative goals. When resources are distributed equitably, a state of mutual satisfaction is hypothesized to foster a willingness to continue to collaborate (Baumard, André, & Sperber, 2013; Tomasello et al., 2012). Thus, in order to maintain cooperative relationships over time, it is important that resources are distributed fairly, and no one is exploited.
There are abundant scenarios between collaborating peers where fairly distributing resources becomes a heightened concern. Take, for example, a cookie jar placed just out of the reach of two children, with no chairs or footstools in sight to gain the required height advantage. A practical solution would be for one child to offer their back as a stool, allowing their peer to access the cookie jar. Taking the position of stool in the collaboration requires some level of trust, as taking this role means you will not have control over the cookies when it comes time to divide and are thus vulnerable to be exploited. The child who does retrieve the cookies will face a decision between whether to share them equally or perhaps eat them all quickly before a collaborator is able to intervene. The choice to eat all the cookies may be materially beneficial in the short term, but could have long-term social and material ramifications that outweigh this initial advantage. For instance, the relationship between these children would likely suffer, and it would be unlikely that the exploited child would engage in future cookie retrieval collaborations. Furthermore, if this child exhibited this behavior repeatedly, then he or she may be marked as selfish, unfair, or simply as a bad collaborator. Thus, the child’s reputation may be damaged, and the number of potential partners who are willing to engage in future collaboration with the child would become limited. As a child develops and experiences the consequences of not sharing with a collaborator, the negative consequences of such unfair behavior may drive future opportunities to share towards equity, a mutually beneficial strategy.

This previous example is meant to highlight the type (and potential complexity) of peer interactions that may facilitate socialization, and thus development, of equitable sharing of collaboratively obtained resources. Peer socialization of fairness, classically
described by Piaget (1932/1997), is not unique to a collaborative context, and likely guides the development of fairness across many resource acquisition contexts that children experience. However, it may be particularly important in collaborative interactions due to their interdependent nature, which makes balancing peer outcomes critical (Warneken, Lohse, Melis, & Tomasello, 2011).

Recent empirical evidence finds that 3-year-olds will divide collaboratively obtained resources equitably (Hamann, Warneken, Greenberg, & Tomasello, 2011; Ülber, Hamann, & Tomasello, 2017; Warneken et al., 2011). The early emergence of equity\(^ 1\) in collaborative contexts suggests that collaboration may play a role in the development of fairness, but currently the precise nature of this role is not well understood. In two studies, three-year-old children shared resources equally with a partner provided they worked collaboratively to obtain a resource, as compared to conditions in which resources were windfall gains or retrieved through individual work (Hamann et al., 2011; Warneken et al., 2011). For example, when, through experimental manipulation, a “lucky” child ended up with three marbles and an “unlucky” peer with only one, the lucky child was more likely to let the unlucky child have a marble when the marbles were obtained via collaboration as opposed to by individual work (Hamann et al., 2011). Similarly, when the four marbles were pooled in the center of a board, collaborating children were more likely to end up with two per person than when the marbles were just given as a windfall (Ülber et al., 2015; Warneken et al., 2011). Finally, when children earned candies while playing with a puppet, but by chance ended up with

\(^1\) Henceforth the term equity is used rather that equality in cases where peers contribute equally towards earned resources (as compared to windfall situations without any work at all).
more (i.e., 5 for child, 1 for puppet), they often shared at least one candy with the puppet (Ülber, Hamann, & Tomasello, 2017).

These previous examples of precocious equitable sharing between collaborators is extraordinary, especially when compared to children’s sharing with windfall resources noted earlier, where equality does not emerge until 5-8 years of age (Benenson et al., 2007; Blake et al., 2016; Blake & Rand, 2010; Gummerum et al., 2010; Rochat et al., 2009; Smith et al., 2013). To date, little is known about the psychological underpinnings of this remarkable behavior. In order to generate hypotheses regarding the psychological mechanisms that underlie shifts of sharing behavior in collaborative contexts it is important to first consider evidence relevant to the psychological nature of collaborative interactions and their underlying developmental processes.

1.3. The Nature and Development of Collaboration

When a personal goal cannot be achieved individually, it becomes essential for people to collaborate towards that end, forming what becomes a shared goal. Thus, collaboration creates a state of interdependence between individuals, because the contribution of each collaborator is essential in order to achieve a shared goal. Collaborative interactions tend to have three main features: mutual responsiveness, commitment to the joint activity, and commitment to mutual support (Bratman, 1992). Mutual responsiveness requires sensitivity on the part of collaborators to the intentions of each other, which allows for the formation of intermediate goals necessary for the completion of the intended action. Collaborators must also be committed to the joint activity in which they are engaged, or the collaboration will not be sustained. Finally, a commitment to mutual support requires that collaborators flexibly adapt their actions
based on the needs of their partners with the aim of achieving the shared goal. The awareness of joint goals and coordination of mutual action distinguishes collaboration from by-product cooperation, where the action of multiple individuals is directed towards the same goal, but the goal is achieved without coordination of action or intention (Boesch & Boesch, 1989).

Children’s ability to collaborate emerges around the middle of the second year of life, when they are typically able to collaborate on simple problem solving tasks (Brownell & Carriger, 1990; Warneken, Chen, & Tomasello, 2006; Warneken & Tomasello, 2007). By 18-months-of-age, children will attempt to re-engage an adult partner in order to continue a collaborative activity (Warneken et al., 2006). Children’s skills of collaboration continue to improve in the second year of life, with 24-month-olds now able to collaborate with peers (Brownell & Carringer, 1990). By 24 months of age children will also attempt to re-engage an adult partner who is unable (i.e., constrained by physical limitations, but motivated) to perform their role in a collaborative activity. However, they do not attempt to re-engage unwilling (i.e., physically capable, but not motivated) partners, providing evidence that children in this age range consider the intentions of their collaborative partners (Warneken, Gräfenhain, & Tomasello, 2012). Evidence that children appear to enjoy collaborative activities comes from the finding that, when given the choice between obtaining a reward collaboratively or through individual work, 3-year-olds more often choose the collaborative option (Rekers, Haun, & Tomasello, 2011). Children also demonstrate a commitment to the joint goals established during collaboration; 3.5-year-olds will continue to work until a partner has received a reward, even if they have already received their own (Hamann, Warneken, &
Thus, from infancy through to the pre-school years children’s emerging collaborative skills progress from making a well-intentioned, yet inflexible contribution, toward increased flexibility and commitment to the achievement of joint goals. This progression in behavioral complexity over early development highlights the importance of understanding the development of the social cognitive abilities that underlie these developmental shifts.

Theorists have proposed that the abilities to hold a joint goal with a partner and to coordinate the roles needed to achieve the goal are two essential social cognitive components of human collaboration (Fletcher, Warneken, & Tomasello, 2012; Searle, 1990). In order to hold a joint goal and coordinate action toward that goal, children must possess social cognitive skills enabling them to represent the intentions and goals held by both themselves and their partner. Understanding the goals and intentions of another person is a skill that is present in nascent form toward the end of the first year of life (Lou & Baillargeon, 2005; Woodward, 1998). However, these skills continue to develop in the second year. For instance, when an actor tries but fails to complete an action, infants show a sophisticated understanding of intention by imitating the actor’s intended action and not their failed attempt (Meltzoff, 1995). Furthermore, infants are selective in the actions they imitate showing an ability to separate a person’s intention from the actions used to achieve it (Gergely, Bekkering, Király, 2002). Beginning in infancy and continuing throughout early childhood, children are also developing social understanding of other’s desires, beliefs, knowledge and emotions (Wellman & Liu, 2004; Yott & Poulin-Dubois, 2016).
While infants have remarkable abilities to read goals and intentions of others (Baldwin, Baird, Saylor, & Clark, 2001; Woodward, 1998), adults play an important supportive role in fostering the development of intentional understanding (Carpenter, Nagell, Tomasello, 1998; Tomasello & Farrar, 1986). Infants between 12 and 18 months of age can collaborate with adults on simple tasks, but it is not until 24 months of age that they are able to collaborate with a peer (Brownell & Carringer, 1990). The relative delay in peer collaboration suggests that the ability to integrate one’s own goals and intentions with those of another is still developing at this age, and the introduction of a peer who is at a similar emerging skill level makes such coordination more challenging. Barresi and Moore (1996) suggest that it is through cooperative games and interactions with adults that children gain the social experience necessary to recognize and generate joint intentions. Indeed, it has been proposed that triadic interactions with adults may be the foundation for the development of joint intentionality in children, given that adults provide a stable partner, which in turn allows for the formation of predictable routines between adult and child wherein social understanding can gradually be constructed (Carpendale & Lewis, 2004). Given the added challenges of peer collaboration, and the necessity to meet these challenges, it is possible that early peer interactions provide the setting where the abilities to coordinate and collaborate are developed to a new, more refined level (Zerwas, Balaraman, & Brownell, 2004). In a study of early peer interaction, Brownell, Ramani, and Zerwas (2006) found that collaboration between peers was sporadic at 19 months of age, showing little evidence of coordinated action. However, by 27 months of age, children were much more skilled at coordinating their actions in order to achieve a joint goal.
In studies with older children, researchers have also attempted to identify the psychological nature of collaboration. Fostering a state of interdependence between peers through collaboration has been found to create cohesion and increase prosociality. In their now classic study, Sherif and colleagues (Sherif, Harvey, White, Hood, & Sherif, 1961) placed children attending a summer camp into two groups, the Rattlers and the Eagles. In the early days of the camp, situational conditions were created that fostered intergroup competition. This resulted in tension between the two groups, which was reflected in negative attitudes, assignment of blame to negative events, and overt antisocial behavior. When the intergroup tension was deemed to be sufficient, Sherif and colleagues sought to test their hypothesis that this tension could be overcome by the introduction of conditions that necessitated intergroup collaboration. For example, experimenters shut off the water for the entire camp, a situation requiring members of both groups to contribute to efforts to turn the water back on. The effect of this intergroup collaboration was immediate and by the end of camp, the Rattlers used money they had won in intergroup competition to buy refreshments that they shared across group boundaries. Sherif and colleagues argued that collaboratively working on a common problem changes attitudes towards social partners, reducing competition and increasing prosociality, even across intergroup boundaries (Sherif et al., 1961).

Thus, collaboration is an essential component of human social interactions, something we enjoy, and that fosters the achievement of goals beyond the reach of individuals. Furthermore, the nature of collaboration necessitates dynamic responsiveness with your partner to ensure they have the means to fulfill their contribution to the joint commitment you endeavor to achieve. It is this mutual responsiveness and joint
commitment to a shared goal that may make collaborators particularly sensitive to the material and resulting internal state outcomes of their partner. However, the precise nature of this concern for collaborative partners is not yet well understood. There is evidence that collaboration increases perspective taking (Carpenter et al., 2005), equitable sharing (Hamann et al., 2011; Warneken, et al., 2011), affiliation (Plötner, Over, Carpenter, & Tomasello, 2015), and prosociality (Gräfenhain, Carpenter, & Tomasello, 2013; Hamann, Warneken, & Tomasello, 2012; Plötner et al., 2015; Sherif et al., 1961), but how the psychological underpinnings of this positive cascade of behaviors may increase fairness concerns has not been delineated as yet.

1.4. Children’s Sharing After Collaboration

As noted, in windfall paradigms where children give away resources and establish equity as a consequence, a generous or prosocial motive is confounded with a motive to achieve equitable outcomes. The confound results in an interpretive problem regarding the psychological nature of the effect; children’s decisions could be motivated either by a desire for equity or by a desire to be more generous to the partner. There is a related interpretive problem in paradigms where children collaborate to earn resources (e.g., Hamann et al., 2011; Warneken et al., 2011), where it is not clear what component of the collaborative interaction influences children’s sharing behavior. Children may be influenced by the context of collaborating to earn the resources they subsequently share, by the more general context of collaborating towards a shared goal that is unrelated to the resources shared, or by simply having engaged in a positive social interaction. Disentangling these contextual factors can address the question of whether collaboration results in a shift in the relationship between collaborators (i.e., a social preference shift)
or a shift in attitude towards collaboratively obtained resources (i.e., distributional preference shift). Researchers typically interpret the collaboration effect on sharing in 3-year-olds as an increased concern for equity (Hamann et al., 2011; Warneken et al., 2011). If collaboration does increase a concern for equity in young children in these paradigms, it is not clear how broadly this concern is applied. For instance, equity concerns may be restricted to the interpersonal context of collaborating to earn resources. Alternatively, a concern for equity between collaborators may extend beyond the child’s own interpersonal experiences to become a normative concern.

This dissertation presents three studies that aim to address these outstanding questions regarding the nature of the psychological processes that result in precocious equal sharing between collaborators: Is sharing after collaboration motivated by equity or generosity? Which component of the collaborative interaction results in increased sharing? If collaboration motivates equity, then is equity only a concern within the collaborative context, or is it applied more broadly, becoming a normative concern?

1.4.1. Equity or Generosity

Although equity and prosocial motives need not be mutually exclusive (Blake, McAuliffe & Warneken, 2014), if we are to understand the motivational consequences of collaboration on sharing, then it is important to design experimental investigations that distinguish which of these factors serves the primary role in motivating increases in sharing behavior.

To date, studies assessing children’s sharing after collaboration have primarily proposed that this behavior is motivated by equity (Hamann et al., 2011; Hamann et al., 2014; Warneken et al., 2011), but these designs cannot distinguish whether children’s
decisions are motivated by a desire for equity or by a desire to be more generous toward the partner. We will refer to the former motive as the *Equity Hypothesis*, and the latter motive as the *Generosity Hypothesis*. Specifically, when children offer their peer a resource, one interpretation is that they want both to receive the same amount, thus achieving equity. However, it is also possible that they feel more generous towards the peer with whom they just collaborated, and the equal outcome is merely a side effect of children being more prosocial and generous toward that peer. This latter possibility gains empirical support from Plötner et al. (2015) who found that 3.5-year-olds expressed feelings of trust, liking and affiliation towards collaborative partners over agents with whom they had worked on a task in parallel. Similarly, Hamann et al. (2012) found that children were more willing to spontaneously help a peer if they had collaborated on a task together. Furthermore, as they worked on the task together, children were more likely to help and wait for their collaborative partners to complete the task before moving on to other activities (Gräfenhain et al., 2013).

Given these findings, it is possible that children are more inclined to be prosocial, and therefore generous, towards a collaborator, without this being motivated by a desire for equity per se. This interpretation is consistent with Sherif and colleagues’ proposal that collaboratively working on a common problem changes children’s attitudes towards social partners, reducing competition and increasing prosociality even across group boundaries (Sherif et al., 1961). The claim that collaboration motivates equity (Tomasello et al., 2012) based on studies of children’s sharing (Hamann et al., 2011; Warneken et al., 2011) may be premature given the litany of evidence that collaboration also increases prosociality (Gräfenhain et al., 2013; Hamann et al., 2012; Plötner et al., 2015; Sherif et
al., 1961). If we are to understand the motivational processes that underlie this remarkable behavior, then experiments designed to address these conflicting accounts are needed. Study 1 addresses these conflicting accounts.

1.4.2. Shared Resources, Shared Goals or Positive Social Interaction?

In addition to discerning the motivational underpinnings, it is important to ask which components of the collaborative interactions impact children’s sharing. In the original studies, children collaborated to retrieve resources that they could immediately share (Hamann et al., 2011; Warneken et al., 2011). It is possible that collaborating to obtain resources in this task created a concern for equity specific to the spoils of collaboration, as when collaborators are seen to have an equal claim to resources due to equal contribution of labor. This interpretation is buttressed by evidence that from three years of age children show a sensitivity to merit when dividing collaboratively earned resources, preferring that resources are divided in proportion to work contributed (Hamman et al., 2014).

Another possibility is that children extend general prosocial preferences towards collaborators, which could result in greater generosity toward their collaborating partners regardless of how resources were obtained. As noted above, collaboration increases social preferences for a collaborator, preferences that are not tied to equity and extend beyond the specific context and/or resources obtained with the collaborator (Gräfenhain et al., 2013; Hamann et al., 2012; Plötner et al., 2015; Sherif et al., 1961). Alternatively, children may extend a general preference for equality to collaborators, regardless of how resources are obtained.
Finally, children’s sharing may be influenced by the positive social interaction inherent in collaborative interactions, rather than the collaboration per se. There is evidence in several non-collaborative contexts that children do show preferential treatment of particular others with whom they share affiliation or a prior positive relationship. For example, children share more generously with friends than non-friends (Moore, 2009), with in-group compared to out-group members (Fehr et al., 2008), and those with whom they experience affiliation though minimal group membership or similar interests (Sparks, Schinkel, & Moore, 2017). Contingent social interactions elicit similar preferences for social partners, including synchrony in peer actions (Tunçgenç & Cohen, 2016a,b), and singing and drumming, which also increased sharing (Rabinowitch & Knafo-Noam, 2015). A systematic test of the importance of the components of collaborative interactions (i.e., earned resources, shared goals and social engagement) in children’s sharing behavior is necessary to understand the psychological processes that result in greater sharing after collaboration. The components of collaborative interactions are examined in Study 2.

1.4.3. Enforcement of Equity Between Collaborators

While children share collaboratively obtained resources equally by three years of age (Hamann et al., 2011; Warneken et al., 2011; Ülber et al., 2017), it is not clear whether this preference extends outside of their own interactions to the judgment of fair behavior in others. Whether children understand and enforce fairness norms in third party situations has been studied in the context of windfall resources. Smith et al. (2013) noted that 3-year-olds understand equality norms, and state that resources should be divided equally, but then subsequently ignore this prescriptive norm in their own behavior.
Rakoczy, Kaufmann and Lohse (2016) found that 3- to 5-year-old children protested unfair distributions regardless whether they were affected themselves, or witnessed the violation occur to a third party. Although both 3- and 5-year-old children protest unfair distributions, 5-year-olds used normative language more often in this study. These findings suggest that children enforce norms of equality through protesting unfair distributions from early in ontogeny.

By 6 years of age children punished unequal distributions by discarding resources that were shared unequally, they did so even when punishment came at the cost of paying their own resources (Jordan, McAuliffe, & Warneken, 2014; McAuliffe, Jordan, & Warneken, 2015). Thus, we see evidence that from an early age children are willing to intervene in unfair situations. Researchers report normative protest of unequal distributions of resources in 3-year-olds, and costly TPP in 6-year-olds. Together these findings suggest that children’s preference for equality is applied broadly and not tied to interpersonal exchanges.

If collaboration does increase a concern for equity, as has been claimed (e.g., Hamann et al., 2011), it is important to ascertain whether the concerns are restricted to the interpersonal context between the child and a collaborator, or have a normative dimension. By testing children’s third party evaluations of unfair sharing in the collaborative context in Study 3, important insights can be gained into the social bounds of children’s concern for equity within collaboration, whether they are interpersonal or normative.
1.5. The influence of collaboration on fairness: Three studies examining the role of motivation, social context and norms.

The overall goal of the studies in this dissertation is to better understand the role of collaboration in the development of fairness. The finding that very young children share more after collaborating (Hamman et al., 2011; Warneken et al., 2011), coupled with claims that collaboration is critical for the success of the human species (Tomasello et al., 2012; Baumard et al., 2013), inspired the design of a series of three inter-related studies that explore the psychological factors inherent in collaboration that are driving this effect. Three factors are explored: motivation, social relations, and normative concerns. Each factor is assessed in one of the three studies, which are united by the common goal of understanding the influence of collaboration on children’s fairness.

Study 1 distinguishes between two hypotheses that have been advanced to account for the motivation underlying children’s increased sharing when resources are obtained collaboratively, compared to individual work (Hamman et al., 2011; Warneken et al., 2011; Ülber et al., 2017). Children’s decisions could be motivated either by a desire for equity or by a desire to be more generous to the partner, two possible motives that could not be disambiguated in the prior research. The *Equity Hypothesis* states that when children have contributed equally towards earned resources, collaboration leads to a greater sense of equity. In contrast, the *Generosity Hypothesis* advances the claim that children will behave more generously towards a peer with whom they just collaborated, and the equal outcome is merely a side effect of children being more prosocial and generous.

To disambiguate the *Equity* and *Generosity Hypotheses* Study 1 used a measure of inequity aversion. The inequity game is able to disambiguate these motivational factors
because in order to maintain equity, children must make a non-generous choice. In this task, pairs of children sit across from each other and one child decides whether to accept or reject resource allocations of equal (1-1) or unequal (1-4, DI condition; 4-1, AI condition) distributions. If an offer is accepted, both children receive the rewards they were allotted. Accepting DI is particularly generous, because it imparts a relative advantage to the partner. Rejecting an offer in the Inequity Game results in a payoff of zero to both participants. Therefore, rejections of both DI allocations and AI allocations are equitable, but non-generous, as they deprive the partner from obtaining a reward. Thus, the Inequity Game allows a test of equity independent of any motive to be generous. In Study 1 children worked either collaboratively or individually to earn resources that were later divided in the inequity game (Blake & McAuliffe, 2011).

Study 2 focused on the nature of the collaborative relationship itself. Two questions were investigated. First, do children need a concrete joint goal to produce increased sharing, or will joint social engagement between peers, common across most collaborative interactions, elicit a similar effect? Second, is the increase in equal sharing observed in previous work (Hamman et al., 2011; Ülber et al., 2017; Warneken et al., 2011) specific to the context of jointly earned resources, or will it also be evident when collaborators share other resources obtained outside of the collaborative context?

To address these questions in Study 2, children’s sharing was assessed before and after three conditions of peer interaction where children played social games: Joint Resources, Joint Goal, and Social Play. In the Joint Resource condition children performed complementary roles in a game while collaborating to earn resources that were later shared. In the Joint Goal condition, children once again collaborated towards a joint
goal, but in this case they collaborated to extract toys in a collaborative game, and unrelated windfall resources were subsequently divided. In the Social Play condition, children engaged in a social game that required complementary roles but did not contain a concrete goal. In this condition the goal was to play a social game, whereas in the collaborative conditions (Joint Goal and Joint Resource) children engaged in a problem-solving task with the concrete goal of extracting an object. The Social Play condition served as an important control against the possibility that simply engaging in a joint social activity would produce similar effects on sharing as compared to collaboration towards a concrete goal. Children’s sharing was assessed before and after the social game phase using dictator games, with candy as the resource, to establish the impact of the social interactions on children’s sharing. Thus, Study 2 examined children’s behavior across the contexts of collaborating to earn resources, collaborating towards a shared goal, and simply engaging in a positive social interaction, to disambiguate the importance of these factors on children’s sharing after collaboration.

Study 3 explored whether children view equal sharing of collaboratively earned resources as a norm that dictates fairness between collaborators. Prior work has found that children are aware of equality as an injunctive norm (i.e., What should you do?) from 3 years of age (Smith et al., 2013). Furthermore, children will protest unequal sharing at this age and use more normative language by 5 years of age (Rakoczy et al., 2016). Punishment of unequal sharing emerges by 6 years of age, with children even willing to pay a cost to punish inequality (Jordan et al., 2014; McAuliffe et al., 2015). Although the evidence suggests that 3-year-olds are aware of the norm of equal sharing, there is no evidence that they act on that knowledge under windfall conditions (Smith et al., 2013).
Given that prior collaboration accelerates the onset of equal sharing in children, it is important to identify whether collaboration also enhances children’s normative concern for equality. In comparison to viewing partners in non-collaborative contexts, will children who view collaboration between partners be more willing to punish in TPP contexts, and will TPP emerge at an earlier age when children have previously viewed collaborating partners?

To assess whether collaboration elicits a stronger normative concern for equality, Study 3 presented children with a simple procedure in which puppets shared earned resources obtained through collaboration or individual work. On each trial, by chance a “lucky” puppet gained control over all of the resources and was subsequently asked to share. Children saw blocks of several trials where the puppet shared either equally or unequally. At the end of each block, children were shown the resources each puppet had accumulated, and given the opportunity to punish or allow the resources to be distributed. This design allowed for a between subjects comparison of children’s punishment of unequal sharing across collaboration and parallel (non-collaboration) work conditions. Additionally, children’s punishment of unequal sharing could be compared relative to equal sharing, serving as an important within subject control.

The findings from these inter-related studies will make several important contributions to our understanding of the effect of collaboration on children’s sharing and the role of collaboration in the development of fairness more generally. First, Study 1 will be the first to disambiguate between equity and generosity as motivational determinants of children’s sharing after collaboration. Next, Study 2 is unique in its approach to discerning the critical factors that underlie the positive impact of collaboration on
sharing; earning collaborative resources, mutual achievement of a shared goal and social play. Finally, Study 3 extends the question of collaboration and sharing to a novel context; the normative force of equity between collaborators held by a third party observer. Together these studies deepen our understanding of the influence that these motivational, social relational, and normative factors have on children’s sharing in collaborative contexts. Ultimately, the findings from these studies will inform the psychological nature of the link between collaboration and increased sharing, and in doing so will significantly contribute to our understanding of the development of fairness in young children.
Chapter 2.

Study 1. Children’s Collaboration Induces Fairness Rather than Generosity\(^2\)

2.1. Abstract

From four years of age, children reject resource allocations where they receive fewer resources than a peer (disadvantageous inequity aversion- DI). By eight years of age, children also reject allocations where they receive more resources than a peer (advantageous inequity aversion- AI). Together AI and DI constitute forms of inequity aversion, a hallmark of fairness that extends beyond a personal concern (DI) to include others (AI). Other work demonstrates that children reduce inequity by sharing more after collaboration. However, it is unknown whether collaboration leads to greater sharing because it encourages prosociality (*Generosity Hypothesis*) or because collaboration elicits stronger egalitarian tendencies (*Equity Hypothesis*). The current study used the *Inequity Game* to assess children’s sensitivity to both AI and DI across resource acquisition contexts of collaboration and individual work. A relative increase and earlier age of emergence of AI would support the *Equity Hypothesis*, as AI demonstrates a general concern for equity. A relative decrease or delayed emergence of DI would support the *Generosity Hypothesis*, as allowing a peer to receive an advantage would show generosity. Children between the ages of 4-10 years were recruited from rural

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\(^2\) This study has been published along with data collected in India as 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.
Canada, a population that shows both AI and DI. Pairs of children worked either collaboratively or in parallel obtaining candy that was then used in a test of DI and AI. Results showed that collaboration did not encourage children to accept DI offers, providing evidence against the *Generosity Hypothesis*. However, older children showed AI at an earlier age than was previously observed. This suggests that collaboration can induce a willingness to sacrifice an advantage to achieve equity, consistent with the *Equity Hypothesis*. 
2.2. Introduction

2.2.1 Inequity Aversion

Cooperators have to find ways to distribute resources in a mutually satisfactory way for a cooperative interaction to be sustained in the long-term. It has been proposed that “inequity aversion,” defined as a willingness to sacrifice rewards to create greater equity (Fehr & Schmidt, 1999), captures this aspect of human fairness. Importantly, inequity aversion takes two forms, disadvantageous inequity aversion (DI) and advantageous inequity aversion (AI) (Loewenstein et al., 1989; Fehr & Schmidt, 1999). DI is expressed in cases where individuals pay a cost to prevent a peer from receiving more. This behavior may be motivated by spite (McAuliffe et al., 2014) and envy (Shaw & Olson, 2012) and not by egalitarian fairness preferences. DI can signal to others that one is not willing to accept exploitation (Brosnan & de Waal, 2014; Yamagishi, Horita, Takagishi, Shinada, Tanida, & Cook, 2009). By contrast, AI involves sacrificing resources when the individual receives more than a peer. This demonstrates a recognition of equity as a norm of fairness that applies broadly and may be motivated either by an internalization of this norm or by a desire to signal that one is a good cooperative partner who is unwilling to exploit others (Blake, McAuliffe, et al., 2015; Brosnan & de Waal, 2014). Rejections of AI go against both the individual’s immediate benefit and prevent the individual from gaining a relative advantage, making this behavior a marker of a strong sense of fairness.

Much research suggests that DI and AI are supported by different psychological mechanisms. Adults show both AI and DI, but show a stronger response to DI than AI (Dawes, Fowler, Johnson, McElreath, & Smirnov, 2007; Fehr & Schmidt, 1999; Loewenstein et al., 1989). More recently, studies with children point to different
developmental origins of both types of inequity aversion. DI and AI follow different developmental trajectories, with DI emerging around 4 years of age, and AI emerging by 8 years of age in the US (Blake, McAuliffe, et al., 2015; Blake & McAuliffe, 2011; McAuliffe, Blake, Kim, Wrangham, & Warneken, 2013; Shaw & Olson, 2012). Thus, it appears that children’s earliest sense of fairness is self-focused, with children only rejecting inequity when they are at a disadvantage. Later in development, this concern is extended to include others such that children reject allocations that would benefit themselves more than a peer, showing what appears to be a generalized preference for equity. Furthermore, children may show an increase in generosity when they have agentive control to distribute resources (Chernyak & Kushnir, 2013; Shaw, Choshen-Hillel, & Caruso, 2016). The cause of children’s shift from a self-focused to a more general sense of fairness remains an open question.

One possibility is that while DI is present early in ontogeny, AI is present only later and may be the result of children internalizing the social norms that guide behavior in their group (Chudek & Henrich, 2011; House et al., 2013; Smith et al., 2013). The hypothesis that AI and DI are supported by different mechanisms gains support from a recent study by Blake, McAuliffe and colleagues (2015) testing the emergence of inequity aversion across seven diverse societies. This study found that DI emerged in all of the groups that were tested, though with variability in the age of emergence. This suggests that DI may be a more general feature of human behavior, although cultural factors may influence its development. In contrast, AI emerged later than DI, and only in three of the populations included in this study (US, Canada and Uganda). This variability
in the emergence of AI provides support for the notion that it emerges as a result of a norm-based sense of fairness (Chudek & Henrich, 2011).

2.2.2. Equitable Sharing in Children

Beyond studies on inequity aversion, studies of children’s sharing with different paradigms suggest that a strong sense of equity may be a feature of later development, not emerging before school age. For example, in dictator games (DG), younger children tend to keep most of the resources, but towards 5-8 years of age, they become more likely to split resources equally (Benenson, Pascoe, & Radmore, 2007; Blake & Rand, 2010; Gummerum et al., 2010; Rochat et al., 2009; Smith et al., 2013). Similarly, binary choice tasks show that young children choose a payoff that benefits them, with children at 6-8 years becoming more likely to pay a cost to choose an option that also benefits a peer (Fehr et al., 2008; House et al., 2012; House et al., 2013; Moore, 2009; Thompson, Barresi, & Moore, 1997). In summary, studies of children’s sharing and inequity aversion suggest that children’s strong egalitarian tendencies emerge relatively late in development, not before around 5-8 years of age.

2.2.3. Sharing After Collaboration

Critically, the aforementioned studies all involved windfall gains, in which children are simply presented with resources and can decide how they should be distributed. However, an important aspect of determining fair resource distributions is how the resources are obtained in the first place. This question is particularly important given the hypothesis that inequity aversion serves to stabilize cooperation, with individuals choosing how to share the fruits of their collaborative labor (Baumard et al., 2013; Tomasello et al., 2012). Recent empirical work supports this hypothesis, showing
that even preschool children create equal resource distributions in collaborative contexts. Children as young as 3 years of age will share resources equally with a partner provided they have worked collaboratively to obtain a resource, as compared to conditions in which resources were windfall gains or retrieved through individual work (Hamann et al., 2011; Warneken et al., 2011). For example, when a “lucky” child ended up with three marbles and the “unlucky” peer with only one, the lucky child was more likely to let the unlucky child have a marble when the marbles were obtained via collaboration as opposed to by individual work (Hamann et al., 2011). This essentially amounted to a binary choice where children decided to share or keep the extra marble. Similarly, when the four resources were pooled, collaborating children were more likely to end up with two per person than when the resources were just given as a windfall (Ülber, Hamann, Tomasello, 2015; Warneken et al., 2011).

2.2.4. Equity or Generosity

An interpretive problem of this prior work on the connection between collaboration and sharing is that children’s decisions could be motivated either by a desire for equity or by a desire to be more generous to the partner. A desire to be more generous, referred to as the Generosity Hypothesis, is to be contrasted with the Equity Hypothesis that motivated the work above. Specifically, when children offer their peer a resource, one interpretation is that they want both to receive the same amount. However, it is also possible that they feel more generous towards a peer with whom they just collaborated, and the equal outcome is merely a side effect of children being more prosocial and generous. This latter possibility gains empirical support from Plötner, Over, Carpenter, and Tomasello (2015) who found that 3.5-year-olds expressed feelings of
trust, liking and affiliation towards collaborative partners over agents who had worked on a task in parallel. For example, children were more likely to help the collaborator over a non-collaborator and to choose the collaborator when asked whom they liked better. Similarly, Hamann, Warneken and Tomasello (2012) found that children were more willing to spontaneously help a peer if they had collaborated on a task together. Furthermore, children are more likely to help and wait for a collaborative partner to complete their task before moving on to other activities (Gräfenhain et al., 2013). Thus, it is possible that children are more inclined to be prosocial and therefore generous towards a collaborator, without this being motivated by a desire for equity per se. This interpretation is congruent with a long tradition in social psychology going back to the seminal work by Sherif and Sherif, who argued that collaboratively working on a common problem changes children’s attitudes towards social partners, reducing competition and increasing prosociality even across group-boundaries (Sherif et al., 1961). The Generosity Hypothesis is thus a plausible and empirically founded alternative explanation that could explain previous results relevant to children’s sharing after collaboration.

As a general methodological point, in paradigms where children give away resources and establish equity as a consequence, a generous or prosocial motive is confounded with a motive to achieve equal outcomes because the only way in which a child can move towards equity is to give one of their own resources to a partner (Blake et al., 2014). Thus, from prior work it is unknown whether collaboration increases equal outcomes as a side effect of a general positive attitude and generosity or due to a heightened sense of fairness.
To be able to test whether collaboration actually leads to greater equity, a procedure is needed that disambiguates egalitarian motives from generosity. The *Inequity Game* developed by Blake and McAuliffe (2011) achieves exactly that, because to establish equity, children have to act in a way that is not generous. In this task, pairs of children sit across from each other and one child (the actor) decides whether to accept or reject resource allocations of equal (1-1) or unequal (1-4, DI condition; 4-1, AI condition) distributions. If an offer is accepted, both children receive the rewards they were allotted. Rejecting an offer in the *Inequity Game* results in a payoff of zero to both participants. Therefore, rejections of both DI allocations and AI allocations are non-generous, as they deprive the peer from obtaining a reward. Thus, the *Inequity Game* allows a test of egalitarian tendencies independent of any motive to be generous.

With this method it is possible to disambiguate whether children’s sharing after collaboration is motivated by generosity or equity. Children’s responses to AI (i.e., 4 candies for self, 1 for peer vs. none for either) are particularly important to provide evidence for the notion that collaboration is tied to fairness in terms of egalitarian preferences: If collaboration engenders a strong sense of fairness, children should be more likely to reject advantageous allocations after collaboration than after parallel work controls, creating equity even though it is costly to both partners. By contrast, children’s responses to DI are particularly informative about children’s potential sense of generosity, as here children have to choose whether or not to convey a greater benefit to the other (i.e., 1 candy for self, 4 for peer vs. none for either): If collaboration makes children more generous towards a collaborator, they should be less likely to reject DI allocations than parallel-work controls in order to maximize the gain for the peer.
To distinguish between motives of equity or generosity, there must be the potential for participants to increase rejections of AI allocations and decrease rejections of DI allocations. In addition, it is important to choose a sample with the potential to shift in the age of emergence of AI and DI. A previous study (Blake, McAuliffe et al., 2015) allowed us to identify a population of children and the appropriate age-ranges to meet these criteria. In the previous study, children from a rural Canadian community showed DI from 5 years of age, with AI emerging by 9 years of age, allowing for both shifts in the strength and age of emergence of AI and DI. Thus, an age range of 4 to 10 years for a sample of children from this same community was selected. This range began at the age directly preceding that where children from the same population had previously shown an emergence of DI. The selected range also allows for an earlier or later emergence of AI relative to what was observed previously (Blake, McAuliffe et al., 2015).

Study 1 investigates the effect of prior collaboration on children’s inequity aversion. Pairs of children were given the opportunity to earn candies either collaboratively or through parallel work. Earned rewards were then presented to the children using the Inequity Game, making it possible to compare children’s responses to equal and unequal allocations of candy under the two work type conditions. The unequal allocations were either advantageous or disadvantageous and varied between subjects. This method holds the amount of work required to obtain resources constant, while varying the type of work (collaboration, parallel work) needed to obtain them. The dependent measure was children’s rate of rejections of equal and unequal allocations in the Inequity Game. In this way, it was possible to measure the impact of work type on
children’s expression of DI and AI by comparing the relative rate of rejection of equal and unequal trials.

This design enables the differentiation of two hypotheses. The *Equity Hypothesis* states that collaboration leads to a greater sense of equity, predicting that children will reject *more* disadvantageous and advantageous allocations following collaboration than following parallel work. By contrast, the *Generosity Hypothesis* states that collaboration leads to more generosity towards a collaborator. This hypothesis thus predicts that children will reject *fewer* disadvantageous and advantageous allocations following collaboration than following parallel work.

Another important question examined in Study 1 was the age of emergence of inequity aversion. If DI and AI emerge earlier after collaboration than previously found in these populations, this would be additional evidence for the *Equity Hypothesis*. Specifically, in this sample, the hypothesis would predict that DI emerges earlier than 5 years of age, which is the age at which Canadian children previously showed DI after windfall gains (Blake, McAuliffe et al., 2015). In addition, if children who collaborated for resources showed AI before 9 years of age, which is the age at which Canadian children previously showed AI for windfall gains, this would further support the hypothesis that collaboration elicits equity concerns. By contrast, the *Generosity Hypothesis* predicts that even though children from this population had shown DI after windfall gains, DI would be delayed or absent after collaborative gains, and AI would be delayed or absent. The hypotheses are thus driven by the predicted developmental trajectory of AI and DI.
2.3. Method

2.3.1. Participants

A total of 132 pairs of participants were sampled from within a range of 4 to 10 years of age (M = 88.5 months, range = 50.4 – 131.1 months, 62 females). Participants were recruited through summer camps in a rural community in Eastern Canada (see Appendix A for population demographics). A total of n=4 participants were not included in the final data set because they did not complete the procedure (n=2), or failed to follow the instructions (n=2). This sample size was selected based on typical samples used in prior work on inequity aversion that employed a similar approach to analyses (Blake, McAuliffe, et al., 2015). Age was analyzed as a continuous variable, but in the interest of counterbalancing across the four conditions participants were divided into 3 age groups (4-5, 6-7, 8-10 years), and there were roughly an equal number of participants from each age group across conditions, as well as a nearly balanced distribution of gender.

Table 2.1. Counterbalancing Study 1: Participants distributed by age group, condition, and gender (female)

<table>
<thead>
<tr>
<th>Condition</th>
<th>Age Group</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>4-5</td>
<td>6-7</td>
</tr>
<tr>
<td>CO-AI</td>
<td>9(4)</td>
<td>11(5)</td>
</tr>
<tr>
<td>CO-DI</td>
<td>10(5)</td>
<td>10(4)</td>
</tr>
<tr>
<td>PW-AI</td>
<td>9(5)</td>
<td>10(2)</td>
</tr>
<tr>
<td>PW-DI</td>
<td>9(4)</td>
<td>10(5)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2.3.2. Design

Study 1 employed a 2 X 2 X 2 design with type of work (collaboration, parallel work) and type of inequity (AI and DI) both as between participants variables, and allocation (equal or unequal) as a within participant variable. Gender matched pairs of
children were randomly assigned to one of 4 conditions (Collaboration-AI, Collaboration-DI, Parallel Work-AI, Parallel Work-DI). Because participant pairs were recruited at summer camps, they were likely to have prior social experience with one another. However, random assignment across conditions ensured that prior relationship within dyads did not vary systematically across conditions.

Children were tested in two blocks of trials. Within each block participants first received 4 work trials and then 6 inequity trials before repeating this process immediately in the second block. Thus, in each block, children started with the Pulling Game, where they worked to obtain a pool of Skittles either through collaboration or in parallel (depending on condition). On each trial 6 candies were acquired, for a total of 24 candies per block. Children then proceeded to the Inequity Game, where the experimenter distributed the resources collected by the pair in the first phase. The Inequity Game test trials consisted of 3 equal (i.e., 1/1 for self/partner) and 3 unequal trials (i.e., AI: 4/1 for self/partner, or DI: 1/4 for self/partner), for a total of 6 test trials per block. The second block of trials was run exactly like the first, yielding a total of 8 trials where resources were earned and 12 test trials where they were distributed in the Inequity Game across the two blocks.

Trial type (equal, unequal) varied within participants and the presentation of equal and unequal trials was randomized within block. Children were randomly assigned to one of two roles: the actor, who made all decisions in the game or the recipient, who made no decisions. The roles of actor and recipient were always the same across the entire session.
2.3.3. Apparatus

The Pulling Game was modeled after Hamann et al. (2011), originally adapted from an apparatus used by Hirata and Fuwa (2006) with chimpanzees. The Pulling Game was built on a large board (60cm x 32cm) having two configurations: collaboration and parallel work. Under the collaboration configuration one central block (10cm x 7.5cm) moved along a track in the center the board. The block had a rope (120cm) that was loosely attached to it through two loops. The block only moved down the track if both ends of rope were pulled at the same time, otherwise the rope unraveled. When the block reached the edge of the panel, it knocked the rewards onto ramps that distributed the rewards to participants. In the parallel work configuration, the apparatus was the same except there were two blocks (5cm x 7.5cm), each with separate ropes (40cm) attached. Under this configuration individual participants could control the movement of only one block by pulling their rope (See Figure 1 for schematic illustration).
Figure 2.1. Schematic illustration of Pulling Game in a) parallel work and b) collaboration configurations.

Figure 2.2. Illustration of Inequity Game in a) Unequal-AI, b) Unequal-DI and Equal distributions.
The *Inequity Game* (Blake & McAuliffe, 2011) presents actors with the choice to accept or reject allocations of resources between themselves and a passive recipient (see Figure 2.2). After the experimenter placed the resources (Skittles) on separate trays for the actor and recipient, the actor accepted or rejected the allocation by pulling one of two handles. The actor pulled a green handle to accept allocations, which tipped the trays and distributed candy into bowls designated for the actor and recipient. The actor pulled a red handle to reject allocations, which distributed the candies into a center bowl for discarding. The equal allocation trials were used as a control to ensure that children were not pulling the handles at random.

### 2.3.4. Procedure

Before the experimental phase of this study, children were familiarized with the games in a practice phase where they learned how to play the *Pulling Game* and the *Inequity Game*.

*Practice Phase.* The experimenter introduced the *Pulling Game* by demonstrating how each child could pull on one of the ends of ropes to make the wooden blocks move forward and knock the candies into each participant’s tray. In the *Collaboration* condition, children were shown that in order to retrieve the candies from the apparatus, they must each hold onto one end of the rope and pull together. In the *Parallel Work* condition, children were shown that they each controlled a separate block using the end of their rope and could retrieve the candies aligned with their block through individual work.

Following the *Pulling Game*, the *Inequity Game* was introduced. Here the experimenter first explained the roles of the actor and recipient for the *Inequity Game* to
the two participants, with the same script as that of Blake, McAuliffe et al. (2015). The experimenter demonstrated the action of the two handles (i.e., green/accept and red/reject) found on the actor’s side of the Inequity Game. The order of the handle that was pulled first in the demonstration was counterbalanced across participants. During the demonstration, the participants were asked not to touch the apparatus unless instructed to do so, not to talk to each other during the game, and not to eat any of the candy until the end of the game.

Children next received a set of practice trials so that they could experience the consequences of pulling both handles. The candies used in the practice phase of the Inequity Game were not earned during the Pulling Game and came from a separate bowl. During practice the actor sat in front of the handles and decided whether to accept or reject allocations made by the experimenter on the trays on either end of the apparatus. The actor was presented with three allocations and asked to either accept by pulling the green (accept) handle or reject the offer using the red (reject) handle. For the three practice trials, the allocations were one candy for each child, one for the actor and none for the recipient, and one for the recipient and none for the actor. The order of the last two types of trials was counterbalanced between participants. If the actor pulled the same handle on each trial they were asked to pull the other handle at the end of practice (for a 1-1 allocation), in order to ensure they understood the consequences for the alternative option.

**Experimental Phase.** The experimental phase contained two blocks. In each block, children first completed the Pulling Game and then moved on to the Inequity Game. In both conditions of resource collection (collaboration, parallel work), each trial
was completed when participants knocked the 6 candies onto a ramp that dispersed 3 candies to each participant’s side of the apparatus. In the Collaboration condition, the 6 rewards obtained in each trial were placed in a central container. In the Parallel Work condition the 6 candies were placed in two separate containers, one container for each participant, 3 candies each. After the completion of four trials, the experimenter collected the candies earned by the participants and placed them in the same central bowl used in the Collaboration condition, then stated that the candies will be divided up in the next game and then the participants can take them home. Children who received the Collaboration condition were told “Look at all the candies you earned together (pointing to the central container), now we are going to play another game where we will divide up the candies that you earned together for you each to take home”. In the Parallel Work condition children were told “(participant A) look at all the candies you earned (pointing to their container) and (participant B) look at all the candies you’ve earned (pointing at their container). Now we are going to play another game where we will divide up the candies that you earned for you each to take home, but first we will add them together (pouring them into a single bowl).”

The procedure of the Inequity Game was the same as that used by Blake and McAuliffe (2011), with the exception that trials were presented in two blocks and the sequence of equal and unequal trials were randomized within blocks. Prior to testing, random sequences of equal and unequal trials were created to determine the presentation of these trials in each session. Participants began the Inequity Game immediately after completing the Pulling Game. The experimenter began a trial by placing the predetermined allocations first on the recipient’s tray and then on the actor’s tray, stating
the amount each time. While doing so, the experimenter held down both trays with a stick, which was then lifted so that the actor could make a decision (i.e., accept or reject). The experimenter avoided non-verbal cueing by not looking or talking to the actor. This procedure was repeated for all 6 trials (i.e., 3 equal, 3 unequal). After the last trial in the first block, participants returned to the Pulling Game to begin the second block of trials.

2.3.5. Coding and Statistical Analyses

All sessions were videotaped. The outcome variable of interest was whether children accepted or rejected allocations in the Inequity Game. Children’s responses were recorded live by a secondary experimenter, and later coded from video by an independent video coder who was blind to the study hypotheses. Disagreements between the live and video coding were rare or absent (Cohen’s \( \kappa = 0.98 \)), and any disagreements were resolved by rechecking the trials from video.

The primary analyses were conducted using the statistical software R (version R 3.0.1, 2013, The R Foundation for Statistical Computing). Participants’ decisions were analyzed using a Generalized Linear Mixed Models (GLMMs; Bolker, Brooks et al., 2009) with a binary response term (reject = 1, accept = 0) as the outcome variable. Models were run using the package ‘lme4’ (Bates, Maechler, & Bolker, 2012). Full models were created containing the predictor variables of interest based upon the experimental design (age in years; resource distribution; inequity type; work type). All models included subject identity as random intercepts to control for repeated measures within subject. In addition, block (1 or 2) and trial number (within block) were included as fixed effects to assess potential changes over the session. After building the models, the predicted effects and associated 95% confidence intervals of the three-way interaction
were graphed in the interests of the hypotheses (work type x allocation x age). Next the graph was examined for the point at which the confidence intervals for the probability of rejecting equal and unequal allocations showed no overlap. This point was considered to be a conservative estimate for the age at which inequity aversion emerged (see Blake, McAuliffe et al., 2015 for this approach).

2.3.6. Preliminary Data Analysis

The first step was to test whether inequity type (AI/DI) differentially influenced children’s probability of rejecting different allocations, replicating prior work (Blake, McAuliffe et al., 2015). This relationship would be confirmed by an interaction of allocation and inequity type. Thus, a model was run predicting rejections as a function of allocation (equal, unequal), inequity type (disadvantageous, advantageous), age of actor (years), trial number (1-6), trial block (1 or 2), gender (male, female), and the two-way interactions of allocation x inequity type and block x trial. Removing the interaction term of allocation and inequity type significantly reduced fit (LRT, $\chi^2_{1} = 48.72, p < 0.001$), showing that inequity type influenced children’s rejections of equal versus unequal allocations. Therefore, separate analyses of inequity types (AI, DI) were performed in subsequent models. Because gender did not emerge as a significant predictor and was not part of the hypotheses, it was excluded from condition-specific models.

2.3.7. General Data Analysis

Separate models for the AI and DI conditions were created. A GLMM was performed with rejections as a function of distribution, work type, actor age, trial number, block number, as well as all two-way and three-way interactions of work type, distribution, and age (Table 2.1). This full model was then compared to a model that
excluded the three-way interaction; the LRTs for the model comparisons are reported in their respective results sections below.

2.4. Results

2.4.1 Advantageous Inequity Aversion

The first question examined was whether children were more or less likely to reject advantageous allocations after collaboration versus parallel work. Figure 2.3 shows that in the Collaboration condition, older children were more likely to reject advantageous allocations than equal allocations. In the Parallel Work condition, children’s rate of rejections of advantageous allocations increased with age, but the confidence intervals overlapped for all ages. The model comparison for the inclusion of the three-way interaction revealed that the three-way interaction term was a significant predictor of children’s rejections ($\chi^2_{6} = 4.58, p = 0.03$; see Table 2.1 for model output). The significant 3-way interaction provides support for the Equity Hypothesis because it suggests that participants were increasingly more likely to reject advantageous offers with age in the Collaboration condition, but not in the Parallel Work condition. This pattern of results runs counter to the Generosity Hypothesis, which predicted the exact opposite of what was found, namely, a significant decrease rather than increase in rejections.

The next question examined was the age of emergence of children’s AI. Figure 2.3 shows advantageous inequity aversion emerged in the Collaboration condition just after 7 years of age, with regression lines continuing to diverge with age. By contrast, in the Parallel Work condition, although the regression lines began to diverge as children increased rejections of AI allocations with age, the confidence intervals overlapped at all
ages. Importantly, the Collaboration condition appeared to elicit AI at an earlier age (just after 7 years) than was previously observed (9 years) in this population (Blake, McAuliffe et al., 2015). This provides converging evidence congruent with the Equity Hypothesis and runs counter to the prediction from the Generosity Hypothesis, which suggested that AI should be absent or diminished in the Collaboration condition.

2.4.2. Disadvantageous Inequity Aversion

The first question examined was again whether children were more or less likely to reject DI allocations after collaboration versus parallel work. Figure 2.4 shows that in both the Collaboration and the Parallel Work conditions, children appeared overall more likely to reject unequal over equal allocations, a pattern that became stronger with age. The model comparison for the inclusion of the three-way interaction revealed that the three-way interaction term did not emerge as a significant predictor of children’s rejections. Thus, it is possible to conclude that after collaborative as well as parallel work, children show DI that increases with age. The Generosity Hypothesis predicted that DI should be reduced after collaboration as compared to parallel work, a pattern that was not supported by the data. The same holds when considering age, with the Generosity Hypothesis predicting that DI should decline with age in the Collaboration condition as compared to the Parallel Work condition. However, there was no support for this hypothesis, and a trend in the opposite direction was found, with DI tending to increase, rather than decrease with age in the Collaboration compared to the Parallel Work condition.

The next question examined in order to distinguish between the two hypotheses was the age of emergence of DI. Specifically, if collaboration led to earlier rejections of
DI offers, then this would provide evidence for the *Equity Hypothesis*. Alternatively, if collaboration led to a delay or absence of DI, then this would show support for the *Generosity Hypothesis*. Therefore, the predicted values of this relationship were graphed using the full model described above. Inspection of Figure 2.4 shows that once DI emerged, the difference in responding to unequal and equal distributions grew stronger with age in both conditions. Additionally, DI emerged just after 5 years in the *Collaboration* condition and just before 6 years in the *Parallel Work* condition. Here again, a slightly earlier emergence of DI after collaboration than parallel work tentatively supports the *Equity Hypothesis*, and is the opposite to what would be predicted by the *Generosity Hypothesis*.

Overall, the analyses conducted show a pattern of results that are congruent with the *Equity Hypothesis*, and the opposite of what was predicted from the *Generosity Hypothesis*. 
Figure 2.3. Model predictions for the AI condition, with collaboration (CO) and parallel work (PW) conditions displayed separately. Ribbons show 95% confidence intervals. The point at which the confidence intervals diverge represents the age of emergence.
Figure 2.4. Model predictions for the DI condition, with *collaboration* (CO) and *parallel work* (PW) conditions displayed separately. Ribbons show 95% confidence intervals. The point at which the confidence intervals diverge represents the age of emergence.
Table 2.2. Model Output for Full Model, AI, and DI. Estimates and standard errors (s.e.) of fixed effects in Generalized Linear Mixed Models predicting children’s rejection behavior. Baselines were set as follows: Inequity type: AI; Allocation = Equal, Work type = Collaboration, Block = 1, Gender: Female; Age and Trial Number were included as continuous predictors.

<table>
<thead>
<tr>
<th>Model: both AI and DI</th>
<th>AI model</th>
<th>DI model</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Intercept)</td>
<td>-3.70***</td>
<td>-0.44</td>
</tr>
<tr>
<td></td>
<td>(0.58)</td>
<td>(1.26)</td>
</tr>
<tr>
<td>Inequity Type (DI)</td>
<td>-0.57</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.30)</td>
<td></td>
</tr>
<tr>
<td>Allocation (Unequal)</td>
<td>0.67***</td>
<td>-5.39***</td>
</tr>
<tr>
<td></td>
<td>(0.19)</td>
<td>(1.39)</td>
</tr>
<tr>
<td>Age</td>
<td>0.21***</td>
<td>-0.29</td>
</tr>
<tr>
<td></td>
<td>(0.06)</td>
<td>(0.17)</td>
</tr>
<tr>
<td>Gender (Male)</td>
<td>0.18</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.22)</td>
<td></td>
</tr>
<tr>
<td>Block(2)</td>
<td>-0.12</td>
<td>0.49</td>
</tr>
<tr>
<td></td>
<td>(0.31)</td>
<td>(0.46)</td>
</tr>
<tr>
<td>Trial</td>
<td>-0.02</td>
<td>0.08</td>
</tr>
<tr>
<td></td>
<td>(0.06)</td>
<td>(0.08)</td>
</tr>
<tr>
<td>Inequity Type (DI): Allocation (Unequal)</td>
<td>2.03***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.30)</td>
<td></td>
</tr>
<tr>
<td>Block (2): Trial</td>
<td>0.07</td>
<td>-0.11</td>
</tr>
<tr>
<td></td>
<td>(0.08)</td>
<td>(0.12)</td>
</tr>
<tr>
<td>Work Type (PW)</td>
<td>-2.40</td>
<td>-0.99</td>
</tr>
<tr>
<td></td>
<td>(1.60)</td>
<td>(2.08)</td>
</tr>
<tr>
<td>Age: Allocation (Unequal)</td>
<td>0.87***</td>
<td>0.71**</td>
</tr>
<tr>
<td></td>
<td>(0.18)</td>
<td>(0.25)</td>
</tr>
<tr>
<td>Age: Work Type (PW)</td>
<td>0.39</td>
<td>0.06</td>
</tr>
<tr>
<td></td>
<td>(0.21)</td>
<td>(0.29)</td>
</tr>
<tr>
<td>Allocation (Unequal): Work Type (PW)</td>
<td>2.44</td>
<td>1.02</td>
</tr>
<tr>
<td></td>
<td>(1.86)</td>
<td>(2.07)</td>
</tr>
<tr>
<td>Age: Allocation (Unequal): Work Type (PW)</td>
<td>-0.50*</td>
<td>-0.32</td>
</tr>
<tr>
<td></td>
<td>(0.24)</td>
<td>(0.30)</td>
</tr>
</tbody>
</table>

AIC                   | 1459.97  | 733.23   | 688.14   |
BIC                   | 1513.26  | 789.51   | 743.29   |
Log Likelihood        | -719.99  | -354.62  | -332.07  |
Num. obs.             | 1524     | 804      | 732      |
Num. groups: actor.ID | 127      | 67       | 61       |
Variance: actor.ID.(Intercept) | 0.86     | 0.77     | 1.03     |
Variance: Residual    | 1.00     | 1.00     | 1.00     |

*** p < 0.001, ** p < 0.01, * p < 0.05, p<0.1
2.5. Discussion

The primary goal of Study 1 was to distinguish between two hypotheses that could explain why children are more willing to share with a peer after collaboration. The method disambiguated whether collaboration leads to greater sharing because children are more prosocially inclined (Generosity Hypothesis) or because collaboration elicits stronger egalitarian tendencies (Equity Hypothesis). The weight of the evidence favors the Equity Hypothesis and runs counter to what would be predicted under the Generosity Hypothesis.

One important source of evidence is children’s responses to AI allocations. Children as young as 7 years of age reliably rejected AI offers at a higher rate than equal offers, after collaboration but not after parallel work. The emergence of AI is indicative of a strong sense of equity. Thus, the Equity Hypothesis predicted that AI should emerge earlier in the Collaboration condition than was observed in the Parallel Work condition. Therefore, the earlier age of emergence of AI provides evidence in support of the Equity Hypothesis. Furthermore, the pattern of results for AI is the opposite of what would be predicted under the Generosity Hypothesis.

The second piece of evidence comes from children’s responses to DI. A similar pattern of results across the two work type conditions for DI was observed, with children becoming more likely to reject DI allocations with age. The Generosity Hypothesis predicts that collaboration should lead to a greater acceptance of DI allocations because this delivers a large reward to the recipient. Instead, children rejected DI allocations at a similar rate across both work type conditions.
In summary, the overall pattern of results support the *Equity Hypothesis*, suggesting that collaboration leads to a stronger sense of equity and fails to provide evidence for the *Generosity Hypothesis*, which predicts an increase in maximizing the payoff of a collaborating peer.

### 2.5.1. Emergence of AI

A second goal of the study was to test whether collaboration can elicit a sense of equity an age range that had previously not shown AI. Blake, McAuliffe et al. (2015) found that AI emerged under windfall conditions in children from the same rural Canadian population at 9 years, in line with other North American samples, where AI emerges between 8-9 years of age (Blake, McAuliffe, et al., 2015; Blake & McAuliffe, 2011; McAuliffe et al., 2013; Shaw & Olson, 2012). Study 1 findings show that under collaborative conditions, Canadian children display AI from 7 years of age, two years earlier than was observed under windfall conditions (Blake, McAuliffe, et al., 2015). Overall, the earlier emergence of AI following collaboration in Canada provides further support for the *Equity Hypothesis*. Specifically, these results extend the findings of Hamann et al. (2011) and Warneken et al. (2011) to show that collaboration can engender a sense of equity at an earlier age than under windfall conditions (Blake, McAuliffe, et al., 2015). Overall, these results runs counter to the *Generosity Hypothesis*, which predicted that AI would be absent or delayed after collaboration. Therefore, the earlier age of emergence of AI after collaboration also favors the *Equity Hypothesis* over the *Generosity Hypothesis*.

It is perhaps surprising that children did not display AI in the *Parallel Work* condition, given that they showed it in a windfall situation (Blake, McAuliffe et al.,
However, obtaining resources through parallel work and as a windfall have important differences. In particular, in previous studies where a child and a partner worked in parallel, children were reported to attend to criteria of merit (e.g., Baumard, Mascaro, & Chevallier, 2012; Kanngiesser & Warneken, 2012). Therefore, it is possible in Study 1 that children also considered merit and were less inclined to share resources equally that they had obtained by themselves, in contrast to findings in the original studies reporting equal sharing after collaboration with windfall resources (Hamann et al., 2011; Warneken et al., 2011).

2.5.2. Origins of Equity Preference

Our findings raise the question about the source of this equity preference. One possibility proposed in the Interdependence Hypothesis is that concerns for equity emerge in collaborative contexts (Tomasello et al., 2012; Tomasello & Vaish, 2013). In this framework, the interests of every collaborative partner must be balanced in order to achieve mutually satisfactory outcomes that maintain cooperation. When collaborative partners have contributed equally to acquiring resources, the distributive strategy that will maintain cooperation is equity. This proposal is supported by recent studies that show equal sharing after collaboration (Hamann et al., 2011; Warneken et al., 2011) and sharing in proportion to effort between collaborators (Hamann et al., 2014). The current study contributes to this line of thinking by demonstrating that collaboration can also lead children to destroy the resources acquired in order to achieve equity.

Another possibility, which is not necessarily in conflict with the first, is that the preference for equity is the result of behavioral conventions adopted from authorities such as parents, unrelated adults, or older peers. These norms are internalized or acted on
in the interest of signaling to others that one is behaving according to social expectations (Chudek & Henrich, 2011). In this case, such a norm may be specific to the collaborative context and likely prescribes that the spoils of collaborative effort should be distributed according to effort (i.e., equal work = equal pay). Thus, children ought to show this preference earlier in collaborative than other conditions. Distinguishing between the possible sources of the equity preference will require further studies. Nevertheless, Study 1 extends the collaboration effect to a new context, showing that collaborating to attain resources leads children to sacrifice a relative advantage in order to achieve equity when they are subsequently asked to decide on the allocation of those resources.

### 2.5.3. Two Mechanisms of Inequity Aversion

Study 1 provides additional evidence for the stability of the emergence of DI across resource acquisition contexts. Blake, McAulliffe et al. (2015) found that although variability existed in the age of emergence across societies, DI was present in all seven populations included in the study. Additionally, in the present study, the age of emergence for DI was similar for resources obtained collaboratively or through parallel work, demonstrating stability across these contexts. In contrast, AI appeared to emerge during middle childhood, but only in certain societies (Blake, McAulliffe et al., 2015). In Study 1, AI emerged for collaboratively obtained resources, but not for those obtained through parallel work. When considered along with the findings across societies, the evidence suggests that DI may be a more common feature of human psychology, whereas AI may be more sensitive to factors that vary both across societies and across the contexts in which resources are obtained.
2.5.4. Limitations

There are a number of interpretive limitations in Study 1 that will require further investigation. First, the study did not explore the possibility that collaboration leads to greater generosity in ages outside of the selected range. For example, it is possible that the motivation that underlies sharing changes across development. Children’s sharing after collaboration may be motivated by generosity earlier, whereas the motive may shift to equity later in development. To further investigate this possibility, future research should investigate the *Equity* and *Generosity Hypotheses* with an extended age range that includes two- and three-year-olds, who have been found to share more equitably after collaboration (Hamann et al., 2011; Ülber et al., 2015; Warneken et al., 2011).

Additionally, it is necessary to examine the specific mechanism that leads older children to favor equity after collaboration. Is the observed equity preference dependent on the resources obtained or the relationship between collaborators? It is possible that collaborating to obtain resources creates a sense of joint ownership over those resources. If this were the case, AI would appear only when distributing the jointly earned resources with the collaborative partner. Alternatively, collaboration may activate a preference for equity that extends beyond the specific resources obtained with the collaborator. Plötner et al. (2015) found evidence that children extend preferences to collaborators outside of the immediate context of collaboration, but it is unclear if these preferences extend to equity. Relatedly, because the design of Plötner et al. kept the work contribution constant between participants and across conditions, the findings do not address the potential role of merit in terms of amount of work-effort. Children use principles of merit when dividing collaboratively obtained resources (Hamann, Bender, & Tomasello, 2014), but the importance of merit in distributional judgments has been reported to vary across...
societies (Schäfer, Haun, & Tomasello, 2015). Therefore, it is unclear whether collaboration leads to a generalized preference for equity or a preference for equity that is based on merit (i.e., equal pay for equal work). Investigating these potential mechanisms in future studies will provide deeper understanding of the nature of the influence of collaboration on children’s sharing. Even though the current study does not differentiate between these other possibilities, the findings were able to differentiate between the role of generosity and equity in children’s sharing after collaboration.

2.5.5. Conclusion

In summary, Study 1 provides evidence that collaboration results in strong sense of fairness, not observed under parallel work conditions. Furthermore, the findings support the view that this sense of fairness is driven by equity over generous or prosocial motives. Presented with an opportunity to endow partners with a relative advantage, children rejected these generous allocations regardless of how the resources were obtained. However, when presented with a personal relative advantage, children who collaborated sacrificed this advantage in favor of equity.
Chapter 3.

Study 2. Children Increase Sharing to Collaborators, but Restrict Equality to the Spoils of Collaboration

3.1. Abstract

Research has shown that preschoolers increase equal sharing after collaborating to earn resources, suggesting that collaboration may serve as an important context for the development of fairness. The current study explored the influence of specific components of collaborative interactions to better understand the cognitive foundations of this precocious egalitarianism. The effect of three forms of social interaction on children’s sharing were compared: collaborating to earn resources that were subsequently shared, collaborating towards a shared goal without earning resources, and playing a social game without earning resources. Children shared more after collaboration, both when resources shared were earned in the collaboration game and when they were given as windfall. Importantly, when the resources shared were earned through collaboration, children increased equal sharing (i.e., 2 items to each). However, when resources were given as a windfall after collaborating towards a shared (different) goal, children shared more overall (e.g. increasing from 0 to 1 item shared) but did not shift towards equity. Social play was not found to influence children’s sharing, highlighting the importance of the collaborative context to increase children’s sharing. Overall, these findings suggest that while collaboration fosters a general increase in sharing, equity may be specific to collaboratively earned resources.
3.2. Introduction

Cooperation is a hallmark of human societies, but in order for cooperation to be sustained, resources must be distributed in mutually satisfactory ways. Egalitarian sharing of collaboratively earned resources is hypothesized to stabilize cooperation (Baumard et al., 2013; Tomasello et al., 2012), but the developmental origins of this behavior remain unknown. Studies of children’s sharing suggest that equality concerns may be a feature of later development, not emerging until middle childhood. In studies using the Dictator Game (DG), a procedure where children are given control over resources and the opportunity to share with an anonymous peer, children tend to keep most resources for themselves until 5 years of age, at which age the amount shared begins to increase until 8 years of age, when equal sharing becomes the most common behavior (Benenson et al., 2007; Blake et al., 2016; Blake & Rand, 2010; Gummerum et al., 2010; Rochat et al., 2009; Smith et al., 2013). Similarly, in binary choice tasks, young children tend to choose a payoff that benefits them. In contrast, older children (5-8 years) are more likely to choose an option that also benefits a peer, even when it is costly to do so (Fehr et al., 2008; House et al., 2012; House et al., 2013; Moore, 2009).

3.2.1. Sharing After Collaboration

Critically, these previous studies present children with windfall gains, resources given without prior effort, which may not be the most representative context to examine the foundations of fairness. Collaboration is hypothesized to be a special context, where dividing the spoils of collaborative labor equitably serves to stabilize cooperation between individuals (Baumard et al., 2013; Tomasello et al., 2012). Recent empirical work supports this hypothesis, showing that even preschool children create equal
resource distributions in collaborative contexts. Children as young as 3 years of age will share resources equally with a partner provided they have worked collaboratively to obtain the resource, as compared to conditions in which resources were windfall gains or retrieved through individual work (Hamann et al., 2011; Ülber et al., 2017; Warneken et al., 2011). Furthermore, collaboration motivates equality, as seen when children from diverse societies discard collaboratively earned resources when they are distributed unequally, even at the cost of a personal advantage (Study 1; Corbit et al., 2017; Ülber et al., 2017).

3.2.2. Resource or Relationship

While these studies are informative, it is not clear whether increased equality is directed to the resources or to the collaborators themselves. Specifically, when children share collaboratively earned resources their motivation to share equitably may emerge from a sense of joint ownership over the resources. Children understand joint ownership and use cues of ownership to determine fair distributions of resources from three years of age (Blake & Harris, 2009; Huh & Friedman, 2017; Rochat, Robbins, Passos-Ferreira, Oliva, Dias, & Guo, 2014). Alternatively, collaboration may induce a concern for equity between collaborators, even with resources earned outside of a collaborative context. For instance, Rakoczy, Kaufmann, and Lohse (2016) found that children protested unequal distributions of collaboratively earned resources in a third-party context. Additionally, Ng, Heyman, and Barner (2011) found that children prefer people who share equally compared to those who share a larger number but smaller (unequal) proportion of resources.
Children prefer equity to generosity with collaboratively earned resources (Corbit et al., 2017), but even if these fairness concerns are tied to the resources, children may be inclined to behave prosocially towards collaborators in other contexts. Classic work in social psychology argued that collaboration changes children’s attitudes towards social partners, reducing competition and increasing prosociality, even across group-boundaries (Sherif et al., 1961). Recently, Plötner et al. (2015) found that preschoolers expressed feelings of trust, liking and affiliation and behaved prosocially more often towards collaborative partners over neutral agents. Hamann et al. (2012) found that children were more willing to spontaneously help a peer if they had collaborated on a task together, and Gräfenhain et al. (2013) reported that children were more likely to help and wait for a collaborator. Given these findings, it is possible that collaboration fosters social preferences between collaborators that are not specifically tied to equity, but result in prosociality.

Another important consideration when interpreting the impact collaboration has on children’s sharing is whether children are influenced by collaboration per se, or by engaging in a positive social interaction common to other contexts such as play. Children’s sharing is positively influenced in several non-collaborative contexts. For example, children share more generously with friends (Moore, 2009), with in-group members (Fehr et al., 2008), and those with whom they share affiliation (Sparks, Schinkel, & Moore, 2017). Additionally, synchrony in peer actions has been found to increase prosociality (Tunçgenç & Cohen, 2016a, 2016b). Similarly, engaging in contingent social interactions increases positive social attitudes (Good & Russo, 2016;
Rabinowitch & Knafo-Noam, 2015). Thus, it is important to assess the influence of social interaction, a component of collaboration that is common to other contexts, on sharing.

The aim of Study 2 was to investigate the influence of earning resources, achieving a shared goal, and engaging socially, all components of collaborating to earn resources, on children’s sharing. Sharing between age- and gender-matched pairs of 3- to 5-year-old children was measured, before (baseline) and after (post-social) three conditions of social interaction: Joint Resources, Joint Goal, and Social Play. The age range of 3-5 years was selected to capture the onset of equal sharing of collaboratively obtained resources (Hamman et al., 2011; Warneken et al., 2011), while allowing for a later emergence of prosociality toward collaborators (5 years of age; Plötner et al., 2015) and contingent peer interactions (Tunçgenç & Cohen, 2016a,b). In the Joint Resource condition children performed complementary roles while collaborating to earn resources that were subsequently shared. This condition extends prior work (Hamman et al., 2011; Warneken et al., 2011) to the context of collaboration with complementary roles. In the Joint Goal condition, children collaborated towards a joint goal but did not earn resources that could be shared; instead they later shared windfall resources that were provided outside of the collaborative context. This condition tested whether children would share more with collaborators, beyond of the context of sharing collaboratively earned resources. In the Social Play condition, children engaged in a social game that required complementary roles but did not have a concrete goal. The goal was to play a social game, whereas in the collaborative conditions (Joint Goal and Joint Resource) children engaged in a problem-solving task with the concrete goal of extracting an object from the apparatus.
Previous work suggests that children increase equal sharing with collaboratively earned resources (Corbit et al., 2017; Hamman et al., 2011; Ülber et al., 2017; Warneken et al., 2011), thus, an increase in equal sharing was hypothesized for the Joint Resource condition. Children extend social preferences towards collaborators (Plötner et al., 2015), but whether these preferences favor equity, generosity, or don’t extend to sharing resources that were not obtained through the collaboration remains unknown. Findings from a comparison of the Joint Resource with Joint Goal condition will inform these possibilities. The Social Play condition will serve as a control, assessing whether collaboration is indeed a special context that increases sharing.

3.3. Method

3.3.1 Participants

Participants ranged in age from 3-to-5 years of age and were recruited through summer camps in a rural community in Eastern Canada (see Appendix A for population demographics). A total of 76 dyads of participants were sampled, with approximately balanced sampling across the age range (3, 4, 5 years) and gender (N=40 females). Age and gender were also balanced across the three between-participant conditions. This sample size was selected to achieve adequate statistical power based on typical sample sizes used in prior work on children’s sharing after collaboration (Warneken et al, 2011).
Table 3.1. Counterbalancing Study 2: Participants distributed by age group, condition, and gender (female)

<table>
<thead>
<tr>
<th>Condition</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shared Goal</td>
<td>6(4)</td>
<td>9(5)</td>
<td>10(5)</td>
<td>26(14)</td>
</tr>
<tr>
<td>Shared Resource</td>
<td>7(4)</td>
<td>8(4)</td>
<td>11(6)</td>
<td>26(14)</td>
</tr>
<tr>
<td>Social Play</td>
<td>7(3)</td>
<td>7(2)</td>
<td>10(6)</td>
<td>24(11)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>76(39)</td>
</tr>
</tbody>
</table>

3.3.2. Design

This study used a 3 (social interaction condition: Joint Resources, Joint Goal, Social Play) X 2 (sharing trial: baseline, post-social) repeated measure design with social interaction conditions varying between participants and the repeated measure of baseline/post sharing varying within. Participants were randomly assigned to conditions with age and gender approximately balanced within conditions. Because participant pairs were recruited at summer camps, they were likely to have prior social experience with one another. However, random assignment across conditions ensured that prior relationship within dyads did not vary systematically across conditions. There were three phases in the study: 1. baseline sharing in which children received a dictator game with windfall resources, 2. social interaction in which children played a collaborative game that differed across conditions (Joint Resources, Joint Goal, and Social Play), 3. post-social interaction sharing in which children received a second dictator game with resources that were either given as windfall or earned collaboratively depending on the social interaction condition.
3.3.3. Apparatus

The social interaction phase of this study used two apparatuses (Figure 3.1). Children in the Joint Resources and Joint Goal conditions completed the social interaction phase with the elevator game (Warneken, Chen, & Tomasello, 2006). The goal of this game was to retrieve an item from inside a movable cylinder contained in the center of the apparatus. There were two complementary roles that had to be coordinated to retrieve the toy. One child had to lift the cylinder on one side of a clear plastic window on the apparatus and the other child had to retrieve the toy from inside the cylinder. The clear plastic window serve as a barrier by blocking the two sides of the apparatus so that it was not possible for one child to both lift and retrieve the toy. Thus, the game was designed so that it was impossible for one child to independently perform both actions, necessitating collaboration between the children. In the Joint Resources condition children worked together to collect resources (gummy candies) from the cylinder, which were then divided in the post-social sharing phase. In the Joint Goal condition, children worked together to retrieve toy animals from the apparatus. Importantly, in the Joint Goal condition children shared gummy candies, and not the toys retrieved from the apparatus, thus children shared windfall, not earned resources. Children in the Social Play condition played the double tube game (Warneken et al., 2006), and then shared windfall resources. In this game, two 75cm tubes were mounted on a box at an angle of 20 degrees. To play the game, one child dropped a wooden block down the tube, while the other child caught the block with a tin cup. While the participants likely perceived all conditions as games, the important distinction between these games is that the elevator game contains an instrumental goal (i.e., retrieving the candy or toys) that required collaboration between
two partners, whereas the double tube game is a joint activity in which the goal was to play a social game together (Warneken et al., 2006).

![Figure 3.1. Schematic illustration of the double tube game with block in cup (a) and the elevator game in the retrieval position (b).](image)

3.3.4. Procedure

*Phase 1: Baseline Sharing.* For the dictator game four gummy candies were arranged in front of the child. Participants were told, “Here are 4 candies. I am giving them to you. You can keep them all for yourself, or you can share them with another child who will come to play this game later. You can place all the candies for you to keep in this bag, and all the candies you want to give to the other child in this bag. You decide how many candies to put in each bag”. Children were then invited to allocate their candy behind a privacy screen so that their sharing decisions were anonymous.
**Phase 2: Social Interaction.** Children were assigned to pairs, matched in age and gender, at the beginning of the social interaction phase. During the social interaction phase, pairs of children were presented with either the elevator game (*Joint Resource, Joint Goal*) or the double tube game (*Social Play*), depending on the condition to which they were assigned. One child in the pair was randomly assigned to be the target child who would be administered a follow up sharing task. Participants received a demonstration from an adult experimenter, who explained that each game had two roles that the participants could take turns at playing in the game. After the demonstration, children were given the opportunity to play the game four times, and were encouraged to alternate roles after each trial. In the *Joint Resource* and *Joint Goal* conditions, which used the elevator game, participants retrieved an object during each trial and placed the object in a bucket. In the *Social Play* condition, which used the double tube game, children were given four blocks to be used in the apparatus over the four trials. The experimenter re-baited the elevator cylinder or provided the block for the games on each trial.

**Phase 3: Post-Social Interaction Sharing.** The child who was assigned as the target child was individually administered a second dictator game following the social interaction phase. This child was given 4 gummy candies and invited to decide how to divide them, using similar instructions as those used in the baseline sharing task. The only difference in instructions was that the recipient was now identified as the peer from the social interaction phase. The dependent measure was the number of candies donated by the participant, ranging from 0 to 4 candies, which was compared to sharing in the baseline phase.
3.4. Results

3.4.1. The Effect of Collaboration on Sharing

The first question examined was whether children changed their sharing behavior after collaboration, and if so, how this effect varied across conditions. Preliminary analysis revealed no statistically significant difference in baseline levels of sharing across the three conditions ($F=0.86, p=.43, \eta^2=.02$). A mixed factorial ANCOVA (3x2) was then conducted with Age as a continuous variable, Condition (Joint Resource, Joint Goal, Social Play) as a between-participant factors and Sharing (baseline and post-social) as the repeated measure. The ANCOVA revealed a marginally significant main effect of Age ($F=5.60, p=.053, \eta^2=.052$) and a significant two-way interaction between Condition and Sharing ($F=6.89, p=.002, \eta^2=.16$), presented in Figure 3.2. To follow up on the two-way interaction between Condition and Sharing, post hoc t-tests were performed comparing baseline to post-social sharing for each of the three conditions. Comparison of baseline ($M=1.00, SD=0.96$) to post-social interaction ($M=1.72, SD=0.61$) sharing in the Joint Resource condition revealed a significant increase in sharing, with a large effect size ($p<0.01, g=0.90$). There was also a significant increase from baseline ($M=1.11, SD=0.95$) to post-social interaction ($M=1.65, SD=0.71$) sharing in the Joint Goal condition, with a medium effect size ($p<0.05, g=0.64$). In contrast, baseline ($M=1.35, SD=0.88$) and post-social ($M=1.21, SD=0.90$) sharing did not differ significantly in the Social Play condition ($p=0.60, g=0.16$). The pattern of increased sharing in both the Joint Resource and Joint Goal conditions, but not the Social Play condition, supports the hypothesis that collaborating towards a shared concrete goal results in a general increase in sharing.
3.4.2. Equity or Generosity?

A second research question concerned the effect of the social interaction on equal sharing across the conditions, that is, the proportion of children who shifted from unequal to equal sharing after the social interaction phase. In this case equal sharing meant sharing 2 of 4 candies, while unequal sharing could be any of the other outcomes (i.e., sharing 0, 1, 3, 4 candies), children’s sharing was coded as equal (=1) or unequal (=0).

Figure 3.3 shows the proportion of individual participants who shared equally (2 candies each) across conditions and sharing trials. The proportion of children who share equally in the Joint Resource condition was 44% at baseline, and increased to 80% in the post-social interaction phase. In the Joint Goal condition children increased from 50% equal
sharing at baseline to 69% in the post social phase. In the Social Play condition children decreased from 58% equal sharing at baseline to 50% in the post social phase. The shift in equal sharing was significant only for the Joint Resource condition \( \chi^2 (2, 25) = 6.88, p < .01 \).

![Figure 3.3](image)

**Figure 3.3.** Proportion of children who shared equally as a function of condition (Joint Resource, Joint Goal, Social Play) and sharing trial (baseline and post-social). Error bars represent standard errors of the proportions.

Finally, to confirm that a higher proportion of children in the Joint Resource shift to equality compared to the Joint Goal condition a Fisher’s Exact Probability test was conducted with the subsample of children who increased sharing from baseline to post-social sharing (N=10 from Joint Resource and N=10 from Joint Goal conditions). In the Joint Resource condition, of the 10 children who increased sharing, all 10 children
increased to equal sharing following social interaction. In the Joint Goal condition, of the 10 children who increased sharing, only 5 children increased to equal sharing following social interaction. Thus, a higher proportion of children increased to equality in the Joint Resource as compared to the Joint Goal condition (Fisher’s Exact Probability, $p = .033$).

Overall, children increased sharing after collaborating towards a shared goal in both the Joint Resource and Joint Goal conditions, but not after playing a game in the Social Play condition. The marginal main effect of age suggests that children tended to increase sharing with age across conditions and the repeated measures (baseline and post-social sharing). Equal sharing increased significantly from baseline to post-social sharing only in the Joint Resource condition. The general increase in sharing across the Joint Resource and Joint Goal conditions suggests that collaboration increases sharing regardless of how resources are obtained. The significant increase in equal sharing in the Joint Resource condition, but no others, suggests that equality was of greater concern for children when resources were earned collaboratively. In sum, collaboration towards a shared goal appears to result in a general increase in prosociality between collaborators, whereas equality may be specific to the context of jointly earned resources.

3.5. Discussion

Previous research reported that collaboration increased equal sharing in young children, but the components of collaboration and the underlying cognitive mechanisms that produce this effect were not investigated. Study 2 contrasted specific components of collaboration to examine their influence. The findings reveal an overall increase in sharing across conditions where children collaborated towards a shared concrete goal, but this increase was only characterized by an increase in equity when children were dividing
collaboratively earned resources. Thus, while collaborating towards a shared goal appears to elicit social preferences towards collaborators, a concern for equity was stronger with collaboratively earned resources. A potential question that arose from previous work is whether children’s sharing was influenced by collaboration per se, or whether children were instead responding to more basic components of these interactions known to increase prosociality, such as, engaging in social play or synchronous action (Tunçgenç & Cohen, 2016a, 2016b). Study 2 provides evidence against this possibility. Indeed, collaboration increased sharing without the cue of synchronous action and social play alone did not influence sharing, indicating that collaboration does indeed matter.

In line with previous work (Hamman et al., 2011; Ülber et al., 2017; Warneken et al., 2011), children in Study 2 increased equal sharing when dividing collaboratively earned resources. The reasons why equity increases with collaboratively earned resources remains an open question. One potential explanation is that collaborating to earn resources creates a sense of joint ownership over those resources, thus, children view the resources as a common good to which they have an equal claim as a collaborative partner. This explanation is consistent with the finding that although children increased sharing towards a collaborator whether they earned the resource or shared windfall resources, equal sharing increased only when dividing collaboratively earned resources. Prior research (Huh & Friedman, 2017) confirms that children understand joint ownership by three years of age; however, systematic study of the influence of collaboration on children’s sense of ownership over jointly earned resources, and the role this may play in equal sharing, is needed.
3.5.1 Reciprocity

The positive impact of collaboration on sharing may in part be due to reciprocity. Collaborating toward a shared goal may engender an opportunity for future reciprocity of help given during collaboration. Evidence of reciprocity extending from earlier social interaction is consistent with the findings in the two collaborative conditions (*Joint Resource, Joint Goal*). It is not consistent with the results from the social play condition, suggesting that help offered to achieve a shared goal may promote a reciprocal relationship, which is not elicited in the mutual responsiveness achieved in social play. Recent research suggests that reciprocal sharing (i.e., sharing where both partners take turns dividing resources across repeated trials) is dependent on the development of requisite cognitive abilities, and emerges around five years (Sebastian-Enesco & Warneken, 2015; Warneken & Tomasello, 2013). Additional research will be needed to establish whether reciprocity plays a role in sharing after collaboration with younger children.

3.5.2. Affiliation

Study 2 found that prosociality towards collaborators increased in both collaborative contexts where children shared concrete goals (*Joint Resource, Joint Goal*). Collaboration fosters affiliation between peers, and affiliation has been found to increase prosociality generally (Plötner et al., 2015), and sharing specifically (Sparks et al., 2017). Thus, one mechanism through which the experience of collaboration may increase prosocial behavior is by fostering affiliation between collaborative partners, strengthening their social bond. This possibility is supported by research reporting that children behaved more prosocially towards collaborators and rated them higher on scales of liking, affiliation and trust (Gräfenhain et al., 2013; Hamann et al., 2012; Plötner et al.,
Affiliation has been found to enhance the affective benefit of giving in adults (Aknin, Sandstrom, Dunn, & Norton, 2011). Given that children understand the emotional benefits of giving, and this understanding predicts sharing (Paulus & Moore, 2016), affiliation may serve as a proximate mechanism by which the affective benefit of sharing is enhanced, resulting in greater generosity. The present study found a general increase in generosity towards collaborators; elucidating the precise cognitive mechanisms for this increase is a promising direction for future research. Although this evidence is suggestive, the possibility that affiliation may mediate the influence of collaboration on children’s sharing requires explicit investigation.

Collaboration may also serve to prime the partner’s emotional perspective, which extends beyond completion of the collaborative goal to the distribution of resources. There is evidence that even young children represent the role of their partners when coordinating actions and intentions in collaborative interactions (Brownell et al., 2006; Warneken, Steinwender, Hamann, & Tomasello, 2014). However, whether this perspective taking extends to the partner’s emotional perspectives, remains unknown. Recent research has found that priming children with the emotional consequences of sharing (or not sharing) for a recipient increases generosity in 3- to 6-year-old children (Paulus & Moore, 2015). These researchers found that children understood the emotional benefit of generosity, and that this understanding positively predicted sharing.

Furthermore, children’s sensitivity to negative emotion is predictive of altruistic sharing (Rajhans, Altvater-Mackensen, Vaish, & Grossmann, 2016). Thus, by its nature of demanding intentional coordination with a partner, collaborating toward a shared goal
may facilitate perspective taking of psychological states more generally, extending to the emotional domain.

3.5.3. Limitations

Although the Social Play condition did not impact sharing in the present study, it is possible that peer play may foster prosociality under other conditions. Here the type of interaction was kept as similar as possible across conditions, while varying whether there was a shared concrete goal and whether the resources subsequently shared were earned collaboratively. Although collaborating over four trials in the Joint Resource and Joint Goal conditions was sufficient to influence children’s sharing, it is possible that peer play would also increase sharing if it were extended over a longer period. Indeed, peer play of the type found in the Social Play condition serves as a foundation for budding friendships, and young children share more with friends than non-friends (Moore, 2009). Nevertheless, the null results from the Social Play condition strengthen the conclusion that children in the collaborative conditions were indeed influenced by the forms of collaboration they experienced.

3.5.4. Conclusion

In summary, children increase sharing towards collaborators, an increase that is not restricted to the spoils of collaboration, but rather is directed more generally toward the collaborator. While collaboration produced a general increase in sharing across two conditions, increased equality was only found when the resources shared were earned through collaboration. Furthermore, playing a social game did not affect children’s sharing, highlighting the importance of collaboration toward a concrete goal as a crucial determinant of sharing. Overall, these findings suggest that while collaboration may
foster a general increase in prosociality, sharing collaboratively earned resources may be a truly special context for the development of egalitarian sharing.
Chapter 4.

Study 3. Collaboration Increases Third Party Punishment of Inequity in Young Children

4.1. Abstract

Previous work has found that prior collaboration fosters an earlier onset of equal sharing in children (Hamann et al., 2011; Warneken et al., 2011). Whether early egalitarian sharing is applied only within collaborative interactions or is a more general, normative concern for promoting fairness for others remains an open question. Third party punishment of unfair sharing demonstrates a willingness to intervene against normative violations. In Study 3, children aged 3-7 years watched as puppets earned resources obtained through collaboration or individual work and subsequently shared these resources. Participants then received the opportunity punish or allow the puppet’s allocation in sharing, which was either equal or unequal. When resources were earned collaboratively by the puppets, children across all ages were more likely to punish inequity, compared to when resources were obtained through parallel work. Additionally, in the Collaboration condition children punished inequity more often than equity across all ages. In contrast, only the older participants in the Parallel Work condition punished inequity more often than equity. When children were asked to justify their decision to punish or not, they cited normative concerns (i.e., “because that’s not fair”) at a similar rate across the two work type conditions. This pattern suggests that although children conceive of fair as equality across the two resource acquisition contexts, they show a
greater motivation to intervene against normative violations when they occur under collaborative conditions.
4.2. Introduction

One of the ways cooperation is maintained in human societies is through punishment of unfair behaviors (Fehr & Fischbacher, 2003; Henrich et al., 2010). Adults are willing to punish individuals who distribute resources unfairly, even when the punisher is not personally affected (Fehr & Fischbacher, 2004; Henrich et al., 2006, 2010; Raihani, Thornton, & Bshary, 2012). This form of third party punishment (TPP) is hypothesized to occur as a way of promoting cooperative norms (Fehr & Fischbacher, 2004). TPP of unequal sharing shows a willingness to intervene to enforce equity norms in the absence of a personal exposure to unfairness. Thus, TPP signals a concern for fairness that extends beyond personal or interpersonal interests toward a normative sense of fairness.

4.2.1. Development of Interpersonal Equity

The developmental roots of fairness can be observed in infancy. Beginning in the second year of life infants show a preference for equal distributions of resources and exhibit surprise when resources are divided unequally between third parties (Geraci & Surian, 2011; Schmidt & Sommerville, 2011; Sloan et al., 2012). The development of sharing from preschool to middle school age has been studied extensively using the dictator game (DG), where children are presented with windfall resources (i.e., resources that are not earned) and given the option to share some of those resources with a peer, often anonymously. In studies using the DG, children younger than 5 years tend to keep most of the resources, but in the 5-to-8 years age range, they become more likely to split resources equally between themselves and a peer (Benenson et al., 2007; Blake et al., 2016; Blake & Rand, 2010; Gummerum et al., 2010; Rochat et al., 2009; Smith et al., 2013). In binary choice tasks in which children are presented the option to pay a cost to
share equally or keep all the resources for themselves they show a similar pattern, becoming more likely to choose equality between 5 to 8 years of age (Fehr, Bernhard, & Rockenbach, 2008; House et al., 2012; Moore, 2009; Thompson et al., 1997).

Children’s preference for equality during middle childhood is further evidenced by the emergence of “inequity aversion”, defined as a willingness to sacrifice greater rewards to maintain equity (Fehr & Schmidt, 1999). As noted previously, the Inequity Game, developed by Blake and McAuliffe (2011), measures children’s aversion to two forms of inequity, DI and AI. DI shows a concern to not have less than a peer, which could be considered a personal sense of fairness. This behavior may be motivated by spite (McAuliffe et al., 2014) and envy (Shaw & Olson, 2012) and not by equitable fairness preferences. AI shows a concern of not having more than a peer, which shows an interpersonal concern for fairness that goes against immediate self-interest. DI and AI follow different developmental trajectories, with DI emerging around 4 years of age, and AI emerging by 8 years of age in the US (Blake & McAuliffe, 2011; Blake et al., 2015; McAuliffe et al., 2013; Shaw & Olson, 2012). Thus, it appears that children’s earliest sense of fairness is self-focused, with children only rejecting inequity when they are at a disadvantage. Later in development, this concern is extended to include others such that children reject allocations that would benefit themselves more than a peer, showing what appears to be a preference for equity even in interpersonal contexts.

4.2.3. Development of Normative Equity

In between the emergence of a personal concern for fairness (DI) at 4 years of age and an interpersonal concern for fairness (AI) at 8 years of age children begin to show a normative concern for fairness. Perhaps the earliest example of children’s normative
sense of fairness can be seen in their response to the question of how resources “should” be shared. Already by three years of age children respond that resources should be divided equally, a prescriptive norm they fail to follow in their own sharing until 8 years of age (Smith et al., 2013). The knowledge-behavior gap in equal sharing (Blake, McAuliffe, & Warneken, 2014), which refers to the delay between the onset of normative knowledge and behavioral adherence to a prescriptive norm of equal sharing, presents an important puzzle to understanding the role of norms in determining sharing behavior.

One way researchers have attempted to establish how children’s normative preference for equity begins to influence behavior that acts to maintain equity is to turn to evidence from children’s third party evaluations of unfair behavior in others. Rakoczy, Kaufmann, and Lohse (2016) show that children protest unfair sharing, both when they are the recipient, as well as when they are a neutral observer. Specifically, children 3- and 5-years-of-age saw a puppet distribute resources that were unequally divided between the puppet and either another puppet (i.e., third party), or the participant (i.e., first person), depending on the condition. Children frequently protested unequal distributions regardless of whether they were affected themselves, or witnessed the violation occur to a third party. Although both 3- and 5-year-old children protested unequal distribution in this study, 5-year-olds used normative language (i.e. “that’s not fair”) more often.

Robbins and Rochat (2011) found that 5-year-old children punished puppets that behaved selfishly towards them and another puppet, though it is unclear from this study whether children were engaging in TPP or responding to the fact that they were treated unfairly. McAuliffe, Jordan, and Warneken (2015) sought to test TPP in 5- and 6-year-old children separately from their experience of unfairness. They found that 6-year-olds
punished unequal distributions, even when punishment came at a cost (i.e., they had to pay a resource to punish). Additionally, Jordan, McAuliffe, and Warneken (2014) reported in-group favoritism in TPP from 6 years of age, suggesting that TPP may not be applied impartially. Specifically, children were more likely to punish unfair out-group members, while also more likely to reject distributions that were unfair to an in-group member. Together these studies provide evidence that children are sensitive to inequity, even when they are not personally affected. By 3 years of age children understand the ‘fair=equal’ norm and protest against inequality, by 5 years of age they protest against inequality using normative language, and by 6 years of age children engage in TPP of inequality and are willing to pay a cost to punish. These findings suggest that children’s concern for equality develops considerably between 3 and 6 years of age, beginning with an understanding that ‘what’s fair is equal’, and quickly extending to a willingness to sanction violations of this norm. Thus, by 6 years of age children show a normative concern for equality, one that they apply broadly to themselves and others, and one for which they are willing to engage in costly TPP to maintain.

4.2.4. Equity After Collaboration

Importantly, the aforementioned studies all involve windfall gains, resources given without prior effort. However, an important aspect of determining fair resource distributions is how the resources are obtained in the first place. Sharing collaboratively earned resources is hypothesized to be a context where equity serves to stabilize cooperation between individuals (Baumard et al., 2013; Tomasello et al., 2012). Thus, collaborating to earn resources may create a context where concerns for fairness are heightened.
Recent empirical work supports this hypothesis, showing that even preschool children create equitable resource distributions more often in collaborative contexts. Children as young as 3 years of age will share resources equally with a partner provided they have worked collaboratively to obtain the resource, as compared to conditions in which resources were windfall gains or retrieved through individual work (Hamann et al., 2011; Ülber et al., 2017; Warneken et al., 2011). Furthermore, as was shown in Study 1, collaboration motivates equity, with children from diverse societies showing inequity aversion at an earlier age with collaboratively earned resources compared to those earned through parallel work (Study 1; Corbit et al., 2017; Ülber et al., 2017).

Thus, children share the spoils of collaboration equally and are willing to sacrifice collaboratively earned resources in the interest of maintaining equity, demonstrating an interpersonal concern for fairness during collaboration that emerges earlier than in other contexts. However, it remains unknown whether this concern for equity results from a normative concern for equality between collaborators or is restricted to the context of interpersonal collaboration. Specifically, do children view equality between collaborators as a prescriptive norm dictating how the spoils of collaboration should be divided? Examining children’s third party evaluations of deviations from equal sharing in the collaborative context can help to resolve this question. Of particular interest is whether children will sanction unequal sharing of collaboratively earned resources through punishment, demonstrating a strong normative concern for equity.

The goal of Study 3 was to investigate whether children view equitable sharing of collaboratively earned resources as a prescriptive norm that dictates fairness between collaborators. TPP of unequal sharing emerges by 6 years of age (Jordan et al., 2014;
McAuliffe et al., 2015) with windfall resources. Thus, if collaboration elicits a strong normative concern for equity, beyond that which is present in other contexts, children should punish inequity between collaborators more often and at a younger age than that between non-collaborators. Prior work has established that a suitable control for collaboration is parallel work (Corbit et al., 2017; Hamann et al., 2014; Ülber et al., 2017). Contrasting collaboration with parallel work keeps the context of earned resources constant across conditions, varying only the type of work required to obtain resources.

To this end, in Study 3 children between 3 and 7 years of age were presented with a simple procedure in which puppets shared earned resources obtained through collaboration or individual work. This age range allowed for specific hypotheses based on previous empirical work. For instance, 3 years is the earliest children have been shown to share collaboratively obtained resources equitably (Hamann et al., 2011; Warneken et al., 2011). By 5 years of age children protest the unequal division of resources using normative language (Rakoczy et al., 2016), though they have not been shown to reliably punish unequal sharing in third party context until 6-years-of-age (McAuliffe et al., 2015; Jordan et al., 2014). Thus, if collaboration elicits TPP of inequity in ages less than 6 years, it would provide evidence that collaboration does indeed foster an earlier emerging normative concern for equity.

Children were assigned to either a Collaboration or Parallel Work condition and watched puppets earn resources in the pulling task (Corbit et al., 2017). On each trial, by chance a “lucky” puppet gained control over all 4 resources and was subsequently asked to share the resources. Each child saw two blocks of 4 trials where the puppet shared either equally (i.e., 2 each) or unequally (i.e., 3 for self, 1 for other). At the end of each
block children were shown the resources each puppet had accumulated over the 4 trials, and then were asked if they wanted to allow the puppets to take home the resources they had accumulated, or if the resources should be discarded so that no one got any. Thus, the design allowed for a between participants comparison of children’s punishment of unequal sharing across the Collaboration and Parallel Work conditions. Additionally, children’s punishment of inequity could be compared relative to equitable sharing, serving as an important within participant control. Children’s spontaneous protest was also assessed to provide an additional behavioral measure of children’s sanctions against normative violations. Finally, a measure of normative justification for children’s punishment decision was included in order to obtain a measure of participant’s knowledge of normative behavior across the two work type conditions.

4.3. Method

4.3.1. Participants

A total of 104 participants were sampled continuously between the ages of 3 to 7 years (M = 66.4 months, range = 36.6 - 84.5 months, 48 females). Participants were recruited through summer camps in a rural community in Eastern Canada (see Appendix A. for population demographics). Age and gender were balanced across the two between-participant conditions. This sample size was selected to achieve adequate statistical power based on typical sample sizes used in prior work on third party punishment in children (McAuliffe et al., 2015). In the final data set, 9 participants were not included, either because they did not complete the procedure (n=1), or failed to pass comprehension checks (n=8).
Table 4.1. Counterbalancing Study 3: Participants distributed by age group, condition, and gender (female)

<table>
<thead>
<tr>
<th>Condition</th>
<th>Age Group</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3-5</td>
<td>5-6</td>
<td>7</td>
<td>Total</td>
<td></td>
</tr>
<tr>
<td>Collaboration</td>
<td>20(9)</td>
<td>23(12)</td>
<td>11(4)</td>
<td>54(25)</td>
<td></td>
</tr>
<tr>
<td>Parallel Work</td>
<td>20(9)</td>
<td>20(10)</td>
<td>10(4)</td>
<td>50(23)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>104(48)</td>
</tr>
</tbody>
</table>

4.3.2. Design

This study employed a 2 (Work Type: collaboration or parallel work) X 2 (Distribution: equal or unequal) design. Work type was a between participants factor, while distribution was administered as a within participant factor. Each child witnessed two puppets sharing in two blocks of four sharing trials, followed by a single third party punishment trial where they had the opportunity to punish the puppet that had allocated resources. The trials within blocks consisted of either equal or unequal allocations, and order of blocks was counterbalanced across participants.

4.3.3. Apparatus

The Pulling Game (Study 1; Corbit et al., 2017) was modeled after Hamann et al. (2011) and originally adapted from Hirata and Fuwa (2006). The apparatus is built on a large board (60cm x 32cm) and has two configurations: collaboration and parallel work. Under the collaboration configuration one central block (10cm x 7.5cm) moves along a track in the center the board. The block has a rope (120cm) that is loosely attached to it through two loops. The block only moves down the track if both ends of rope are pulled at the same time, otherwise the rope will unravel. When the block reaches the edge of the panel, it knocks the rewards onto ramps and distributes the rewards to participants. In the
parallel work configuration, the apparatus is the same except there are two blocks (5cm x 7.5cm), each with separate ropes (40cm) attached. Under this configuration individual participants control the movement of only one block by pulling their rope (See Figure 4.1 for schematic illustration), and the block knocks their rewards onto their side of the board. Skittles were used as the resources in this game.

Figure 4.1. Schematic illustration of Pulling Game in a) parallel work and b) collaboration configurations.

4.3.4. Procedure

The familiarization phase introduced participants to the Pulling Game. In this phase the primary experimenter (E1) demonstrated how the two roles were played showing that each person can pull on one end of a rope to make wooden blocks move forward and knock the candies into each individual’s tray. In the Collaboration condition, children were shown that in order to retrieve the candies from the apparatus, they and their partner had to each hold on to one end of the rope and pull together. In the Parallel
Work condition, participants were shown that they controlled a separate block using the end of their rope and they could retrieve the candies aligned with their block through individual work.

When participants understood the Pulling Game they were introduced to a first puppet (P1) that was animated by a second experimenter (E2) and who played the game with them. Across the two work conditions, participants completed 4 trials of the Pulling Game alongside the puppet, earning 2 candies in each trial for a total of 8 candies during the introductory phase. These candies were set aside for the participants to take home.

During the experimental phase E1 introduced participants to two additional puppets (P2 and P3), animated by E2, who would have a turn playing the game. In this phase, unbeknownst to the participants, the Pulling Game was modified to dispense all the candy to one side. On each trial the puppets worked either individually or collaboratively, depending on condition, to retrieve candies, but by “chance” the candies were all dispersed to P2’s tray. Then E1 intervened by asking the puppet that received all the candies to share with the puppet that received none. Children observed two blocks of 4 trials, one where the P2 distributed unequally across the 4 trials and the other where distributions were equal. In the unequal block P2 shared 1 and kept 3 for themselves on all 4 trials, whereas in the equal block the P2 split the candies equally, giving 2 to each. After sharing, the puppets paused briefly (2 seconds), allowing the participant the opportunity to spontaneously protest. This sequence of steps was repeated for each trial.

At the end of each block, participants were presented with a single punishment trial. During punishment trials puppets displayed their candies (i.e., 12 for P2, and 4 for P3 in the unequal block and 8 each in the equal block). The experimenter highlighted the
resources that each puppet stood to receive. Participants were then given the option to distribute the candies to each puppet, or discard the candies in a wastebasket so that no one received any. If the child agreed to distribute the resources, then the experimenter put the candies in each puppet’s bag, whereas if the distribution was rejected they were placed in a central basket and neither puppet received any candies. After the punishment decision was made, participants were asked two follow up questions. The first was a comprehension check where, depending on their decision, children were asked what happens to the candies when they were distributed or discarded. Next, participants were asked why the candies should be placed in the wastebasket or the puppet’s bags to take home. The second question served to provide an open-ended justification of their punishment decision.

4.3.5. Coding and Statistical Analyses

All sessions were videotaped. The primary outcome variable was whether children accepted or punished allocations in the TPP Game. Children’s behavior while observing the sharing phase of the Pulling Game was also coded for whether they protested or not. Finally, children’s justification of their decision to punish or not was also coded for their use of normative language. Examples of normative language include “because it was fair” or “it should have been equal”, and are contrasted with examples of descriptive responses, such as “so that no one gets any” or “so they can take them home”. Children’s behaviors across these measures were recorded live, and later coded from video by an independent video coder who was blind to the study hypotheses. Disagreements between the live and video coding were rare or absent (Cohen’s $\kappa = .98$), and any disagreements were resolved by rechecking the trials from video.
To investigate whether the third party punishment of unfair sharing in two resource acquisition contexts is dependent on age a Generalized Linear Mixed Model (GLMMs; Bolker, Brooks et al., 2009) with binomial error distribution and logit link function was used. The dependent measure was the participant’s decision to punish or not on a given trial (punish = 1, accept = 0). The three-way-interaction between Work Type (collaboration and parallel-work), Distribution (equal and unequal sharing) and the age were included as fixed effects. The gender and test block were included as control effects. Furthermore, the identity of the participants was included as a random effect into the model. The models were fitted in R using the function ‘glmer’ from the R package ‘lme4’ (Bates, Mächler, Bolker, & Walker, 2015). The statistical significance of the full model was determined by comparing its fit with that of the null model comprising only the random effect, using a likelihood ratio test (LRT), available as R function ‘anova’, package ‘stats’. P-values for the individual effects were based on likelihood ratio tests comparing the full with their respective reduced models (R function ‘drop1’). The LRT was used for testing the interactions for significance. If an interaction turned out to be not significant, it was removed from the model to reliably interpret the lower terms included. This method of analysis was repeated for the additional outcomes variable of protest (protest = 1, no protest = 0) and children’s use of normative language when justifying their punishment decisions (normative = 1, non-normative = 0). In the case of protest, participants showed zero instances of protest towards equal distributions, and due to this floor effect on equal trials, distribution was not included in the model.

The age at which TPP emerged in the two work type conditions was also examined. Using the full model, a graph was created from the predicted effects and
associated 95% confidence intervals of the three-way interaction of interest for the hypotheses (i.e., Work Type x Distribution x Age). Next the graph was examined for the point at which the confidence intervals for the probability of rejecting equal and unequal allocations showed no overlap. This point was considered to be a conservative estimate for the age at which TPP emerged (see Blake, McAuliffe et al., 2015 for this approach).

### Table 4.2
Estimates and standard errors (s.e.) of fixed effects in Generalized Linear Mixed Models predicting children’s rejection behavior on measures of punishment, protest and normative justification. Baselines were set as follows: Allocation = Unequal, Work type = Parallel Work, Block = 2, and Age was included as a continuous predictor.

<table>
<thead>
<tr>
<th></th>
<th>Punish</th>
<th>Protest</th>
<th>Justification</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Intercept)</td>
<td>-2.22</td>
<td>-5.40</td>
<td>-12.69</td>
</tr>
<tr>
<td></td>
<td>(0.51)</td>
<td>(1.84)</td>
<td>(3.66)</td>
</tr>
<tr>
<td>Distribution (U)</td>
<td>-2.59</td>
<td>-1.03</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.41)</td>
<td>(0.71)</td>
<td></td>
</tr>
<tr>
<td>Work Type (PW)</td>
<td>-1.04*</td>
<td>-0.94*</td>
<td>1.78***</td>
</tr>
<tr>
<td></td>
<td>(0.41)</td>
<td>(0.57)</td>
<td>(0.52)</td>
</tr>
<tr>
<td>Actor Age (Continuous)</td>
<td>-0.25</td>
<td>0.85**</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.31)</td>
<td>(0.29)</td>
<td></td>
</tr>
<tr>
<td>Distribution (U): Actor Age</td>
<td>1.14*</td>
<td></td>
<td>1.17*</td>
</tr>
<tr>
<td></td>
<td>(0.36)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

|                        |        |         |               |
| Block                  |        |         | 1.17*         |
|                        |        |         | (0.52)        |

| AIC                     | 171.06 | 109.99  | 181.26        |
| BIC                     | 190.41 | 120.53  | 196.82        |
| Log Likelihood          | -79.53 | -51.00  | -85.63        |
| Num. obs.               | 186    | 103     | 166           |
| Num. groups: actor.ID   | 93     | 103     | 83            |
| Variance: actor.ID.(Intercept) | 0.00 | 0.25 | 4.13 |
| Variance: Residual      | 1.00   | 1.00    | 1.00          |

*p < 0.001, **p < 0.01, *p < 0.05
4.4. Results

4.4.1. Punishment: Preliminary Analysis

The comparison of the full against the null model was significant (LRT: $\chi^2 = 61.534$, df = 4, $p < 0.001$). The three-way-interaction between work type x distribution x age was not significant (LRT: $\chi^2 = 0.674$, df = 1, $p = 0.412$). The model was reduced by dropping all non-significant two-way interactions included in the three-way-interaction, (work type x distribution, LRT: $\chi^2 = 1.161$, df = 1, $p = 0.281$; work type x age, LRT: $\chi^2 = 1.043$, df = 1, $p = 0.307$). Finally, the model was comprised from the terms included in three-way-interaction, with work type as a main effect and a significant two-way-interaction between distribution and age. The *Collaboration* condition revealed significantly higher rejection rates than the *Parallel Work* condition (LRT: Estimate = -1.052, SE = 0.408, $\chi^2 = 7.021$, df = 1, $p = 0.008$). Furthermore, the older the participants were, the more likely they were to reject unequal trials relative to equal trials (LRT: Estimate = 1.138, SE = 0.473, $\chi^2 = 5.878$, df = 1, $p = 0.015$; Figure 4.3, Table 4.1).

Overall, children punished more when resources were obtained collaboratively, and more often on unequal trials compared to equal trials, a pattern that became stronger with age.
Figure 4.2. Probabilities of trial rejection for the two-way-interaction between distribution and age depicted by the model line and 95% confidence limits (colored areas). The area of the circles corresponds to the respective number of data points constituting that data point.

4.4.2. Age of Emergence of Punishment

The age of emergence of TPP across the two work type conditions was also examined and is presented graphically with the predicted values of the likelihood of punishing unequal and equal distributions across the age range age along with 95% confidence intervals for each work type condition (Figure 4.3). In the Collaboration condition the regression lines predicting punishment of unequal and equal distributions diverge amongst the youngest participants and divergence increases with age. Between 4 and 5 years of age the confidence intervals no longer overlap. Similarly, in the Parallel Work condition, the regression lines begin to diverge amongst the younger children, until
the confidence intervals no longer overlap just before 6 years of age. Thus, children increasingly punished unequal allocations relative to equal allocations with increasing age in both work type conditions. The similar pattern of increasing the relative punishment of unequal compared to equal trials across the two work type conditions is reflected in the significant two-way interaction of age * distribution ($\chi^2 = 5.878$, df = 1, $p = 0.015$).

Figure 4.3. Model predictions of children’s punishment decisions with Collaboration and Parallel Work conditions displayed separately. Ribbons show 95% confidence intervals. The point at which the confidence intervals diverge represents the age of emergence.

4.4.3. Comparison to Previous Work

Previous research revealed that 6 years was a transition point when children begin to punish unequal sharing in windfall contexts (Jordan et al., 2014; McAuliffe et al., 2015). To examine whether TPP of collaborators emerged in younger children,
participants were divided into two age groups, 3-5 years and 6-7 years of age, before and after the age (6 years) where TPP was observed in previous work (see Figure 4.4). Based on previous findings (McAuliffe et al., 2015) it was predicted that older children in both conditions would punish unequal distributions more often than equal ones. Based on the recent findings of Corbit et al. (2017), it was predicted that younger participants would engage in TPP only in the Collaboration condition and not in the Parallel Work condition. To test these hypotheses, individual contrasts of punishment following equal and unequal trials were performed using McNemar’s tests across age groups and work type conditions. Younger participants punished unequal allocations ($M = 0.47, SD = .51$) significantly more often than equal allocations ($M = 0.11, SD = .32$) only in the Collaboration condition ($p = 0.021$), and not in the Parallel Work condition (equal $M=0.14, SD= 0.35$; unequal $M= 0.23, SD= 0.43$; $p= 0.73$). Punishment behavior amongst the older participants (6-7 years of age) was similar across the work type conditions. Older participants punished unequal allocations in both conditions (collaboration $M = 0.74, SD = .45$; parallel work $M = 0.58, SD = .51$) significantly more often ($p < 0.001$) than equal allocations (collaboration $M = 0.09, SD = .29$; parallel work $M = 0, SD = 0$).
Overall, children punished more when resources were earned through collaboration compared to when they were earned through individual work. Importantly, they were also more likely to punish unequal allocations compared to equal ones, a tendency that grew stronger with age. Furthermore, the younger participants in the Collaboration condition punished unequal allocations more often than equal trials, a tendency that was not observed for this age in the Parallel Work condition. The older participants punished unequal allocations more often in both the Collaboration and the Parallel Work conditions. This pattern of findings is consistent with the hypothesis that punishment of inequity would be more robust and be observed at an earlier age for
resources obtained collaboratively compared to those obtained individually.

4.4.4. Normative Understanding

A GLMM of children’s decisions on unequal trials revealed that Age was a significant predictor of children’s decision to protest: Age (LRT, $\chi^2_6 = 17.00, p < 0.01$). Work type was a marginally significant predictor of children’s decision to punish: Work Type (LRT, $\chi^2_6 = 3.31, p = 0.07$), with protest marginally higher in the Collaboration condition (M=0.39, SD=0.49) compared to the Parallel Work condition (M=0.22, SD=0.42). These results support the conclusion that children’s protest of normative violations increased with age across both conditions, with a marginally higher rate of protest in the Collaboration condition.

A GLMM of children’s use of normative justifications for their decision to punish revealed two significant predictors of decision: distribution (LRT, $\chi^2_6 = 32.78, p < 0.001$) and age (LRT, $\chi^2_6 = 47.52, p < 0.01$). Thus, while children’s use of normative justification increased with age and they were more likely to use normative justifications on unequal trials, they did not show sensitivity to work type condition. Children appeared to demonstrate similar conceptual understanding of fairness norms across the work type conditions, an understanding that increased with age.

4.5. Discussion

Previous research finds precocious equal sharing after collaboration (Hamann et al., 2011; Warneken et al., 2011) as well as an earlier emergence of inequity aversion in the collaborative context (Corbit et al., 2017; Ülber et al., 2017). These results support the claim that children show a concern for interpersonal fairness in collaborative contexts, but leave open the question of whether this concern has a normative basis. The
present study is the first to show that indeed children enforce fairness norms more often when violations occur between collaborators; TPP of unfair sharing was stronger under collaborative conditions compared to when resources were earned through individual work.

McAuliffe and colleagues report that TPP emerged at 6 years under windfall conditions (McAuliffe et al., 2015; Jordan et al., 2014). The current findings suggest that TPP may emerge earlier under collaborative work conditions. Younger participants (3-5 years) in the current study punished unequal allocations more often than equal allocations in the Collaboration condition, but not in the Parallel Work condition. Older participants (6-7 years) punished unequal allocations more often in both the Collaboration and Parallel Work conditions. Thus, collaboration appears to foster an earlier normative concern for equity, not observed in other contexts. This conclusion gains tentative support from the age of emergence of TPP as depicted in Figure 4.3; in the Collaboration condition TPP emerged between 4 and 5 years of age, while in the Parallel Work condition TPP emerged just before 6 years.

Participants in the current study were marginally more likely to protest against inequity in the Collaboration compared to the Parallel Work condition. That this effect was only marginal is perhaps not surprising when considering that by 3 years of age children engage in protest of unequal sharing in other contexts (Rakoczy et al., 2016). When participants were asked to justify their punishment decision, use of normative language (e.g. “that’s not fair” or “they should be equal”) increased with age, but did not differ between the two Work Type conditions.
In summary, young children were more likely to punish unequal sharing in a collaborative compared to individual work context, while evidence of normative expectations was similar across these contexts. Although children referred to equity norms to a similar extent across Work Type conditions, suggesting that children held similar beliefs about fairness across conditions, their motivation to intervene and act to maintain equity was stronger when inequity occurred between collaborators.

4.5.1. Knowledge Behavior Gap

In windfall sharing contexts children express equality as the norm for how resources should be shared by three years of age (Smith et al., 2013). It is possible that children’s normative justifications for TPP (i.e., inequality) in the current study, and lack of a difference across Work Type conditions, reflects the early development of a general norm of equity. Nevertheless, it is clear from the present results and from previous findings that knowledge of a prescriptive norm is not sufficient to motivate behavior. In what has been termed the knowledge-behavior gap (Blake et al., 2014; Blake, 2018), 3-year-olds state that resources should be shared equally, but it is not until 8 years of age that they behave accordingly (Smith et al., 2013). The present findings suggest that collaboration may be a special context in which the gap between knowledge of fairness norms and fairness behavior is reduced. This view is supported by findings that equal sharing and inequity aversion emerge earlier between collaborators (Corbit et al., 2017; Hamann et al., 2011; Ülber et al., 2017; Warneken et al., 2011). The knowledge-behavior gap for fairness is likely sensitive to the motivational processes that innervate this behavior. To more deeply understand the influence of collaboration on fairness behavior it is essential to understand the motivational processes that are initiated by collaboration.
4.5.2. Inequity Aversion

One of the hypothesized motivations for TPP is inequity aversion (Dawes et al., 2007; Raihani & McAuliffe, 2012) and collaboration results in an earlier emergence of inequity aversion (Corbit et al., 2017). It is reasonable to surmise that children’s higher rate of punishment in the collaborative context may be motivated by inequity aversion that is generally increased in collaborative contexts. Alternatively, collaboration may increase another form of aversion hypothesized to motivate punishment, an aversion to the selfish intentions of the unfair actor (Cushman et al., 2009; Falk et al., 2008; Fehr et al., 2003; Nelson, 2002). Although the present experiment was not designed to differentiate between these alternatives, some insight can be gained by examining children’s justifications of their decisions to punish. A majority of children who punished unequal sharing in the Collaboration (85.6%) and Parallel Work (80.0%) conditions referenced equality or fairness in their justifications, but none on the participants used negative descriptions of unfair agent’s character to justify their decision to punish. Thus, the agent’s selfish intentions were unlikely to act as a primary motivational factor in the present study. While it will be important to design future studies to explicitly differentiate between these motivational alternatives, the weight of current evidence supports the hypothesis that collaboration fosters a generalized preference for equity (Corbit et al., 2017), and this in turn may motivate a variety of behaviors related to fairness, including the enforcement of fairness norms through punishment.

4.5.3 Collaboration and Norms

Study 3 found that collaboration induced a greater normative concern for equity. A natural question that follows from this finding is whether collaboration creates a context that extends beyond the domain of equity to a concern for adherence to norms in
general. Specifically, would collaboration extend beyond the moral domain, and also increase children’s concern for conventional norms? As early as 3 years of age, children demonstrate sensitivity to group membership in their protest of normative violations. Furthermore, children protest moral violations regardless of group status, but are more likely to enforce conventional norms with in-group members (Schmidt, Rakoczy & Tomasello, 2012). It is possible that children have different expectations for in-group and out-group members regarding their awareness of the group’s conventions. Specifically, they may expect in-group members to be aware, and out-group members to lack awareness, of the conventions set by their group. Thus, out-group members would not be expected to adhere to conventional norms. Alternatively, children may consider that it is more important that norms, both moral and conventional, are followed within groups due to the likelihood of within-group collaborations. In collaboration, following the way “we” do things is especially important because it provides common ground between collaborators and allows for the seamless coordination of action towards a shared goal. Thus, although Study 3 provides convergent evidence with Study 1 to suggest that norms of equity are important in the collaborative context, further research should investigate whether the collaborative context facilitates a greater concern for adherence to norms in general.

4.5.4. Limitations

In order to familiarize them with the procedure, children in Study 3 first worked with a puppet partner to earn resources either through collaboration or parallel work, dependent on their condition. This protocol was followed to ensure that the youngest

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3 Moral norms serve the function of reducing harm, whereas conventional norms are a standard of how things are done within a group, not tied to harm reduction.
children (3 years) understood the mechanics of the Pulling Game before they engaged in third party evaluations of other agents playing the game. Specifically, it was important that participants in the Collaboration condition understood that the Pulling Game required both agents to contribute and pull the rope at the same time. Similarly, it was important that participants in the Parallel Work condition understood that resources were earned by agents pulling separate ropes individually. It is possible that participants’ prior, firsthand experience in the familiarization phase could have influenced their subsequent decision to punish inequity in others. However, care was taken to mitigate potential carry-over effects by introducing two new puppets during the experimental phase, ensuring that children did not have prior experience with the agents whose behavior they were evaluating. Nevertheless, additional research is needed to clarify whether personal experience with the work contexts (i.e., collaborative or parallel work) influences subsequent third party judgments. Nevertheless, Study 3 provides strong evidence that children punish inequity at a higher rate in a collaborative context compared to when resources were earned through parallel work.

4.5.5. Conclusion

In sum, children were more likely to punish unfair sharing when resources were earned through collaboration compared to individual work. The pattern of differential punishment across Work Type conditions was stronger for young children (3-5 years old), whereas older children (6-7 years of age) punished inequity regardless of how resources were earned. In contrast to the punishment measure, no difference was observed between children’s reference to fairness in their normative justifications across the two Work Type conditions. This pattern suggests that while children conceive of
equity as fair regardless of how the resources were earned, they showed a greater motivation to act by punishing inequity when it occurred between collaborators. These findings contribute to a growing body of evidence in support of the hypothesis that collaboration is a special context for the development of fairness.
Chapter 5.

General Discussion

5.1. Summary of Findings

The overall goal of the studies that comprise this dissertation was to understand the psychological mechanisms underlying children’s precocious equal sharing of collaboratively earned resources. Each study investigated separate components of the collaboration effect, ranging from motivational underpinnings in Study 1, to social components in Study 2, and finally, to children’s normative concerns for fair sharing between collaborators in Study 3. Together, this program of research provides converging evidence that collaboration elicits fairness concerns in children ranging from 3 to 10 years of age, the age range of children included across the studies. Importantly, the findings indicate that fairness concerns do not emerge at 3 years of age and remain static over the remainder of ontogeny. Instead, we see a dynamic process of development over this age range beginning with the emergence of equal sharing at 3 years of age, followed by a willingness to punish unfair behavior in others at 4 years, and culminating by 7 years, when children discard resources that are divided unequally even when they must sacrifice a personal advantage. The three hallmarks of fairness investigated in this program of study - sharing, inequity aversion, and third party punishment of inequity - emerge years earlier in the collaborative context when compared to contexts of individual work or windfall resources. This convergent evidence suggests that collaboration is indeed a special context for the development of fairness.
Study 1 investigated the importance of two motivational determinants hypothesized to increase children’s fairness after collaboration: equity or generosity. Children earned resources either collaboratively or through parallel work prior to being presented with two forms of inequity, DI and AI, and then were given the choice to accept or reject each form of inequity. When children received an allocation that put them at a disadvantage (DI), inequity aversion emerged between 4 and 5 years of age in both work type conditions (i.e., Collaboration and Parallel Work). In contrast, when unequal allocations placed children at a relative advantage (AI), children in the Collaboration condition showed inequity aversion by 7 years of age, whereas AI did not emerge in the Parallel Work condition even by 10 years of age. Thus, the findings of Study 1 provide evidence that when presented with the opportunity to show generosity by allowing a peer to gain a relative advantage (DI), the context of how resources were earned had little influence on children’s behavior. In contrast, when children’s strong concern for equity was put to the test (AI), children were willing to sacrifice an advantage in order to maintain equity, but only when resources were earned collaboratively.

Study 2 explored the influence of separate social components of collaborative interactions to better understand the social cognitive mechanisms that underlie this precocious egalitarianism. The effect on sharing of three forms of collaborative social interaction were compared: collaborating to earn resources that were subsequently shared, collaborating towards a shared goal and sharing windfall resources, and playing a social game and sharing windfall resources. Collaboration increased overall sharing regardless of whether resources were earned collaboratively or given as a windfall. Importantly, only when children shared collaboratively earned resources did they show
an increase in equal sharing. In contrast, social play did not influence children’s sharing, highlighting the importance of the collaborative context (holding a shared instrumental goal) when children’s sharing increases. In summary, these findings suggest that collaboration fosters a general increase in sharing, whereas equal sharing may be specific to collaboratively earned resources.

Study 3 explored whether children view equal sharing of collaboratively earned resources as a norm that dictates fairness between collaborators. Children were presented with a simple procedure in which puppets shared earned resources obtained through collaboration or individual work. On each trial, by chance a “lucky” puppet gained control over all of the resources and was subsequently asked to share. Children saw blocks of several trials where the puppet shared either equally or unequally, and at the end of each block they decided whether to allow the resources to be distributed or to punish by discarding the resources. When resources were earned collaboratively, children were more likely to punish unfair sharing, compared to when resources were obtained through parallel work. Additionally, in the Collaboration condition both older (6-7 years) and younger (3-5 years) children punished inequity more often than equity. In contrast, only the older participants in the Parallel Work condition punished inequity more often than equity. When children were asked to justify their decision to punish or not, they cited normative concerns (i.e., “because that’s not fair”) at a similar rate across the two work type conditions. This pattern suggests that while children conceive of fair as equal across the two resource acquisition contexts, they show a greater motivation to intervene against normative violations when they occur under collaborative conditions.
5.2. Implications and Future Directions

5.2.1. Collaboration Promotes Equity

Previous studies (Hamann et al., 2011; Warneken et al., 2011) that reported increased equal sharing after collaboration left open the question of whether children were motivated by equity or generosity. The behavioral measure of inequity aversion employed in Study 1, achieving equity by discarding resources, is a stringent test of children’s equity vs. generosity preferences that helps to disambiguate these motivational underpinnings. Study 1 found that collaboration does indeed elicit a strong concern for equity (AI), not observed in in other contexts (i.e., individual work). Importantly, AI emerged at 7 years of age, several years earlier than AI has previously been observed under windfall conditions (Blake et al., 2015). If children were motivated by prosocial feelings of generosity in Study 1, then they should have accepted DI to allow their collaborator to gain a relative advantage. Instead, participants at all ages rejected DI allocations at a high level, with a trend towards greater rejection of DI allocation in the Collaboration condition compared to the Parallel Work condition. Thus, the findings support the view that equity concerns underlie increased sharing after collaboration in the inequity game.

However, the emergence of AI after collaboration follows by several years (i.e., 7 vs. 3 years) the emergence of equal sharing after collaboration using other sharing tasks (Hamann et al., 2011; Warneken et al., 2011). What accounts for this discrepancy? It is possible that the impact of collaboration on children’s equal sharing after collaboration early in development may be motivated by factors other than equity, including generosity. Consider the possibility that younger children may, like older children, also have a preference for equity, but they have difficulty overriding competing motivations,
for instance, not wanting to throw away perfectly good candy. It is therefore possible that children’s preference for equity may manifest first in equal sharing and later, as cognitive skills such as inhibitory control develop and the concern for equity strengthens, inequity aversion (specifically the more costly AI) emerges. One way of assessing potential explanations for the relatively late emergence of the collaboration effect would be to employ intrinsic measures in the inequity game, such as pupilometry (Hepach, Vaish, & Tomasello, 2015) or reaction time to decision (Blake & McAuliffe, 2011), to assess whether collaboration does elicit conflicting motivations when young children are faced with inequity, even in the years preceding the shift to behaviorally manifested inequity aversion found in Study 1.

Convergent evidence that collaboration does indeed result in a concern for equity was found in Study 2 where 3-5 year old children increased equal sharing of collaboratively earned resources. When children collaborated towards a shared goal and subsequently shared windfall resources they also increased sharing, but most often without achieving equity. This pattern suggests that although collaboration can increase prosociality in general, consistent with findings in other prosocial domains (Gräfenhain et al., 2013; Hamann et al., 2012; Plötner et al., 2015; Sherif et al., 1961), equity may be specific to the context of resources earned through collaboration. Given that increased equity was observed in 3-5 year old children in Study 2 with earned resources, and recognizing that although behavior is not a direct link to motivation, the pattern of results suggests that equity is a concern for collaboratively earned resources, even amongst young children.
5.2.2. Collaboration is a Special Form of Social Interaction

Another unresolved question that follows from previous research showing increased sharing after collaboration is whether children’s sharing was influenced by collaboration per se, or whether children were instead responding to more basic components of these interactions known to increase prosociality, such as engaging in social play or synchronous action (Tunçgenç & Cohen, 2016a, 2016b). Hamann et al. (2011) included an important control condition whereby children engaged in a procedure with the same basic mechanics of collaboration but instead of obtaining resources through collaboration, children obtained resources through parallel work. This elegant control has many strengths; work effort is constant across both conditions and the mechanical action each child must perform is the same. However, parallel work conditions do not control for the possibilities that synchrony (i.e., a stronger cue in the collaboration condition) or merely engaging in a positive social interaction (i.e., usually a feature of collaboration but common to other contexts such a play) underlie the collaboration effect. Study 2 provides two pieces of evidence against these alternative possibilities, and instead supports the view that collaboration is a critical determinant of children’s equitable sharing. Study 2 is the first to test children’s sharing after engaging in collaboration with complementary roles (in contrast to synchronous action employed in previous work), with and without the goal of obtaining a resource that was subsequently shared. In both collaborative conditions (Joint Goal, Joint Resources) the nature of the game was such that children obtained resources through enacting complementary, and not synchronous, actions. Even without cues of synchronicity, collaboration still resulted in an increase in sharing across both conditions. Study 2 is also the first to contrast collaboration with social play that involved complementary roles but
no shared goal. Although children enjoyed the game, this form of positive peer interaction had no effect of children’s subsequent sharing. The pattern of findings across the conditions of Study 2 provides convergent evidence for the unique importance of collaboration as a means to increase children’s sharing.

5.2.3. Resource or Relationship?

As previously noted, prior work could not differentiate between the possibilities that collaboration resulted in social preferences directed towards the collaborator, or distributional preferences directed towards collaboratively earned resources. The findings from this series of experiments suggest that collaboration may result in a shift of both social and distributional preferences, but context is important. Specifically, in Study 2 collaboration resulted in a general increase in sharing, regardless of whether the goal of collaboration was to obtain resources or achieve an unrelated instrumental goal. This demonstrates that greater sharing may have been influenced by a more general increase in social preference for a collaborator. However, when children shared collaboratively earned resources, they almost always shared those resources equitably. This result stands in contrast to cases where children collaborated to earn unrelated resources; in this case children increased sharing but engaged in relatively few instances of equitable sharing. Thus, a distributional preference for equity may be specific to the context of sharing collaborative earned resources, and is likely not elicited by collaborative interactions unrelated to the shared resources, at least not for the 3 to 5 year old children tested in Study 2.
5.2.4. Collaboration Increases Normative Force of Equity

Study 3 presents evidence that norms of equity are particularly salient in the collaborative context. However, the origin of norm enforcement regarding sharing amongst collaborators is unclear. One possibility is that children acquire a general norm of equality early in ontogeny and collaboration creates a context where adherence to norms is especially important. Support for this possibility comes from the findings that by 3 years of age children already understand fair as equality (Smith et al., 2013) and are selective in the context in which they enforce norms (Schmidt, Rakoczy, & Tomasello, 2012). It makes intuitive sense that collaboration would be a context where adherence to norms is important: If you deviate from the way “we” do things, then coordination of action towards a shared goal becomes more difficult. Alternatively, children may acquire a context dependent norm, which specifies that when collaborators have contributed equally to obtain resources they should receive an equal stake (i.e., equity). The design of Study 3 does not differentiate between these alternatives, thus further investigation into how equity norms are acquired in the first place and the relation between collaboration and norm adherence in young children is needed.

5.2.5. The Role of Collaboration in the Development of Fairness

Collaboration during early peer interactions may be a special context for the development of fairness. From an early age children show a self-interested concern for fairness, not wanting to receive less than their peers (DI). This early developing concern is more likely motivated by envy or spite than equity per se (McAuliffe et al., 2014; Shaw & Olson, 2012). When peers share resources in their early social interactions, the desire of each individual not to receive fewer resources that their peer is likely to apply strong social pressure towards equality. Already at 3 years of age children raise objections when
they are presented with unequal divisions of resources that place them at a disadvantage (Rakoczy et al., 2016). In addition to feeling disadvantaged, experiencing DI can have negative emotional consequences for the recipient (Tabibnia, Satpute, & Lieberman, 2008), providing additional pressure towards equality. Indeed, recent research has found that priming children with the emotional consequences of sharing (or not sharing) for a recipient increases generosity in 3- to 6-year-old children (Paulus & Moore, 2015). In addition, children are able to anticipate the positive emotional consequences of sharing and the negative emotional consequences of not sharing for both themselves and their recipient, and this ability predicts subsequent sharing behavior (Paulus & Moore, 2017). It is likely that over repeated peer interactions children learn from firsthand experience that inequity has negative social and emotional consequences, thus, equal sharing and inequity aversion (specifically AI) are likely a natural consequence of a life lived with peers. In the classical approach of Piaget, this outcome is described as equilibrium where mutually satisfactory outcomes are met through balancing all relevant perspectives (Piaget, 1932/1997).

The case of collaborating to attain resources may be a special form of peer interaction, one where children’s concern for equity becomes increasingly important. Specifically, when children collaborate to earn resources, the act of collaboration necessitates mutual commitment towards a joint goal because without active contribution from each collaborator the goal would not be achieved. For this reason, collaboration fosters a state where the each participant is dependent on the other, that is, a state of interdependence. Under conditions of interdependence, it becomes essential that the benefits of the collaboration are shared in a mutually satisfactory way, or the
collaboration breaks down (Baumard et al., 2013; Tomsello et al., 2012). Importantly, Study 1 found that DI (i.e., a personal concern for fairness) did not emerge earlier in development following collaboration relative to parallel work. Thus, it is unlikely that personal concerns for fairness apply greater pressure toward increased equity after collaboration. Instead, it is more likely that collaboration increases the concern each collaborator has for the other’s outcome. On a practical note, concern for the partner’s outcome is beneficial to achieving a joint goal; if one party is unhappy with their outcome then they may no longer fulfill their obligation during ongoing collaboration or engage in future collaborations. On the other hand, the collaboration effect may be the result of a more intrinsic concern for the benefit of collaborators. Collaboration fosters affiliation between peers (Plötner et al., 2015), and affiliation has been found to increase sharing amongst children (Sparks et al., 2017). Collaborators show evidence of representing the mental states of their partners when coordinating actions and intentions in collaborative interactions (Brownell et al., 2006; Warneken et al., 2014). Whether this priming effect extends to the partner’s emotional perspective remains unknown, but given the positive relation between emotional perspective understanding and sharing (Paulus and Moore, 2017), this is an important question to examine in the future. Thus, through affiliation and perspective taking collaborators may come to both understand and care more about outcomes for their collaborative partners. When coupled with a personal concern for fairness (DI), sharing the spoils of early collaborative endeavors may serve as a foundation for the development of fairness.
5.2.6. Conclusion

The consistent finding across this program of study is that collaboration increases children’s concern for fairness, and this concern appears to be motivated by equity over generosity. Presented with an opportunity to endow partners with a relative advantage, children rejected these generous allocations regardless of how the resources were obtained. However, when presented with a relative advantage, children who collaborated sacrificed this advantage in favor of equity. The context of sharing collaboratively earned resources is particularly important in fairness concerns that result in equitable sharing, which occurs more often with collaboratively earned resources then after completing a joint goal. Children’s fairness concerns are not restricted to personal or even interpersonal experiences; rather, the evidence presented here suggests that children have normative concerns for fairness between collaborators. Children engage in third party punishment more often when inequity occurs between collaborators than when resources are earned individually. An important contribution of this series of studies is in providing converging evidence from sharing, inequity aversion and third party punishment paradigms to demonstrate that collaborating to earn resources fosters equity-based fairness, evidence that was largely absent in prior work.

With solid evidence for the critical role of collaboration in fostering fairness across a wide variety of contexts now in hand, future research will need to focus on how this concern develops. Longitudinal studies would help to illuminate the onset of increased fairness across these different situations, and the extent of relatedness between the forms of fairness and between developmental periods. Studies examining the role of peers in socializing fairness concerns are largely absent from the contemporary literature. Yet, long ago Piaget afforded peers a central role in shaping the development of fairness.
when he proposed that equity is achieved when children of equal status must balance their own claims with those of their peers in order to arrive at a mutually satisfactory outcome (Piaget, 1932/1997). The findings from the current series of studies suggest that collaboration may serve a special role in this process, one where the interdependence inherent in collaboration fosters mutual concern and a desire to arrive at a fair solution.
References


Bates, D., Maechler, M., Bolker, B. (2012) lme4: Linear mixed-effects models using S4 classes. R package version 0.999999-0, http://CRAN.R-project.org/package=lme4


Smith, C. E., Blake, P. R., & Harris, P. L. (2013). I should but I won’t: Why young children endorse norms of fair sharing but do not follow them. *PLoS ONE, 8*(3), e59510. doi:10.1371/journal.pone.0059510


Appendix A.

Participant Demographics

The studies were conducted in the town and surrounding county of Antigonish, Nova Scotia, Canada, a region having a total population of approximately 19,000. The core professional occupations in the area are found in the regional hospital, schools, university, and law courts. Agriculture and fishing provide a strong resource base. In addition, there are a large number of people engaged in service, trade and labor jobs. The vast majority of the population in Antigonish is White-Caucasian. The languages spoken are English (96.5%) and French (5%, with all of this population being bilingual). The predominant religion in the area is Catholic (56%) with 21% engaging in other organized religions (Protestant, Baptists, and Buddhist); however, only a minority of families engage in regular weekly religious practice.

In this community it is common for both parents to be employed, and for parents to arrange after-school activities or in-house sitters for their school aged children. Most parents had at least 12 years of formal education, with many having some form of post-secondary education and advanced degrees. Shared parenting is highly valued in this community and both mothers and fathers are actively engaged in the care of their children. When mothers work outside of the home, infants and young children are typically cared for in day care centers (from age 2 years onwards) or private caregivers (infants).

Starting at 5 years of age children spend much of their days (approximately 6 hours) at schools, and also spend approximately 2 hours per day engaging in extracurricular activities (sports, music and arts programs). Children spend the majority
of their waking hours interacting with peers (including school hours), most of which is supervised by adults. There are many possible after school programs centered on sports and the arts in the community and most children partake in afterschool and/or weekend programs. Throughout early and middle childhood, interactions with friends are arranged and monitored by parents or alternate caregivers. The children in this study were recruited from summer camps offered at minimal cost by the town and county of Antigonish. Children’s access to the type of candies used across these studies is frequent and they regularly have control over a small amount of money to buy candies.