



Sex differences in children's formation of exclusionary alliances under scarce resource conditions

JOYCE F. BENENSON, TIMOTHY J. ANTONELLIS, BENJAMIN J. COTTON,
KATHLEEN E. NODDIN & KRISTIN A. CAMPBELL
Department of Psychology, Emmanuel College

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Conclusions that human males behave more competitively than females have been tempered by recent findings that the two sexes use differing competitive strategies. Theoretically, mammalian males generally gain more than females from using riskier strategies, whereas females have more to lose. Females therefore should compete using less risky strategies. Research with humans suggests that one of these may involve alliance and coalition formation. These diminish risk yet exact a cost in terms of payoffs, suggesting that they may elicit sex-differentiated patterns of use. We examined the hypothesis that early sex-differentiated patterns would appear in which human females would form exclusionary alliances under scarce resource conditions more than males would, whereas males would use individualistic strategies more than females would. To test the hypothesis, 15 female and 14 male triads of 4-year-old children were observed under plentiful and scarce resource conditions. Under scarce resource conditions only, females formed more exclusionary alliances than males did, whereas males engaged in more individualistic competition than females did. Discussion focuses on factors that should predict sex differences in the use of coalitions.

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One of the most fundamental behavioural human sex differences concerns competitiveness (Brown 1991). The definition of masculinity in Bem's (1974) widely utilized sex role inventory is based heavily on an individual's degree of competitiveness. Theoretically, in all species in which females bear more responsibility for the survival of offspring, individual success in same-sex competition provides more benefits to males than females in terms of reproductive success (Trivers 1972). Concomitantly, females suffer more reproductive costs than males from behaving competitively because adverse consequences can more easily reduce their capacity to produce and rear offspring (Campbell 1999).

Yet, recent theorizing emphasizes the importance of competition to the reproductive success of human females (Hrdy 1999; Campbell 2004). Just as in other species, human females differ markedly in the quantity and quality

of offspring. Cross-culturally, human females who find long-term mates willing to invest in their offspring markedly increase their reproductive success (e.g. see Hewlett 1992). Competition between human females therefore may exert an important influence on reproductive success (Hrdy 1999; Campbell 2004).

Females consequently should compete but use relatively low-risk strategies that reduce the probability they will suffer adverse consequences. Research on human risk taking confirms that from infancy into adulthood, males take more risks than females do (reviewed in Byrnes et al. 1999). Low-risk forms of competition, such as competition that is indirect and subtle, only recently have been identified. Bjorkqvist (1994) summarized cross-cultural findings from childhood through adulthood that females more than males use indirect strategies, such as spreading rumours and talking behind a target's back, using covert insinuations of wrongdoing or exchanging relationships as a means of revenge. Underwood and her colleagues documented that females more than males use subtle strategies, such as negative facial gestures or voice intonation (Galen & Underwood 1997; Underwood et al. 2004).

Correspondence: J. F. Benenson, Department of Psychology, Emmanuel College, 400 The Fenway, Boston, MA 02115, U.S.A. (email: joyce.benenson@gmail.com; benensjo@emmanuel.edu).

Subtle strategies can occur directly, because they require time to decipher, thereby decreasing the probability of immediate retaliation.

Crick and her colleagues (Crick 1995; Crick & Grotpeter 1995, 1996) suggested that females more than males engage in overt attempts to sever a target's friendships or ties to a group, a strategy they termed 'relational aggression'. Relational aggression includes social exclusion as well as threats to harm the relationship with the target or the targets' relations with others. While it does not require cooperation between allies, potential cooperation is implied in some variants of the definition. Cooperative alliances that target a lone individual reduce risk by diminishing the probability of retaliation. Thus, some forms of relational aggression do not require the use of either indirect or subtle strategies.

These findings fit within a model in which human females incur higher costs than males from engaging in risky forms of competition. Although controversy surrounds the issue of whether sex differences arise in absolute frequencies of indirect, subtle or relationally aggressive competitive strategies (Archer 2004), researchers concur that a larger proportion of females' than males' aggressive acts use these strategies as opposed to direct and overt strategies because of males' greater reliance on direct aggression (Maccoby & Jacklin 1974; Archer 2004).

Age differences also have been reported in the use of female-oriented competitive or aggressive strategies with males using more direct and overt aggression than females beginning in infancy and continuing into adulthood (Archer 2004). Sex differences in absolute frequencies of indirect aggression begin in middle childhood and peak in adolescence (Archer 2004), although some measures of indirect or subtle strategies and relational aggression show sex differences in early childhood (McNeilly-Choque et al. 1996) and little research has been conducted with adults.

Some components of relational aggression resemble the concept of alliances and coalitions found in the animal behaviour literature (de Waal & Harcourt 1992). Mammalian alliances and coalitions prevent a target from attaining a goal such as obtaining a resource or mating. Forming coalitions reduces costs by outnumbering victims, thereby reducing the need for costly aggression and the probability of retaliation (Wrangham 1999). However, coalitions also reduce overall benefits because rewards must be shared.

Mathematically, if all individuals have equal chances of obtaining rewards and being included in coalitions, the expected payoff of an individualistic versus coalitionary strategy is shown in the equation: $r/n = (c/n)(r/c)$, where r represents the number of rewards, n the number of individuals present and c the number of individuals in the coalition. As shown on the left-hand side of the equation, the expected payoff for the individualistic strategy consists simply of the probability of any one individual's obtaining the rewards (r/n). On the right-hand side of the equation, the expected payoff for the coalitionary strategy is the product of the probability that the coalition obtains the rewards (c/n) times the individual's share of the reward after it is divided (r/c). c/n is equivalent to the probability

that any one coalition of equal size will obtain the resources, $1/(n/c)$, because n/c is the expected number of coalitions of size c . Therefore, selection of an individualistic strategy or a coalitionary one cannot be due to decisions regarding expected payoffs. Nevertheless, an individualistic strategy poses higher risks because of the greater likelihoods of aggression and potential retaliation.

Even more critically, if an individual holds an advantage in terms of the probability of obtaining the rewards as high-ranking individuals do, then the expected payoff is higher for an individualistic than a coalitionary strategy. A high-ranking individual can obtain rewards by acting alone without the necessity to divide the rewards that a coalition demands. This constitutes a riskier strategy, however, because both the probability of aggression and retaliation are higher and the certainty of obtaining any particular reward lower. In contrast, joining a coalition greatly diminishes both the risk of aggression and the uncertainty, but requires division of rewards, thereby decreasing payoffs. Unless rewards are unequally divided based on rank, a high-ranking individual will obtain a lower payoff by forming a coalition. Given the trade-off between expected payoff and risk reduction, an individualistic strategy is always preferable for a high-ranking individual unless the costs of aggression are prohibitively high or success requires a coalition.

Theoretically, this should apply to human sex differences in coalition formation. Given that males are willing to incur greater risks than females, unless they are low ranking, they should prefer an individualistic strategy. In contrast, females' lesser willingness to incur risks (particularly aggression and uncertainty of rewards) should produce a preference for coalitionary strategies despite their lower payoffs. Other low-risk strategies, including indirect and subtle forms of aggression, can co-exist with a coalitionary strategy, which may vary in the extent to which it occurs in the presence of the target and hence produces an immediate reaction from the target.

Results from a recent study with 10-year-old children supported the theory that compared to males, females would more frequently use coalitions to reduce group size (Benenson et al., in press). In that study, groups of five same-sex children were asked to work together to create a drama with a large prize given to the best performance. Significantly more female than male groups formed coalitions that excluded one member of the group. In contrast, males engaged in more individualistic conflicts and aggression.

In another study of children and adolescents, exclusion by a group was rated as significantly more hurtful by females than by males (Galen & Underwood 1997), suggesting greater prevalence amongst females. In the same study, females evaluated group exclusion as inflicting as much harm as physical aggression, which seems counterintuitive unless group exclusion occurs with greater frequency than physical aggression. By contrast, males evaluated physical aggression as more harmful than group exclusion.

We designed the current study to examine early manifestations of sex differences in coalition formation under scarce resource conditions. We selected 4-year-old children

to participate, because young children first form rudimentary alliances with one another by age 2 (Brownell et al. 2006) and by age 4, alliances occur regularly (Parten 1932). We then created triads of familiar, same-sex children and provided differing numbers of resources to compare competition during conditions of plenty versus scarcity. We formed triads rather than larger size groups because they are the smallest size group that would permit alliances and coalitions to form and not demand complex social reasoning.

Because young children of this age rarely form true coalitions in which they jointly cooperate to aggress against a third child (de Waal & Harcourt 1992), only exclusionary alliances were examined. Exclusionary alliances were defined as two children cooperating during a joint activity without the third child. While this definition does not measure intentionality on the part of the two alliance partners to harm the interests of the third child as explicitly as in a true coalition, increased use of exclusionary alliances under scarce but not plentiful resource conditions is consistent with the theory that exclusionary alliances are being used as a competitive strategy.

We used four treatments that were distinguished by the number of resources (puppets) available to the triad. In the two baseline treatments, three puppets were provided. In the critical treatment, the triad was given only one puppet, and in an intermediate treatment, the triad was given two puppets. When only one puppet was provided, we expected females to form more frequent exclusionary alliances than males, and males to engage in more individualistic competition.

METHODS

Subjects

We recruited 87 4-year-old children (females: $\bar{X} + SE = 56.67 + 4.06$ months; males: $\bar{X} + SE = 56.76 + 3.90$ months) from seven preschools in the greater Boston, U.S.A., area for the study. Children from the same classroom who received parental consent to participate were randomly assigned to same-sex triads, yielding 15 female and 14 male triads. Of the 87 participants, 71 were Caucasian, 9 were Asian, 5 were Hispanic and 2 were African-American. Five female triads and eight male triads contained at least one individual of a different ethnic background.

Treatments

Before the actual study began, we piloted the procedure at a separate school to ensure that the resources we provided were valued equally by each sex. We selected puppets as the resource for the actual study because they were highly attractive to both sexes. To enhance the value of the puppets, we chose puppets that were larger than 50 cm, brightly coloured, malleable and newly manufactured. The puppets consisted of turtles with retractable heads and legs, elephants with 30 cm trunks, and parrots that squeaked. During piloting, we also determined that

5 min constituted an optimum length for each treatment to maintain children's interest.

For the actual study, each triad participated in four 5 min puppet number treatments. The basic design consisted of triads tested in a sequence of puppet number treatments that differed in terms of scarcity. To control for sequence and puppet effects, we used two sequences of puppet number treatments: 3–2–1–3 puppets and 3–1–2–3 puppets. Half the female and half the male triads followed each sequence. To provide a baseline measure of exclusionary alliance formation, in both sequences, the first and last treatments consisted of three turtle puppets, one for each child. To ensure children's continued interest in the puppets, we gave a triad parrot puppets in the 2-puppet number treatment if we had given the same triad an elephant puppet in the 1-puppet number treatment, and vice versa. We gave half the triads in each sequence elephants first, and the remaining half parrots first.

General Procedures

Two male experimenters conducted the study in an empty room at the preschool that the children attended. One experimenter provided instructions to the children and the second filmed all interactions between the children. The two experimenters alternated roles, so that each interacted with half the female and half the male triads. After children arrived in the experimental room, one experimenter explained the study to the children and ensured each child was comfortable talking to the experimenter. Before each new puppet treatment began, this experimenter first demonstrated how the puppet(s) worked, then placed the puppet(s) in a box and closed the lid so the children would have to negotiate obtaining the puppet(s), and left the room for 5 min. The experimenter filming the children remained in the room, but never interacted with the children. Identical instructions were read to the children before each puppet number treatment. After the study ended, the researcher thanked the children for participating and gave them a package of stickers to take home.

Dependent Variables

Possession

To verify that females and males valued the puppets similarly, one coder recorded the number of seconds that every child possessed a puppet for each of the four puppet number treatments. Possession was defined as physically touching the puppets with a body part and controlling the puppet's movements. The final measure consisted of the mean number of seconds that children in a triad possessed the puppet(s) in each puppet number treatment.

Transfers

To ensure that children were interested in obtaining the puppets, a second coder counted the number of times that the children exchanged the puppets. A transfer was defined as occurring when a puppet left one child's

possession and immediately became the possession of another child. The final measure consisted of the mean number of transfers for a triad in each puppet number treatment.

Exclusionary alliances

Three additional coders recorded exclusionary alliances. The definition of an exclusionary alliance consisted of two children cooperating in a joint activity without the third child for a minimum of 10 s. The most common form of exclusionary alliance consisted of two children verbally planning or physically playing a game without any reference to the third child, but other forms included two children whispering with backs turned towards the third child or hiding from the third child behind furniture or inside the puppet box. Alliance partners never coordinated a verbal or physical attack on a third child, so alliances were simply exclusionary. Exclusionary alliances could occur when one or both of the alliance members possessed the puppet and when neither did.

To facilitate coding of exclusionary alliances, we divided every puppet treatment into five 1 min intervals. Coders recorded whether an exclusionary alliance occurred within each interval and which children participated. Once an exclusionary alliance was identified between two children during an interval, coders switched to focus on other potential alliances. This created an upper limit of five exclusionary alliances per pair and 15 per triad during a puppet number treatment. The final measure consisted of the mean number of alliances formed by a triad in each puppet number treatment.

Direct individual attempts to obtain a puppet

We also coded direct attempts by an individual to obtain the puppet in the 1- and 2-puppet number treatments. Direct attempts to obtain the puppet were defined as grabbing or tugging at the puppet, chasing/trapping a child in possession of a puppet, directly asking for the puppet, or actively attempting to persuade the child with the puppet to part with it. In the 1-puppet number treatment, coding began as soon as one child obtained control of the puppet and continued until this child relinquished control of it or after 120 s had elapsed. The number of seconds of direct individual attempts to obtain the puppet was recorded separately for each of the two children without the puppet, then their scores were divided by the total number of seconds of coding, and averaged across the two children. In the 2-puppet number treatment, only the child without the puppet was coded, using the same procedure as for the 1-puppet number treatment.

Reliability

For both possession and transfers, initial coding showed virtually perfect agreement, so only one coder recorded each. For exclusionary alliances, the three coders initially were trained on standardized examples to 85% agreement. Thereafter, over the 2-month coding interval, coders held weekly sessions in which all three coders compared coding of one triad in each of the four puppet number treatments.

Agreement between a pair of coders on actual triads ranged from 70 to 100% (kappas = 0.52–1.00). To enhance validity further, the final measure of exclusionary alliances included only those alliances identified by at least two coders. For direct individual attempts to obtain the puppet, a second coder rated one-half of the children in the 1- and 2-puppet number treatments (Pearson correlation: $r_{26} = 0.95$).

RESULTS

The triad formed the unit of analysis. Initially we performed analyses with the triad's sex, ethnicity (homogeneous versus heterogeneous) and sequence of puppets (3–2–1–3 versus 3–1–2–3) as independent variables and puppet number treatment (3 puppet first session, 2 puppet, 1 puppet, and 3 puppet last session) as the repeated factor using ANOVA followed by Turkey tests ($P < 0.05$). Because none of the main or interaction effects of ethnicity or sequence were significant, we retained only sex and puppet number treatment in the final analyses.

To verify that females and males valued the puppets similarly, we analysed the mean number of seconds that children in each triad possessed a puppet using a repeated measures ANOVA with puppet number treatment as the repeated factor and sex as the independent variable. Results indicated a main effect for puppet number treatment (ANOVA: $F_{3,81} = 68.05$, $P < 0.001$), but no effects of sex ($F_{1,27} = 0.25$, $P = 0.62$) or puppet number treatment \times sex ($F_{3,81} = 0.23$, $P = 0.88$; 1 puppet: females: $\bar{X} + SE = 89.93 + 6.34$; males: $\bar{X} + SE = 95.45 + 5.31$; 2 puppets: females: $\bar{X} + SE = 169.80 + 10.46$; males: $\bar{X} + SE = 165.26 + 11.12$; 3 puppets first session: females: $\bar{X} + SE = 248.84 + 14.28$; males: $\bar{X} + SE = 260.26 + 11.11$; 3 puppets last session: females: $\bar{X} + SE = 158.62 + 23.10$; males: $\bar{X} + SE = 169.69 + 20.21$). Follow-up tests showed that children spent significantly more time in possession of the puppets in the first 3-puppet number treatment compared to the 1-puppet number treatment, which would be expected based on the number of available puppets. None of the other differences between puppet number treatments were significant.

We also inspected the equality of distribution of resources in both female and male triads in the 1- and 2-puppet number treatments by examining the number of seconds that the puppet was possessed by the child in each triad who obtained the puppet for the fewest number of seconds. We found that puppets were not shared equally within either the female or the male triads. In the 1-puppet number treatment, if the puppet were shared equally, each child would be expected to obtain the puppet on average for 100 s. The mean number of seconds that the child who possessed the puppet least in a triad differed significantly from 100 for females (one-sample t test: $t_{14} = 9.61$, $P < 0.001$; $\bar{X} + SE = 33.33 + 6.93$ s) and for males (t test: $t_{13} = 5.29$, $P < 0.001$; $\bar{X} + SE = 42.71 + 10.82$ s). Using the same analyses for the 2-puppet number treatment with 200 s expected if the puppets were shared equally, we found that the amount of time that the child who possessed the puppet least differed significantly from 200 for

females (t test: $t_{14} = 9.40$, $P < 0.001$; $\bar{X} + SE = 83.67 + 12.38$ s) and for males (t test: $t_{13} = 9.47$, $P < 0.001$; $\bar{X} + SE = 65.50 + 14.21$ s).

Next, we analysed the mean number of transfers that occurred for every triad with puppet number treatment as the repeated measure and sex as the independent variable. Results indicated significant effects of puppet number treatment (ANOVA: $F_{3,81} = 15.89$, $P < 0.001$) and sex ($F_{1,27} = 4.82$, $P < 0.05$), but no puppet number treatment \times sex interaction ($F_{3,81} = 1.55$, $P = 0.21$; Fig. 1). Follow-up tests showed that the two 3-puppet number treatments did not differ from one another in frequency of transfers. As expected, significantly fewer transfers occurred in the 3-puppet than in the 2-puppet number treatments and in the 2-puppet than in the 1-puppet number treatments. Overall, females engaged in significantly more transfers ($\bar{X} + SE = 1.60 + 0.21$) than males did ($\bar{X} + SE = 1.00 + 0.17$).

To test the hypothesis that under scarce resource conditions females formed exclusionary alliances more than males did, we conducted an ANOVA on the number of exclusionary alliances for every triad with puppet number treatment as the repeated factor and sex as the independent variable. Results indicated a significant interaction between puppet number treatment \times sex (ANOVA: $F_{3,81} = 4.26$, $P = 0.01$), but no main effects of puppet number treatment ($F_{3,81} = 0.85$, $P = 0.47$) or sex ($F_{1,27} = 0.07$, $P = 0.79$; Fig. 2). Follow-up tests showed that females formed significantly more exclusionary alliances than males did only in the 1-puppet number treatment. Females also formed significantly more exclusionary alliances in the 1-puppet number treatment than in the two 3-puppet number treatment, with frequencies in the 2-puppet number treatment not differing

significantly from those in the 1- or 3-puppet number treatment. In contrast, frequency of exclusionary alliances differed significantly for males between the 1-puppet and 2-puppet number treatments, but in the opposite direction as that for females: males engaged in significantly fewer exclusionary alliances in the 1-puppet than in the 2-puppet number treatment.

To examine whether exclusionary alliances were formed by the two children without a puppet in the 1-puppet number treatment, which would be indicative of a joint attempt to obtain the puppet by punishing the child with the puppet, we analysed all exclusionary alliances formed in the 1-puppet number treatment. Fourteen female and eleven male triads formed at least one exclusionary alliance during the 1-puppet number treatment. Of the 14 female triads that formed exclusionary alliances, 10 (71%) included exclusionary alliances in which neither child in the alliance possessed a puppet. Of the 11 male triads that formed exclusionary alliances, 3 (27%) included exclusionary alliances in which neither child in the alliance possessed a puppet, a significant sex difference (chi-square test: $\chi^2_1 = 4.81$, $P < 0.01$). This result suggests that, in the 1-puppet number treatment, females more than males used exclusionary alliances as a strategy to punish the child with the puppet and potentially obtain the puppet for themselves.

Finally, to test the hypothesis that males used more direct individual attempts than females did to obtain the puppets, we conducted an ANOVA on the proportion of time that an individual spent directly attempting to obtain the puppet with puppet number treatment (1 versus 2 puppets) as the repeated factor and sex as the independent variable. Results indicated a significant interaction effect of puppet number treatment \times sex (ANOVA: $F_{1,27} = 4.20$, $P = 0.05$), but no

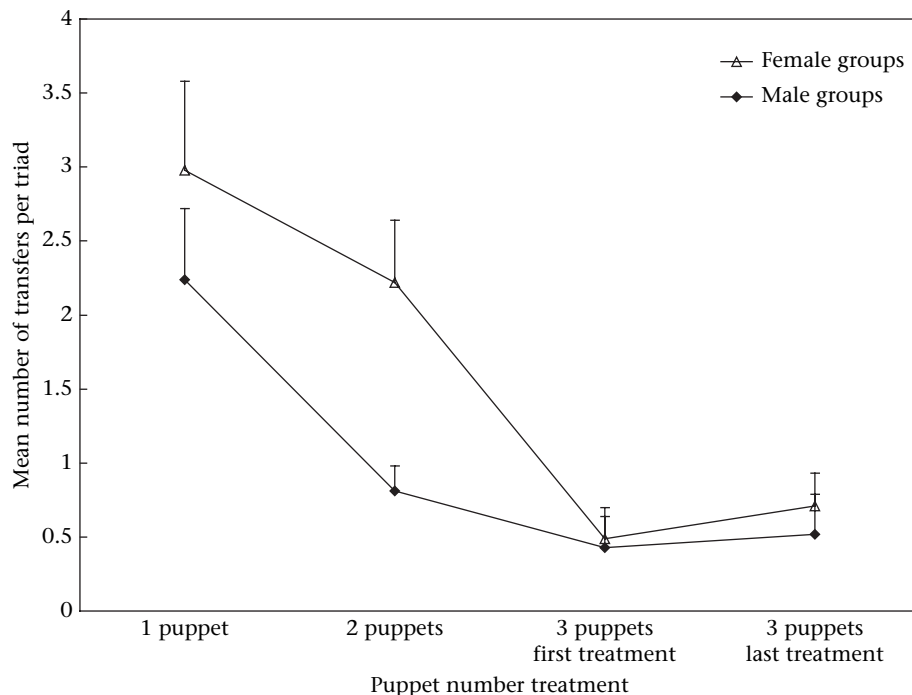


Figure 1. Mean number of transfers within female and male triads across the four puppet number treatments.

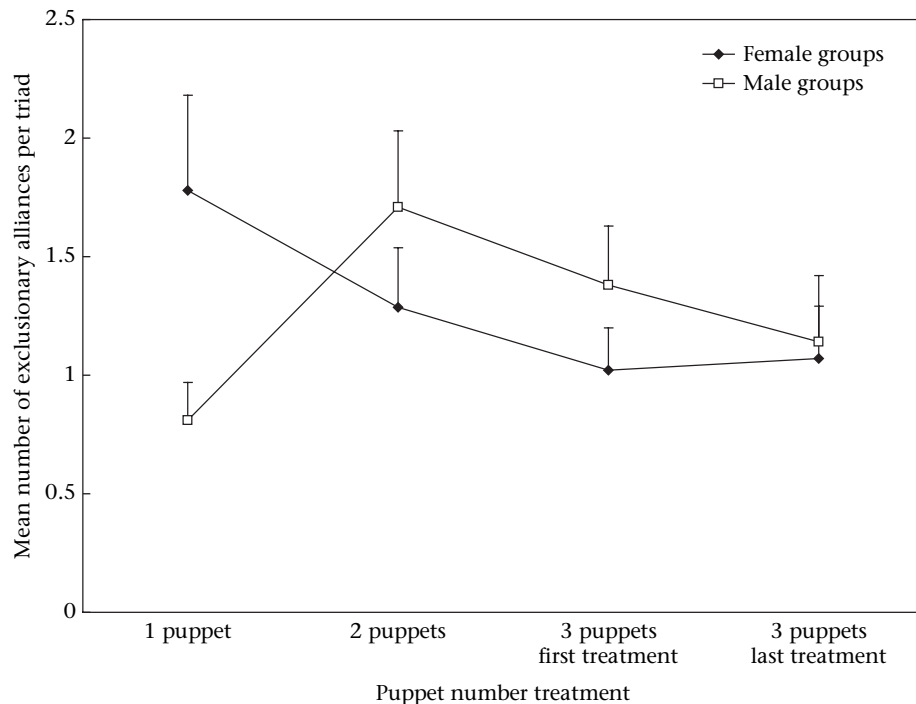


Figure 2. Mean number of exclusionary alliances within female and male triads across the four puppet number treatments.

significant main effects of puppet number treatment ($F_{1,27} = 3.41$, $P = 0.08$) or sex ($F_{1,27} = 2.20$, $P = 0.15$). In the 1-puppet treatment, males spent significantly more time ($\bar{X} + SE = 0.18 + 0.05$ s) attempting to obtain the puppet by themselves than females did ($\bar{X} + SE = 0.07 + 0.02$ s). Males also spent significantly more time directly attempting to obtain the puppet in the 1-puppet number treatment than in the 2-puppet number treatment. In contrast, in the 2-puppet number treatment, the proportion of time spent in direct individual attempts to obtain the puppet did not differ for males ($\bar{X} + SE = 0.06 + 0.02$ s) and females ($\bar{X} + SE = 0.08 + 0.03$ s).

DISCUSSION

Our results are consistent with the hypothesis that young human females form exclusionary alliances more often than males do under the scarcest resource conditions. In the 1-puppet number treatment, females were significantly more likely than males to form exclusionary alliances in which neither individual possessed the puppet, suggesting a sex-differentiated strategy to obtain resources. Rather than directly attempting to obtain the puppet, females more than males may attempt to punish the individual with the resource with the aim of preventing future monopolization of the resource by the target. In contrast, males were more likely than females to attempt individually to obtain the resource directly under the 1-puppet treatment. Overall, evidence supports the interpretation that, from a young age, the two sexes weight the utility of competitive strategies differently.

Males did form exclusionary alliances in the 2-puppet number treatment, indicating that they were capable of

this type of strategy. Males may not have been using exclusionary alliances to compete for scarce resources in the 2-puppet number treatment, however, as suggested by examination of the number of transfers. Although the interaction was not significant, inspection of the number of transfers shows that males did not increase their number of transfers to the same extent that females did between the 3- and 2-puppet number treatments. This suggests that males were not as concerned as females with obtaining the puppets in the 2-puppet number treatment. Alternatively, males may resemble females in their use of exclusionary alliances when no sharing of resources is required (in the 2-puppet number treatment, each individual in the alliance could have a puppet), but not when resources must be shared (in the 1-puppet number treatment).

In contrast, females increased their number of transfers as soon as the number of individuals exceeded the number of resources. Inspection of the means shows that in both the 1- and 2-puppet number treatments, females transferred the puppets more frequently than males did. This result is consistent with current theory that mammalian females have a lower threshold to perceive resource scarcity and respond using less risky strategies than males do (Trivers 1972).

In mammals, females generally use coalitional strategies more than males do (van Hooff & van Schaik 1992; Schino 2001). Standard animal models suggest that this is because female reproductive success depends more on resources that are divisible amongst coalition partners than does that of males. Males' reproductive success by contrast relies more on matings, an indivisible commodity. When resources are clumped or predation is a threat, females may form coalitions, primarily with kin, which promotes

female philopatry and male dispersal (Wrangham 1980; van Schaik 1989). When competition between females or predation threat is reduced, male philopatry can evolve. Those individuals who reside with kin are more likely to form coalitions, as kin are the most valuable coalitional partners because of their greater familiarity and shared genetic fitness (Wrangham 1980).

Connor & Whitehead (2005) expanded the resource defence model to include nonterritorial species in fission–fusion species, regardless of philopatry. In their model, the time that individuals expend defending resources or mates constitutes the key factor determining the formation of coalitions. The product of the mean number of competitors for resources and the time to utilize a resource determines whether individuals benefit from competing as coalitions. Because mates often need to be guarded longer than resources do, males in some species may be more likely than females to form coalitions. However, females' continued care for offspring suggests that coalitions to protect offspring will be important where prolonged threats to offspring survival exist.

Other factors that influence sex differences in coalition formation include individual differences in the capacity to obtain resources or mates. If some individuals excel at obtaining resources or mates because of skill or motivation, and they tolerate sharing, then others should be more likely to join them in coalitions (Gilby et al. 2008). In chimpanzees, *Pan troglodytes*, when a high-ranked male requires an alliance with a lower-ranked male to attain or maintain alpha status (Goodall 1986) or to guard a mate (Watts 1998), then the lower-ranked male will benefit from the alliance provided that the higher-ranked male shares matings. In a number of species, subordinate males will aid harem holders even with no immediate payoffs, presumably because this increases the subordinate's chances of eventually replacing the alpha (van Hooft & van Schaik 1992).

Whether some females specialize in pursuits that increase the probability of others benefiting from forming coalitions with them remains unknown, but subordinate females clearly benefit from aiding higher-ranked females (Schino 2001). In male philopatric chimpanzee communities, high-ranking females form temporary coalitions when their resources are seriously threatened, such as when a female newcomer attempts to join the community (Baker & Smuts 1994; Townsend et al. 2007; Kahlenberg et al., in press). Even in baboons, *Papio cynocephalus anubis*, under rare circumstances when the stakes are high enough, unrelated females form temporary coalitions (Smuts 1987). Coalitions in these instances should greatly reduce risks compared to individual aggression, while producing large benefits. Costs of alliance formation and of extended alliances, as well as proportionality of the distribution of resources within a coalition, also influence which sex forms alliances (Wrangham 2000; Whitehead & Connor 2005).

Residence patterns in humans are unclear (Rodseth et al. 1991; Alvarez 2004; Wilkins & Marlowe 2006), precluding predictions regarding sex-differentiated prevalence of coalitions. Juvenile strategies, however, probably mimic those of adults of the species (Lee & Johnson 1992). The current

results suggest that in humans, both sexes show early evidence of the use of coalitional strategies with unrelated same-sex individuals, but females use exclusionary alliances more than males do when resources become scarce. Alliances and coalitions reduce risk but also diminish individual resources, suggesting that in humans as in many mammalian species, females may be more likely than males to form coalitions.

Nevertheless, the ubiquitous sexual division of labour in human societies (Marlowe 2007) produces many more cooperative all-male than all-female groups (Tiger 1969). Within male groups, coalitions form with dominant or highly skilled or motivated individuals as they constitute a significant mechanism for advancement of subordinate males' quests for resources and status. In contrast, for females, child rearing typically includes the formation of an alliance between a mother and either the father of her child or a female relative (Campbell 2004). This alliance probably results from the need for prolonged protection of children (Connor & Whitehead 2005). Consequently, during a female's child-rearing years, males may form more numerous opportunistic same-sex alliances or coalitions than females, but long-term alliances or coalitions still may be more profitable for females than for males.

A significant limitation of our study is that we found no evidence to support the greater utility of either strategy. This lack of support is probably due to the large variation in the success of each strategy in a small number of groups. Qualitatively, in some groups, the formation of an exclusionary alliance led the child with the puppet to relinquish it immediately. In others, exclusionary alliances produced no consequences. Direct individual attempts to obtain the puppet also varied markedly in success. It is likely that individual differences arise in the effectiveness with which each strategy can be used.

Further limitations of this study include the context in which it occurred. Only triads were included, as this constitutes the smallest unit that would allow alliance formation. Given that most interactions between young children are dyadic (Parten 1932), increasing group size further would have stretched the experiences of children of this age. Likewise, room sizes, filming and interaction with the experimenters added additional constraints that detracted from the ecological validity of this study that must be remedied in future studies.

A more complete model of sex-differentiated competitive strategies in humans will require including additional variables such as type of resource (food or its monetary proxy versus status or reproductive opportunity), its potential divisibility, proportional distribution and value, number of competitors and time needed to utilize the resource, ability to obtain the resource as an individual versus a coalition, presence of kin and friendly nonkin, differences in dominance rank, costs of aggression and of temporary alliance formation, individual differences in skill or motivation to obtain resources, as well as risk. Further research also is necessary with older children and adults who can form true coalitions in which two individuals explicitly aggress against a third.

Recent research shows that females in middle childhood use coalitions more than males do, whereas males use

individualistic strategies more than females do (Benenson et al., in press). Universal sex differences in human social structure may arise in which females form close dyadic relationships more often than males do, and males form larger groups in which individuals both compete and cooperate (Fine 1980; Savin-Williams 1980; Gabriel & Gardner 1999; Markovits et al. 2001) because they prevent a female from resorting to individualistic competitive strategies and from being the target of coalitions. More generally, females should use lower risk strategies, such as indirect and subtle forms of aggression, relational aggression, as well as exclusionary alliances and true coalitions, more often than males do when they are competing for a valued resource that can be shared. During their child-rearing years, females' long-term alliances with marital partners may diminish the utility of alliances with unrelated females.

In the current study, by 4 years of age, when resources were scarcest and indivisible, human females formed more exclusionary alliances and males used more direct individual attempts to procure the resource. Future research that systematically varies factors likely to influence sex-differentiated competitive strategies will allow more complete tests of the current model with human children as well as adolescents and adults.

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