



Sex differences in 2D:4D ratio, aggression and conflict resolution in African children and adolescents: a cross-cultural study

Marina L Butovskaya

Department of Cross-Cultural Psychology and Human Ethology, Institute of Ethnology and Anthropology, Russian Academy of Sciences, Moscow, Russia

Valentina Burkova

Department of Cross-Cultural Psychology and Human Ethology, Institute of Ethnology and Anthropology, Russian Academy of Sciences, Moscow, Russia

Audax Mabulla

Archaeology Unit, Department of History, University of Dar-es-Salaam, Tanzania

ABSTRACT

This study was conducted on children and adolescents from the three tribal cultures from Northern Tanzania: the Hadza, the Datoga and the Iraqw. The comparative data on aggression and conflict management skills were measured at Endomaga Boarding School, Lake Eyasi, Mangola in Northern Tanzania, in 2005-2006. The final sample included 219 children, ranging from 7 to 20 years of age. No sex differences were found in self-ratings or frequency of occurrence of physical, verbal and indirect aggression in Iraqw children and adolescents, or in self-ratings in Hadza. Hadza boys reported a higher occurrence of physical and indirect aggression during the previous week compared to girls. No differences between the sexes were found in constructive conflict resolution and third-party interventions practiced by Iraqw and Datoga children and self-ratings in Hadza. Hadza boys reported a higher frequency of constructive conflict resolution and third-party interventions compared to girls. Significant sexual dimorphism on the 2D:4D ratio was found for our African sample. A significant negative correlation between the right hand 2D:4D ratio and ratings on physical aggression was found for the girls. The girls with the lowest finger index estimated themselves as more verbally aggressive, compared to girls with a medium 2D:4D ratio.

KEYWORDS

Gender (sex) differences; physical aggression; verbal aggression; indirect aggression; constructive conflict resolution; third-party intervention; consolation; socialisation strategies; 2D:4D ratio.

Introduction

Human aggression is believed to be affected by several factors, such as individual, cultural and situational factors in both males and females. In the early 1960s, many specialists considered aggression to be an intrinsically male phenomenon and claimed that aggression in females was so rare that studying it in detail was hardly worth the effort (Buss, 1961). Eventually, however, the accumulation of knowledge from different fields, including ethology, psychology and anthropology, resulted in a much broader understanding of aggression. Under the new paradigm, three different types of aggression were described: physical (more typical of males in all human cultures); direct verbal; and indirect (Osterman *et al*, 1998; Butovskaya & Kozitnsev, 1999a; 1999b; Sutton & Smith, 1999; Butovskaya, 2001). Although, cross-culturally, men tend to engage in physical aggression more often than women, women, too, may be physically aggressive in many cultures (Fry, 1998; Butovskaya *et al*, 2007). Both men and women are verbally aggressive worldwide (Burbank, 1994). Several recent studies also indicate a growing level of female aggression (especially physical aggression) in modern society, which can at least partly be attributed to changes in socialisation practices (Butovskaya & Demianovitsch, 2002). These findings are especially relevant in view of the fact that, in situations of conflict with their peers, adolescents, regardless of their sex, tend to imitate their mother's rather than their father's behaviour (Bjorkqvist, 1997).

Indirect aggression, especially, has received much attention. This has been defined as 'harming others through covert behaviour' (gossiping or spreading rumours) and is believed to be the best way for the perpetrator to maintain their anonymity and minimise the possibility of retaliation (Bjorkqvist *et al*, 1992). This behaviour is not easily observed, and hence the necessary information may be collected mainly by means of interviews and questionnaires. Similar phenomena have also been described as 'social aggression' or 'relational aggression' (Crick, 1996; Galen & Underwood, 1997). However, social and relational aggression may be accompanied by certain direct forms of non-physical aggression, such as negative facial expressions in the case of social aggression, or excluding peers from the group in the case of

relational aggression (Crick, 1996; Underwood *et al*, 2001). Data collected in different countries (Finland, Israel, Italy, Poland and Russia) provide similar information attesting to a higher rate of peer-estimated indirect aggression in females compared to males (Bjorkqvist & Niemela, 1992; Bjorkqvist, 1994; Osterman *et al*, 1998; Bjorkqvist *et al*, 2001; Butovskaya *et al*, 2005; Butovskaya *et al*, 2006a). Owens and colleagues (Owens 1996; Owens *et al*, 2000) came to the same conclusions based on Australian data, although in this case self-estimation was used. A higher rate of indirect aggression in females was demonstrated by cultural anthropologists in Zapotec Indians in Mexico, and in Argentina (Fry, 1992; Fry, 1998). A study conducted in the USA also suggested that relational aggression was more typical of young girls than of boys (Crick & Grotpeter, 1995; Crick, 1996), and the same was true for Russian data (Butovskaya *et al*, 2006b; Butovskaya *et al*, 2007). Some researchers, however, found no gender differences in the rate of indirect aggression among children, adolescents or adults (Rays & Bear, 1997; Richardson & Green, 1999; Walker *et al*, 2000). In fact, one study even revealed a higher rate of indirect aggression in adolescent males compared to females (Linderman *et al*, 1997).

It is now generally assumed that cultural patterns play an important role in the expression of aggression in both sexes. In most cultures, females are less physically aggressive and less inclined to conflict directly with others than males (Crook, 1992; Fry, 1998; Butovskaya & Kozinsev, 1999a; 1999b; LaFreniere *et al*, 2002). Debates around gender differences in indirect aggression are ongoing. New data from other cultures, preferentially non-European, is needed before definite conclusions can be reached.

Girls are frequently said to be more socially competent than boys at all ages, but does this mean that they are more prosocial? Indeed, social skills may be used for hostile purposes. Bjorkqvist *et al* (1992) demonstrated that older schoolchildren use more indirect aggression than younger ones, and thus social intelligence correlates with indirect aggression after age 12. The period between the ages of 11 and 15 is marked by rapid physiological and mental development. At this time, adolescents acquire major social skills and competence in social interactions with their peers, which are critical for social success in adulthood.

In the last 10 years, the post-conflict reunion phenomenon in children has been studied in detail by employing the methods elaborated in primate studies. Various ethological methods were applied for studies of reconciliatory behaviour in children and adolescents from different cultures, including Russia (the Russians and Kalmyks), Sweden, Netherlands, USA, Italy and Japan (Butovskaya *et al*, 2000; Butovskaya, 2001; Ljungberg *et al*, 2005; Fujisawa *et al*, 2005; Kempes *et al*, 2008).

Post-conflict behaviour was also investigated by means of interviews and various questionnaires (based on both peer-ratings and self-ratings) (Osterman *et al*, 1997; Butovskaya *et al*, 2007). Striking gender differences in attitudes towards third-party intervention were found in many cultures (Hay *et al*, 1992; Osterman *et al*, 1997; Cunningham *et al*, 1998; Cowie, 2000). Our recent data on Russian children demonstrated that boys are generally less involved in peacemaking and conflict resolution interventions than are girls (Butovskaya *et al*, 2007). Cultural patterns play an important role in this type of behaviour. Thus, in Caucasus ethnoses (Armenian, Ossetian), the role of peacemaker is a man's prerogative (Butovskaya *et al*, 2006a; 2006b).

As has been mentioned above, the majority of data on aggression and peacemaking in children and adolescents were collected in post-industrial cultures. It remained to be tested whether peculiarities revealed in these studies reflected universal patterns of human behaviour. On the basis of our own experience in Africa, we suggested that the differences between sexes in the level of physical, verbal and indirect aggression may vary from culture to culture. The specific cultural background may also influence the quality and quantity of the intervention of third parties in conflicts (Butovskaya *et al*, 2000; Van Hoogdalem *et al*, 2008). Members of collectivistically oriented cultures tend to use a conflict style in which conflict resolution by third parties plays a more important role than in individualistically oriented cultures (Bierbrauer & Klinger, 2005). Besides this, collectivistically oriented cultures vary substantially in the degree of group egalitarianism, and this factor seems to be influential both for the expression of aggression and for the development of conflict-managing strategies (Boehm, 1999; Fry, 2007).

Currently, one of the issues that is actively disputed is a possible correlation between

behavioural parameters (particularly aggression) and finger length ratio (2D:4D). In humans, the ratio of the second digit (index finger) to the fourth digit (ring finger) is smaller for males than females (Manning *et al*, 2000a; 2000b; Manning, 2002). According to existing data, 2D:4D is lower in males than in females (Manning *et al*, 1998); the sex difference in 2D:4D is apparent in children as young as two years old and has been found to be present in ethnic groups in Europe, the Caribbean, Africa and Asia (Manning *et al*, 1998; Manning *et al*, 2003a). Significant differences in mean 2D:4D between populations were found (Manning *et al*, 1998).

Variation in finger length ratio is thought to reflect the influence of prenatal testosterone during development (Manning, 2002; Manning *et al*, 2003b), and it is believed that this correlation may be due to two non-exclusive causes. The first is that common genes (the Hoxa and Hoxd genes) underlie the development of both the fingers and the gonads (Kondo *et al*, 1997; Peichel *et al*, 1997). The second is that allelic variation in androgen receptor sensitivity influences digit ratio. More masculine finger ratios are associated with androgen receptor alleles with fewer CAG base-pair microsatellite repeats in the terminal domain (Manning *et al*, 2003b).

The current information about the correlation between digit ratio and aggression is quite controversial. Bailey & Hurd (2005) reported that, in a sample of Canadian students, digit ratio was correlated with physical aggression but not with hostility, anger or verbal aggression in males; but there was no correlation between digit ratio and any measure of aggression in females. Meanwhile, Benderlioglu & Nelson (2004) have found that 2D:4D is related to reactive aggression when sufficient provocation is present in young females, but not in males. Again, as reported by Hampson *et al* (2008), based on a sample of undergraduate students, the 2D:4D ratio was a significant predictor of scores on three of the four aggression subscales and total aggression of Buss-Perry inventory in the sample as a whole and in women, while, in men, correlations with 2D:4D were significant only for verbal aggression. The link between 2D:4D and aggression in women was most strongly seen for indirect aggression in another study (Coyne *et al*, 2007).

Because most data on aggression and conflict management in children and

adolescents were collected in post-industrial countries, we suggest that it is highly important to get data from more traditional African and South Asian cultures in order to reveal the general patterns of aggression and peacemaking in humans, as well as to answer the question of the cultural evolution of aggression-peacemaking models. In addition, the data on the correlation between aggression and 2D:4D ratio in children and adolescents is practically absent in general, and particularly for traditional non-European populations. The same is true for the correlation between patterns of conflict management and 2D:4D ratio. We believe this paper will shed some light on the issues mentioned above.

Due to its multiethnic environment and long tradition of peaceful co-existence of different ethnic groups, Tanzania seems to be one of the most appropriate places in the world to answer these questions. The Hadza are one of the best studied groups of modern hunters-gatherers, famous for their egalitarianism; there is no clear dominance or status hierarchy in groups (Woodburn, 1968; Hawkes *et al.*, 2001; Marlowe, 2003). Hadza women have a good deal of independence, and do not hesitate to express their minds. The Hadza live in camps with an average size of about 25 people, and membership is flexible. Monogamy is a norm, with about four per cent of men having two wives at once (Marlowe, 2003). Marital residence is flexible, but it is more common for a couple to live with the kin of the wife than the husband (Woodburn, 1968; Blurton Jones *et al.*, 1992). The level of intermarriage with other ethnic groups is still very low. Commonly, it is Hadza women who marry outside their own ethnic group (Marlowe, 2004; Butovskaya & Drambjan, 2007).

The Datoga (Tatoga, Barabaig, Mangati) are patrilineal and patrilocal semi-nomadic pastoralists (Tomikawa, 1979; Borgerhoff Mulder, 1992). They subsist on herds of cattle, sheep and goats, consume a diet of maize augmented by milk and meat, and are impoverished relative to neighbouring East African pastoralists (Klima, 1965; Sellen, 2003). The Datoga are unusual among East African pastoralists in that women have property rights over livestock and other goods and cattle. They own and exchange livestock and other gifts with members of both their own and their husband's lineage or clan (Borgerhoff Mulder, 1991a; 1991b; Klima, 1965; Tomikawa, 1978; Sellen, 2003). Most families are polygynous and live in extended households

(Sellen, 1995). The Datoga are focused on the maximal number of children in a family, with men quite often fathering 40 or more children (Borgerhoff Mulder, 1992).

The Iraqw practice a mixed pastoral-agricultural economy. They raise cattle, sheep and goats, and they keep some donkeys. Their preferred grain is maize, but they also depend upon more drought-resistant sorghums and millets. Today, the Iraqw are involved in a modern cash economy – they work for wages, growing wheat or onions as cash crops (Winter & Molyneaux, 1963; Snyder, 2005). They are the most numerous ethnic group in the region, the population is increasing by about 3.5% a year and experts estimate the population to be close to 230,000 individuals (Meidertsma & Kessler, 1997). The Iraqw are actively colonising the traditional Hadza lands, converting savanna into maize fields and reducing the Hadza's hunting territories (Butovskaya & Drambjan, 2007). The woman's status in the Iraqw culture is relatively high. They are predominantly monogamous.

The following general hypotheses were tested on three traditional cultures (the Hadza, the Datoga and the Iraqw of Northern Tanzania):

1. 2D:4D ratio in all three populations is sexually dimorphic, and lower in males compared to females
2. 2D:4D ratio is correlated negatively with aggression and positively with peacemaking patterns
3. physical aggression is more often practiced by boys
4. indirect aggression is more often practiced by girls
5. girls are more oriented towards constructive conflict resolution and third-party interventions
6. cultural difference might exist in aggression and peacemaking strategies, and these differences reflect the degree of egalitarianism in the culture.

Methods

Design

We used the questionnaire technique, as well as a limited amount of direct observation and anthropological measurements. These

methods were chosen because long-term direct observation of groups of children was not possible under current study conditions.

Procedure

All the participants were asked to fill out the Swahili version of the Self-Estimated Conflict Behavior inventory originally developed by Bjorkqvist & Osterman (1998). The questionnaire was administered as a group test during school hours. Aggression (physical, verbal and indirect), constructive conflict resolution, third-party intervention, withdrawal and victimisation were measured according to this inventory. Children were asked how typical it was for them to apply physical aggression in interactions with peers (that is, how frequently did they hit, kick, trip, shove, pull, take things and push others). We also asked them about their application of verbal aggression (yelling, insulting, calling names) and indirect aggressive strategies (gossiping, telling bad or false stories, saying bad things behind someone's back etc). The rate of constructive conflict resolution was estimated by asking each child how typical it was for them to solve problems with others, calm the situation down and talk problems over. Participants were also asked about their interventions in their peers' conflicts (attempts to terminate fights between others, active assistance in solving others' conflicts). Respondents evaluated on a five-point scale (0 = not at all; 4 = very often) how often they behaved in the way described in the items. Besides their self-ratings on the degree to which they expressed these qualities, each child was asked to report how many times he/she had practiced these types of behaviour during the previous week.

The inventory was administered to one class at a time, and we were personally present when the inventories were filled out. The whole procedure lasted for about 40 minutes.

After completion of the questionnaires, we made anthropometrical measurements. During this second stage, we measured the length of the second and fourth digits from the basal crease of the digit to the tip of the digit on both hands of each participant. Measurements were done by means of Vernier calipers, accurate to 0.01mm, and the digit ratio was calculated. If a child reported that his/her fingers had been injured some time ago, his/her hands were rejected. To assess the measurement

repeatability, each measurement was repeated twice for 173 schoolchildren. Our measurements were proved to be highly reliable (right hand: 2D: = 0.99, 4D: = 0.99; left hand: 2D: = 0.99, 4D: = 1.00). 2D:4D ratios were calculated following the procedure developed earlier (Manning *et al*, 1998; Manning *et al*, 2000a; Manning, 2002).

Statistical analyses

The data were processed using SPSS 15.0 for Windows. In all analyses, an alpha level of 0.05 was used to determine statistical significance. The mean and standard deviations of all parameters were calculated for boys and girls (whole sample), and sex differences were estimated by independent sample t-tests for 2D:4D on both hands and behavioural parameters. The partial correlations with control for age and ethnic origin were used to estimate the relation between 2D:4D and behaviour separately for boys and girls. To test the interactive effect of gender, culture and age on aggression, peacemaking and victimisation, the univariate analyses of variance (ANOVA) were conducted with post hoc Bonferroni contrasts.

Participants

The data were collected at Endomaga Primary School in Mangola, Northern Tanzania in 2005-2006. During the first stage, we collected data on 219 children in total, ranging from 7 to 20 years of age. Of these, 123 were Hadza (61 boys and 62 girls), 35 were Datoga (21 boys and 14 girls), and 61 were Iraqw, Isanzu and Sukuma (39 boys and 22 girls).

Results

Sex differences in 2D:4D and behaviour (whole sample)

Significant sex differences were found for 2D:4D ratio for the whole sample, both for the right hand (boys: 0.948 ± 0.031 , girls: 0.976 ± 0.032 , $t=-6.52$, $p=0.0001$, $df=217$) and the left hand (boys: 0.949 ± 0.036 , girls: 0.976 ± 0.034 , $t=-5.70$, $p=0.0001$, $df=216$). Besides this, significant sex differences were found for the following behaviours: withdrawal, self-ratings (boys: 2.91 ± 1.34 , girls: 2.40 ± 1.26 , $t=2.52$, $p=0.01$, $df=206$); frequency of physical aggression practiced during the previous week (boys: 1.53 ± 2.35 , girls: 0.92 ± 1.13 ,

$t=2.19$, $p=0.03$, $df=214$); frequency of third party interventions during the previous week (boys: 2.84 ± 2.27 , girls: 1.90 ± 1.81 , $t=2.06$, $p=0.04$, $df=214$).

Relation between 2D:4D and aggressive behaviour (whole sample)

To reveal possible relationship between finger length ratio and aggressive behaviour, we compared individuals with the highest and the lowest ratio, using the t-test for independent samples. Significant differences in self-ratings in verbal aggression were found for boys with the lowest finger length ratio (1.76 ± 0.86 , $n=37$) and boys with medium finger length ratio (>0.93 and <0.95 : 2.22 ± 1.01 , $n=27$, $t=-2.27$, $df=62$, $p<0.03$). Significant differences in frequency of physical aggression during the previous week were found for girls with the lowest 2D:4D (equal and less than <0.95) and girls with a high (but not maximal) 2D:4D (equal and >0.98 and <1.00): 1.38 ± 1.53 , $n=21$ and 0.5 ± 0.79 , $n=18$, accordingly ($t=2.31$, $df=31$, $p<0.03$). Meanwhile, girls with a medium 2D:4D (equal and >0.95 and <0.97) demonstrated significantly higher self-ratings in verbal aggression than girls with the highest 2D:4D ratio (equal and higher than 0.97): 2.15 ± 1.03 , $n=27$ and 1.50 ± 0.81 , $n=26$, accordingly ($t=2.54$, $df=51$, $p<0.02$).

Correlations between 2D:4D and behavioural traits

We calculated partial correlations between 2D:4D ratio on each hand and behavioural traits in the whole Endomaga sample, controlling for age and ethnic origin for boys and girls separately (**Tables 1a** and **1b**). Partial correlations between 2D:4D ratio and self-rating in verbal aggression in boys were positive and significant for both hands (**Table 1a**). The same was true for girls, but for the left hand only (**Table 1b**). For girls, a significant negative partial correlation between 2D:4D and number of physical aggression interactions in the previous week was found for the right hand only (**Table 1b**). Also, a number of significant positive partial correlations between behavioural parameters were found (**Tables 1a** and **1b**).

Sex differences in 2D:4D and behaviour in different ethnic groups

Sex differences in parameters analysed in this study varied for different ethnic groups (**Tables 2a**, **2b** and **2c**). Sex differences in 2D:4D ratio in

Hadza children were significant for both hands. Besides this, Hadza boys reported a higher frequency of physical and indirect aggression, constructive conflict resolution and third party interventions practiced during the previous week compared to girls (**Table 2a**). In Datoga children, sex differences in 2D:4D ratio were similar to that found for the Hadza children, although they did not reach the same level of significance. Significant differences in Datoga children were found for self-ratings on physical and indirect aggression, and girls rated themselves as more aggressive compared to the boys' ratings (**Table 2b**). For the third group, mainly represented by Iraqw children, the sex differences were found for finger length ratio for both hands; no sex differences were found for behavioural traits (**Table 2c**).

Cross-cultural differences in 2D:4D ratio and behavioural parameters for boys and girls

The univariate ANOVA tests were conducted with age and ethnic as independent variables, and 2D:4D and behavioural parameters as dependent variables on the other side, separately for boys and girls. Age differences were non-significant for 2D:4D ratio on both hands, and this was true for boys and girls. The effect of ethnic group, on the contrary, was significant for boys on both hands (right hand: $F [2,120] = 3.12$, $p<0.03$; left hand: $F [2,120] = 3.04$, $p<0.05$). According to Bonferroni contrasts, this difference was significant only between Datoga and Iraqw boys, due to a higher ratio in the Datoga (right hand, Datoga: 0.96 ± 0.03 , $n = 21$; Iraqw: 0.94 ± 0.03 , $n = 39$; left hand, Datoga: 0.97 ± 0.03 , $n = 21$; Iraqw: 0.94 ± 0.03 , $n = 39$). The univariate ANOVA test for indirect aggression in boys revealed the effect of ethnic group ($F [2,112] = 3.421$, $p<0.05$). According to Bonferroni contrasts, Hadza boys ranged higher on self-rating in indirect aggression (Hadza: 2.02 ± 1.13 , $n = 52$; Datoga: 1.35 ± 0.59 , $n = 20$). The effect of ethnic group for boys was also found for self-rating on physical aggression ($F [2,110] = 3.519$, $p<0.03$). Self-rating on physical aggression was significantly higher for Hadza compared to Datoga, with Bonferroni contrasts (Hadza: 2.02 ± 1.13 , $n = 52$; Datoga: 1.35 ± 0.59 , $n = 20$), and higher for Iraqw compared to Datoga (Iraqw: 2.08 ± 0.91 , $n = 38$; Datoga: 1.35 ± 0.59 , $n = 20$). Significant interaction effect of age and ethnic group was found for self-rating on victimisation for boys ($F [4, 110] = 4.316$, $p<0.003$).

Table 1a: Partial correlation between 2D:4D ratio on both hands and behavioural parameters for boys (n = 121)

Control variables		R2D: 4D	L2D: 4D	VA (SR)	InA (SR)	PhA (SR)	CCR (SR)	ThPI (SR)	Wdl (SR)	Vic (SR)	PhA (LW)	InA (LW)	CCR (LW)	PP (LW)	Vic (LW)
Ethnic															
and age	R 2D: 4D	Corr	-	,623	,231										
		P		,000	,017										
	L2D: 4D	Corr	,623		,244										
		P	,000		,011										
	VA (SR)	Corr	,231		,445	,433									
		P	,017		,000	,000									
	InA (SR)	Corr		,445		,545					,325	,238			
		P		,000		,000					,001	,013			
	PhA (SR)	Corr		,433	,545						,311	,261			
		P		,000	,000						,001	,007			
	CCR (SR)	Corr													
		P													
	ThPI (SR)	Corr					,441		,250				,196		
		P					,000		,009				,043		
	Wdl (SR)	Corr					,231	,250							
		P					,017	,009							
	Vic (SR)	Corr					,223								
		P					,021								
	PhA (LW)	Corr		,325	,311							,210			
		P		,001	,001							,030			
	InA (LW)	Corr		,238	,261						,210			,227	
		P		,013	,007						,030			,019	
	CCR (LW)	Corr						,196							
		P						,043						,199	,446
	PP (LW)	Corr									,227	,199			,329
		P									,019	,040		,001	
	Vic (LW)	Corr										,446		,329	
		P										,000		,001	

Legend: Ethnic: 1 = Hadza; 2 = Datoga; 3 = Iraqw. Age (years): 1 = 6-11; 2 = 12-15; 3 = 16-20. R2D:4D = right hand 2D:4D ratio; L2D:4D = left hand 2D:4D ratio; SR = self-rating; LW = number of occurrences last week; VA = verbal aggression; InA = indirect aggression; PhA = physical aggression; CCR = constructive conflict resolution; ThPI = third-party intervention; Wdl = withdrawal; Vic = victimisation; PP = protecting one of peers.

Table 1b: Partial correlation between 2D:4D ratio on both hands and behavioural parameters for girls (n = 98)

Control variables		R2D: 4D	L2D: 4D	VA (SR)	InA (SR)	PhA (SR)	CCR (SR)	ThPI (SR)	Wdl (SR)	Vic (SR)	PhA (LW)	InA (LW)	CCR (LW)	PP (LW)	Vic (LW)
Ethnic and age	R 2D: 4D	Corr	–	,575							–,231				
		P	,000								,025				
	L2D: 4D	Corr	,575	–	,201										
		P	,000	,050											
	VA (SR)	Corr.	,201	–	,510	,219		,201							
		P	,050		,000	,033		,050							
	InA (SR)	Corr	,510	,000	–	,279				,357	,280				
		P	,000			,006				,000	,006				
	PhA (SR)	Corr	,219	,279	,006	–						,348			
		P	,033	,006								,001			
	CCR (SR)	Corr	–	,343						,248			,230		
		P		,001						,015			,025		
	ThPI (SR)	Corr	,343							,389					
		P	,001							,000					
	Wdl (SR)	Corr		,201					–						
		P		,050											
	Vic (SR)	Corr		,357	,000		,248	,389		–			,272		
		P		,000			,015	,000					,008		
	PhA (LW)	Corr	–,231		,280						–				
		P	,025		,006										
	InA (LW)	Corr		,348								–	,312	,345	
		P		,001									,002	,001	
	CCR (LW)	Corr											–		
		P													
	PP (LW)	Corr		,230			,230			,272	,312		–		,404
		P		,025			,025			,008	,002				,000
	Vic (LW)	Corr									,345	,404			–
		P									,001	,000			

Legend: Ethnic: 1 = Hadza; 2 = Datoga; 3 = Iraqw. Age (years): 1 = 6-11; 2 = 12-15; 3 = 16-20. R2D:4D = right hand 2D:4D ratio; L2D:4D = left hand 2D:4D ratio; SR = self-rating; LW = number of occurrences last week; VA = verbal aggression; InA = indirect aggression; PhA = physical aggression; CCR = constructive conflict resolution; ThPI = third-party intervention; Wdl = withdrawal; Vic = victimisation; PP = protecting one of peers.

Table 2a: Sex differences in 2D:4D and behavioural traits in Hadza

Traits	Boys (n= 61)		Girls (n=62)		T	P
	Mean	SD	Mean	SD		
2D:4D right	0.948	0.004	0.978	0.004	-5.41	<0.0001
2D:4D left	0.948	0.005	0.974	0.004	-4.16	<0.0001
Physical aggression (self-rating)	2.11	0.14	1.98	0.13	0.67	NS
Verbal aggression (self-rating)	1.93	0.14	1.68	0.12	1.35	NS
Indirect aggression (self-rating)	2.02	0.16	1.85	0.11	0.86	NS
Constructive conflict resolution (self-rating)	2.92	0.17	2.48	0.16	1.94	NS
Third-party intervention (self-rating)	2.48	0.17	2.42	0.14	0.29	NS
Withdrawal (self-rating)	3.04	0.20	2.44	0.17	2.31	<0.05
Victimisation (self-rating)	1.44	0.11	1.63	0.11	-1.17	NS
Physical aggression (previous week)	1.64	0.37	0.74	0.11	2.36	<0.05
Indirect aggression (previous week)	1.12	0.23	0.61	0.11	2.00	<0.05
Constructive conflict resolution (previous week)	2.53	0.27	1.76	0.20	2.27	<0.05
Third-party intervention (previous week)	3.03	0.28	1.92	0.28	2.78	<0.01
Victimisation (previous week)	2.61	0.31	2.32	0.27	0.70	NS

Means, standard deviations, t-test for independent samples, and P-values (two-tailed) for sexual dimorphism in digit ratios and behavioural parameters. NS – not significant

Table 2b: Sex differences in 2D:4D and behavioural traits in Datoga

Traits	Boys (n= 21)		Girls (n=14)		T	P
	Mean	SD	Mean	SD		
2D:4D right	0.962	0.006	0.978	0.009	-1.03	NS
2D:4D left	0.967	0.007	0.983	0.108	-1.30	NS
Physical aggression (self-rating)	1.75	0.19	2.93	0.30	-3.45	<0.01
Verbal aggression (self-rating)	1.30	0.15	1.86	0.25	-2.03	<0.05
Indirect aggression (self-rating)	1.35	0.13	2.00	0.28	-2.33	<0.05
Constructive conflict resolution (self-rating)	2.53	0.30	2.50	0.31	0.06	NS
Third-party intervention (self-rating)	2.68	0.30	2.36	0.37	0.70	NS
Withdrawal (self-rating)	2.75	0.33	2.00	0.26	1.79	NS
Victimisation (self-rating)	1.50	0.24	1.50	0.25	0.00	NS
Physical aggression (previous week)	1.00	0.25	1.00	0.39	0.73	NS
Indirect aggression (previous week)	1.05	0.30	1.43	0.71	-0.55	NS
Constructive conflict resolution (previous week)	2.45	0.53	1.29	0.53	1.51	NS
Third-party intervention (previous week)	2.55	0.55	1.79	0.60	0.93	NS
Victimisation (previous week)	2.40	0.77	2.64	0.83	-0.21	NS

Means, standard deviations, t-test for independent samples, and P-values (two-tailed) for sexual dimorphism in digit ratios and behavioural parameters. NS – not significant

Table 2c: Sex differences in 2D:4D and behavioural traits in Iraqw

Traits	Boys (n= 39)		Girls (n=21)		T	P
	Mean	SD	Mean	SD		
2D:4D right	0.941	0.005	0.969	0.007	-3.16	<0.005
2D:4D left	0.941	0.005	0.980	0.008	-4.11	<0.0001
Physical aggression (self-rating)	2.08	0.16	1.91	0.22	0.67	NS
Verbal aggression (self-rating)	1.76	0.14	1.45	0.16	1.41	NS
Indirect aggression (self-rating)	2.08	0.15	2.05	0.20	0.14	NS
Constructive conflict resolution (self-rating)	2.82	0.18	2.55	0.28	0.85	NS
Third-party intervention (self-rating)	2.84	0.19	2.45	0.26	1.20	NS
Withdrawal (self-rating)	2.76	0.18	2.68	0.29	0.25	NS
Victimisation (self-rating)	1.89	0.20	1.68	0.25	0.66	NS
Physical aggression (previous week)	1.33	0.28	1.32	0.32	0.03	NS
Indirect aggression (previous week)	0.87	0.18	1.00	0.31	-0.38	NS
Constructive conflict resolution (previous week)	2.15	0.28	2.91	0.47	-1.38	NS
Third-party intervention (previous week)	2.56	0.36	3.09	0.47	-0.88	NS
Victimisation (previous week)	2.23	0.30	2.45	0.41	-0.44	NS

Means, standard deviations, t-test for independent samples, and P-values (two-tailed) for sexual dimorphism in digit ratios and behavioural parameters. NS – not significant

No differences between Hadza, Datoga and Iraqw girls' finger length ratio were found in our sample on both hands, but behavioural differences were substantial. The univariate ANOVA test for self-rating on verbal aggression in girls revealed the effect of ethnic group ($F[2, 98] = 3.613, p < 0.03$). According to Bonferroni contrasts, Hadza girls ranged lower than Datoga (Hadza: $1.98 \pm 0.99, n = 62$; Datoga: $2.93 \pm 1.14, n = 14$), and the same was true for Iraqw and Datoga (Iraqw: $1.91 \pm 1.02, n = 22$; Datoga: $2.93 \pm 1.14, n = 14$). Significant interaction effects of age and ethnic group were found for self-ratings on constructive conflict resolution ($F[4, 98] = 3.510, p < 0.05$) and third party intervention ($F[4, 98] = 5.593, p < 0.001$). Significant age effect was found for self-rating on withdrawal ($F[4, 98] = 4.756, p < 0.01$). According to Bonferroni contrasts, the youngest girls ranged higher than the medium and oldest age groups (young: $3.06 \pm 0.98, n = 36$; medium: $2.06 \pm 1.27, n = 50$; oldest: $2.08 \pm 1.51, n = 12$). Significant ethnic effect was demonstrated for the frequency of constructive conflict resolutions during the previous week ($F[2, 98] = 3.173, p < 0.05$). According to Bonferroni contrasts, Iraqw girls practiced this pattern more frequently, compared to Hadza or Datoga

(Hadza: $1.76 \pm 1.05, n = 62$; Datoga: $1.29 \pm 1.09, n = 14$; Iraqw: $2.91 \pm 2.01, n = 22$). Significant ethnic effect was found for the frequency of protection of peers ($F[4, 98] = 4.876, p < 0.01$). This effect was mainly due to differences between Hadza and Iraqw, according to Bonferroni contrasts (Hadza: $1.92 \pm 1.00, n = 62$; Iraqw: $3.09 \pm 2.20, n = 22$).

Discussion

As demonstrated by previous studies, the digit ratio shows marked variation between ethnic groups and nationalities, including some African samples (Manning *et al.*, 2000a; Manning *et al.*, 2003a). Our data from three African tribal societies confirm this conclusion, as well as our first initial hypothesis: significant sexual dimorphism on the digit ratio was found for the whole African sample, and digit ratio was lower for boys compared to girls.

Counter to our second initial hypothesis, we did not find any significant negative relation between patterns of physical aggression and digit ratio for boys. These findings are in contradiction with results of other studies conducted on non-African populations (Bailey

& Hurd, 2005). Positive relation between verbal aggression and 2D:4D ratio on both hands were found for boys. Although it is not easy to explain the discrepancy of our data with results of other studies, this is possibly due to the specifics of the Endomaga sample. Data on children of different ethnic origin were merged for this analysis, and significant ethnic differences in digit ratio in boys were not taken into account.

On the other hand, the correlations between the 2D:4D and physical and verbal aggression in girls deserve special attention, given the fact of the absence of interethnic differences in 2D:4D ratio. Counter to Bailey & Hurd (2005), but in line with three studies conducted on females of European origin (Benderlioglu & Nelson, 2004; Coyne *et al*, 2007; Hampson *et al*, 2008), a significant negative correlation between the right hand 2D:4D ratio and physical aggression was found for girls. In addition, the girls with the lowest finger index estimated themselves as more verbally aggressive compared to peers with a medium 2D:4D ratio. Given the fact that our data were collected in three traditional African cultures, it is possible to suggest that negative relation between physical aggression and digit ratio may be much more widespread in non-industrial societies. This may especially be the case for cultures where physical aggression between females is less dangerous than that between males, and thus may be less culturally suppressed. According to our observations, females in all three cultures from this study never used guns, spears or bows and arrows while fighting, while the opposite was true for males.

Our third hypothesis was not confirmed for the whole sample: the boys from Endomaga Primary School were not practicing physical aggression more frequently than the girls. On the other hand, the frequency of physical aggression in Hadza boys was higher than in Hadza girls, but the opposite was true for Datoga. No sex differences were registered for Iraqw. Given all these facts, our fourth hypothesis was not confirmed either. Unlike in the majority of studies from western cultures, as well as some traditional cultures (Bjorkqvist & Niemela, 1992; Bjorkqvist, 1994; Crick, 1996; Fry, 1998; Osterman *et al*, 1998; Bjorkqvist *et al*, 2001; Butovskaya *et al*, 2005; Butovskaya *et al*, 2006a), in Endomaga indirect aggression was not practiced by girls significantly more

frequently. At the same time, our data are in line with results reported for some USA samples (Rays & Bear, 1997; Richardson & Green, 1999; Walker *et al*, 2000). One of the possible explanations is the existence of a high correlation between the ratings on physical, verbal and indirect aggression. It is important to stress that our data from three traditional East African cultures provide an example of evident cultural relativism in aggression, particularly, concerning the sex differences in physical, verbal and indirect aggression.

Indeed, the boys from Endomaga with high self-ratings on physical aggression also rated themselves high on verbal and indirect aggression. But there was no correlation between all these ratings and the frequency of constructive conflict resolution or third-party intervention.

Judging from correlations between different types of social activities, boys who were actively engaged in social life, demonstrated physical and indirect aggression more frequently. Those who reported the application of indirect aggression were found to protect other children more frequently. At the same time, these boys were also more frequently attacked by other schoolchildren.

Again, the girls with a high self-rating on physical aggression rated themselves higher on verbal and indirect aggression, but there was no correlation between these ratings and the constructive conflict resolution and third-party interventions practiced during the previous week. Girls who were practicing indirect aggression were victimised more frequently. Those who practiced third-party interventions, protecting other children, also became victims of aggression more frequently than other girls.

In our sample, the children from three traditional East African patrilineal cultures were represented: the Hadza, egalitarian and predominantly monogamous hunter-gatherers; the Datoga, warier, highly polygynous semi-nomadic pastoralists; and the Iraqw, predominantly monogamous agropastoralists (Woodburn, 1982; Hawkes *et al*, 1991; Blurton Jones *et al*, 1992; Borgerhoff Mulder, 1992; Borgerhoff Mulder *et al*, 2001; Marlowe, 2002; Snyder, 2005). Although all the children we studied were from the same primary boarding school and were living together in the same dormitory as well as interacting with each other during the daytime, the Hadza, Datoga

and Iraqw children demonstrated obvious differences in their behaviour, and we believe this is due to early socialisation in different cultural environments. We suggest that these cultural differences may be at least partly responsible for the findings discussed below.

2D:4D ratio in Hadza and Iraqw boys were comparable, while these differences were significant for Hadza and Iraqw on the one side and Datoga and Iraqw on the other. The behavioural profile of Hadza and Iraqw boys was also similar. However, Hadza and Iraqw boys rated themselves higher on verbal and indirect aggression than their Datoga peers. These findings were in line with our direct observations in Hadza camps and among Iraqw farmers: in both cultures, individual quarrels and the spreading of rumours about rivals were quite common and such behavioural patterns were treated tolerantly by group members, while direct physical aggression was culturally restricted. In contrast, in Datoga, both verbal aggression and, especially, indirect aggression were treated as provocations and in the majority of cases were followed by a physical attack on the victim.

Unlike for boys, no differences between the 2D:4D ratio on both hands were found for Hadza, Datoga and Iraqw girls. However, behavioural differences were quite obvious. Hadza girls rated lower on frequency of constructive conflict resolution compared to Iraqw girls, as well as on frequency of third-party intervention. Datoga girls rated themselves higher on physical aggression compared to Hadza and Iraqw girls. Iraqw girls rated higher on constructive conflict resolution compared to Datoga girls.

It has been suggested that girls are usually more sociable than boys, but the data on this came from industrial countries (Butovskaya & Demianovitch, 2002; LaFreniere *et al*, 2002; Butovskaya *et al*, 2007). Our current data seem to question these assumptions. The fifth hypothesis was not confirmed: in all three traditional tribal cultures, self-ratings on constructive conflict resolution and third-party intervention were comparable for boys and girls, and the frequency of these patterns during the previous week were higher for boys compared to girls. It is very possible that this is due to the fact that, in traditional patrilineal cultures, boys are socialised more for social competence compared to girls.

Hadza children differed significantly in their behaviour from their Datoga and Iraqw peers, but these differences were more apparent for girls. This was particularly true for post-conflict behavioural patterns. The Hadza girls reported a lower frequency of constructive conflict resolution and third-party intervention compared to their Iraqw peers, and rated themselves lower on physical aggression compared to Datoga girls. Such cultural differences are quite in line with differences in cultural-specific lifestyles: for Hadza women, there is no real threat in practicing physical aggression as well as verbal aggression because injuries are very low in this culture, unlike the two other cultures. Besides, there is no real opportunity for Datoga or Iraqw women to leave after conflict, while Hadza woman can easily leave one camp and spend time in another camp after conflict.

Gender differences in aggression and peacemaking were obviously expressed in Hadza children and adolescents; however, it was vague in the Iraqw. Importantly, although children in the boarding school reproduced certain cultural stereotypes of conflict resolution, they were also well adjusted to the multiethnic environment. No evidence of any social tension caused by misunderstandings between different ethnic groups was observed.

This study was limited, due to its relatively small sample size and the study design. Children from three examined cultures were interviewed at primary school, they were living in a multiethnic environment and their contact with parents and relatives was limited. The conclusions about individuals' behaviour were made on the basis of self-ratings and self-estimated frequency of particular behavioural patterns used during the previous week. Under such conditions, we are unable to make judgements about the effect of social desirability on children's ratings. To this extent, our conclusions should be treated with some caution, and taken as preliminary. On the other hand, the trends revealed by this study of three traditional East African cultures suggest that cultural diversity in aggressive and post-conflict behaviour could be really high. Sex differences in physical and indirect aggression and conflict management may be more flexible than traditionally expected. More data from the traditional cultures of Africa, Asia and South America are needed to reveal the universal and culturally-specific factors of human aggression and conflict resolution.

Acknowledgements

We thank the teachers and schoolchildren from Endomaga Boarding School, Gorofani Primary School and Dar-es-Salaam Secondary School, as well as local Hadza groups, for their assistance, cooperation and tolerance. Many thanks also to our field assistants, Momoya Caoca, Lidia and Herriott Cledphace. This study was supported by the Russian Foundation for Humanities (Grant 08-01-00015). We also thank the Tanzanian Government and COSTECH, particularly, for providing us with the opportunity to conduct this field study (Research Permit No. 2007-297-ER-2005-126). Special thanks to the anonymous reviewers for their comments and valuable recommendations for the improvement of this paper.

Addresses for correspondence

Marina L Butovskaya
Department of Cross-Cultural Psychology and Human Ethology
Institute of Ethnology and Anthropology
Russian Academy of Sciences
Leninsky prosp. 32a,
117334, Moscow
Russia
Email: m.butovskaya@rambler.ru

Valentina Burkova
Department of Cross-Cultural Psychology and Human Ethology
Institute of Ethnology and Anthropology
Russian Academy of Sciences
Leninsky prosp. 32a
117334, Moscow
Russia
Email: v.burkova@rambler.ru

Audax Mabulla
Archaeology Unit, Department of History
University of Dar-es-Salaam
Tel (office): 255 (22)2410500
Email: AuMab@udsm.ac.tz

References

Bailey A & Hurd P (2005) Finger length ratio (2D:4D) correlates with physical aggression in men but not in women. *Biological Psychology* **68** 215–222.

Benderlioglu Z & Nelson R (2004) Digit length ratios predict reactive aggression in women, but not in men. *Hormones and Behavior* **46** 558–564.

Bierbrauer G & Klinger E (2005) The influence of conflict context characteristics on the conflict regulation preferences of immigrants. *Journal of Cross Cultural Psychology* **36** 340–354.

Bjorkqvist K (1994) Sex differences in physical, verbal, and indirect aggression: A review of recent research. *Sex Roles* **30** 177–188.

Bjorkqvist K (1997) Learning aggression from models: from social learning toward a cognitive theory of modeling. In: S Feshbach & J Zagradska (Eds) *Aggression: Biological, developmental, and social perspectives*. New York: Plenum Press.

Bjorkqvist K, Lagerspetz K & Kaukianen A (1992) Do girls manipulate and boys fight? Developmental trends in regard to direct and indirect aggression. *Aggressive Behavior* **18** 117–127.

Bjorkqvist K & Niemela P (1992) New trends in the study of female aggression. In: K Bjorkqvist & P Niemela (Eds) *Of Mice and Women: Aspects of female aggression*. San-Diego, CA: Academic Press.

Bjorkqvist K & Osterman K (1998) *Scales for Research on Interpersonal Aggression*. Finland: Abo Academi University.

Bjorkqvist K, Osterman K, Lagerspetz K, Landau S, Caprara G & Franczek A (2001) Aggression, victimization and sociometric status: findings from Finland, Israel, Italy and Poland. In: J Ramirez & D Richardson (Eds) *Cross-Cultural Approaches to Aggression and Reconciliation*. Huntington, New York: Nova Science.

Blurton Jones N, Nicholas G, Smith L, O'Connell J, Hawkes K & Kamuzora C (1992) Demography of the Hadza: an increasing and high density population of Savannah foragers. *American Journal of Physical Anthropology* **89** 159–181.

Boehm C (1999) *Hierarchy in the Forest*. Cambridge, MA: Harvard University Press.

Borgerhoff Mulder M (1991a) Datoga pastoralists of Tanzania. *National Geographic Research and Exploration* **72** 166–187.

Borgerhoff Mulder M (1991b) Women's strategies in polygynous marriage: Kipsigis, Datoga, and other east African cases. *Human Nature* **3** 45–70.

Borgerhoff Mulder M (1992) Demography of pastoralists: preliminary data on the datoga of Tanzania. *Human Ecology* **20** (4) 383–405.

Borgerhoff Mulder M, George-Cramer M, Eshleman J & Ortolani A (2001) A study of East African kinship and marriage using a phylogenetically based comparative method. *American Anthropologist* **103** (4) 1059–1082.

Burbank V (1994) *Fighting Women: Anger and aggression in Aboriginal Australia*. Berkeley: University of California Press.

Buss A (1961) *The Psychology of Aggression*. New York: John Wiley & Sons.

Butovskaya M (2001) Reconciliation after conflicts: ethological analysis of post-conflict interactions in Kalmyk children. In: J Ramirez & D Richardson (Eds) *Cross-Cultural Approaches to Aggression and Reconciliation* (pp167–190). Huntington, New York: Nova Science.

Sex differences in 2D:4D ratio, aggression and conflict resolution in African children

- Butovskaya M, Boyko E, Selverova N & Ermakova I (2005) The hormonal basis of reconciliation in humans. *Journal of Physiological Anthropology and Applied Human Sciences* **24** (3) 333–337.
- Butovskaya M, Burkova V & Timentchik V (2006a) *Aggression and Peaceful Coexistence: General mechanisms controlling social tension in humans*. Moscow: Scientific World.
- Butovskaya M & Demianovitsch A (2002) Social competence and behavior evaluation (SCBE-30) and socialization values (SVQ): Russian children ages 3 to 6 years. *Early Education and Development* **13** 169–186.
- Butovskaya M & Drambjan M (2007) Hadza of Tanzania: tradition and modernization. *Asia and Africa Today* **7** 105–110.
- Butovskaya M & Kozintsev A (1999a) Aggression, friendship, and reconciliation in Russian primary school children. *Aggressive Behavior* **25** 125–140.
- Butovskaya M & Kozintsev A (1999b) Sexual dimorphism and the evolution of gender stereotypes in man: a sociobiological perspective. In: J Van der Dennen, D Smillie & D Wilson (Eds) *The Darwinian Heritage and Sociobiology* (pp261–272). Santa Barbara, CA: Praeger.
- Butovskaya M, Timentschik V & Burkova V (2006b) Aggression and conflict resolution in Russian adolescents: gender differences. In: K Osterman & K Bjorkqvist (Eds) *Contemporary Research on Aggression. Proceeding of the XVI world meeting of the International Society for research on Aggression, Santorini, Greece, 2004* (pp10–16). Vasa, Finland: Abo Akademi University.
- Butovskaya M, Timentschik V & Burkova V (2007) Aggression, conflict resolution, popularity, and attitude to school in Russian adolescents. *Aggressive Behavior* **33** (2) 170–183.
- Butovskaya M, Verbeek P, Ljungberg T & Lunardini A (2000) Multicultural view of peacemaking among young children. In: F Aureli & F de Waal F (Eds) *Natural Conflict Resolution* (pp423–450). Princeton: Princeton University Press.
- Cowie H (2000) Bystanding or standing by: gender issues in coping with bullying in English schools. *Aggressive Behavior* **26** 85–97.
- Coyne M, Manning J, Ringer L & Bailey L (2007) Directional asymmetry (right-left differences) in digit ratio (2D:4D) predict indirect aggression in women. *Personality and Individual Differences* **43** (4) 865–872.
- Crick N (1996) The role of overt aggression, relational aggression, and prosocial behavior in the prediction of children's future social adjustment. *Child Development* **67** 2317–2327.
- Crick N & Grotpeter J (1995) Relational aggression, gender, and social-psychological adjustment. *Child Development* **66** 710–722.
- Crook H (1992) Matrifocality and female aggression in Margariteno society. In: K Bjorkqvist & P Niemela (Eds) *Of Mice and Women: Aspects of female aggression* (pp149–162). San Diego, CA: Academic Press.
- Cunningham C, Cunningham L, Martorelli V, Tran A, Young J & Zacharias R (1998) The effects of primary division, student-mediated conflict resolution programs on playground aggression. *Journal of Child Psychology and Psychiatry* **39** 653–662.
- Fry D (1992) Female aggression among the Zapotec of Oaxaca, Mexico. In: K Bjorkqvist & P Niemela (Eds) *Of Mice and Women: Aspects of female aggression* (pp187–199). San Diego, CA: Academic Press.
- Fry D (1998) Anthropological perspectives on aggression: sex differences and cultural variation. *Aggressive Behavior* **24** 81–95.
- Fry D (2007) *Beyond War: The Human Potential for Peace*. Oxford: Oxford University Press.
- Fujisawa K, Kutsukake N & Hasegawa T (2005) Reconciliation pattern after aggression among Japanese preschool children. *Aggressive Behavior* **31** 138–152.
- Galen B & Underwood M (1997) A developmental investigation of social aggression among children. *Developmental Psychology* **33** 589–600.
- Hampson E, Ellis C & Tenk C (2008) On the relation between 2D:4D and sex-dimorphic personality traits. *Archives of Sexual Behavior* **237** (1) 133–144.
- Hawkes K, O'Connell J & Blurton Jones N (2001) Hunting and nuclear families: some lessons from the Hadza about men's work. *Current Anthropology* **42** 681–709.
- Hawkes K, O'Connell JF, Blurton Jones NG, Oftedal OT & Blumenschine RJ (1991) Hunting income patterns among the Hadza: big game, common goods, foraging goals and the evolution of the human diet [and discussion]. *Philosophical Transactions: Biological Sciences* **334** (1270) 243–251.
- Hay D, Zahn-Waxler C, Cummings M & Iannotti R (1992) Young children's views about conflict with peers: a comparison of the daughters and sons of depressed and well women. *Journal of Child Psychology and Psychiatry* **33** 669–683.
- Kempes M, Orobio de Castro B & Sterck E (2008) Conflict management in 6-8-year-old aggressive Dutch boys: do they reconcile? *Behaviour* **145** 1701–1722.
- Klima G (1965) *The Barabaig East: African Cattle Herders*. Prospect Heights, IL: Waveland Press.
- Kondo T, Zakany J, Innis W & Duboule D (1997) Of fingers, toes, and penises. *Nature* **390** 29.
- LaFreniere P, Masataka N, Butovskaya M, Chen Q, Dessen M, Atwanger K, Schreiner S, Montiroso R & Frigerio A (2002) Cross-cultural analysis of social competence and behavior problems in preschoolers. *Early Education and Development* **13** 201–220.
- Linderman M, Harakka T & Keltikangas-Jarvinen L (1997) Age and gender differences in adolescents' reactions to conflict situations: aggression, prosociality and withdrawal. *Journal of Youth and Adolescents* **26** 339–352.

Sex differences in 2D:4D ratio, aggression and conflict resolution in African children

- Ljungberg T, Horowitz L, Jansson L, Westlund K & Clarke C (2005) Communicative factors, conflict progression, and use of reconciliatory strategies in pre-school boys – a series of random events or a sequential process? *Aggressive Behavior* **31** 303–323.
- Manning J (2002) *Digit Ratio: A pointer to fertility, behavior, and health*. New Jersey: Rutgers University Press.
- Manning J, Barley L, Walton J, Lewis-Jones D, Trivers R, Singh D, Thornhill R, Rohde P, Bereczkei T, Henzi P, Soler M & Szwed A (2000a) The 2nd:4th digit ratio, sexual dimorphism, population differences, and reproductive success; evidence for sexually antagonistic genes. *Evolution and Human Behavior* **21** 163–183.
- Manning J, Bundred P, Newton D & Flanagan B (2003b) The second to fourth digit ratio and variation in the androgen receptor gene. *Evolution and Human Behavior* **24** 399–405.
- Manning J, Henzi P, Venkatramana P, Martin S & Singh D (2003a) Second to fourth digit ratio: ethnic differences and family size in English, Indian and South African populations. *Annals of Human Biology* **30** (5) 579–588.
- Manning J, Scutt D, Wilson J & Lewis-Jones D (1998) The ratio of 2nd to 4th digit length: a predictor of sperm numbers and levels of testosterone, LH and estrogen. *Human Reproduction* **13** 3000–3004.
- Manning J, Trivers R, Thornhill R & Singh D (2000b) 2nd to 4th digit ratio and left-lateralised preference in Jamaican children. *Laterality* **5** 121–132.
- Marlowe F (2002) Why the Hadza are still hunter-gatherers. In: S Kent (Ed) *Ethnicity, Hunter-Gatherers, and the 'Other': Association or Assimilation in Africa* (pp247–275). Washington DC: Smithsonian Institution Press.
- Marlowe F (2003) A critical period for provisioning by Hadza men: implications for pair bonding. *Evolution and Human Behavior* **24** 217–229.
- Marlowe F (2004) Marital residence among foragers. *Current Anthropology* **45** 277–284.
- Meidertsma JD & Kessler J (1997) *Towards Better use of Environmental Resources: A planning document of Mbulu and Karatu districts, Tanzania*. Tanzania: Mbulu District Council.
- Osterman K, Bjorkqvist K, Lagerspetz K, Kaukiainen A, Landau S, Fraczek A & Caprara G (1998) Cross-cultural evidence of female indirect aggression. *Aggressive Behavior* **24** 1–8.
- Osterman K, Bjorkqvist K, Lagerspetz K, Landau S, Fraczek A & Caprara G (1997) In: D Fry and K Bjorkqvist (Eds) *Cultural Variation in Conflict Resolution: Alternatives to violence* (pp185–197). Mahwah, NJ: Lawrence Erlbaum.
- Owens L (1996) Sticks and stones and sugar and spice: girl's and boy's aggression in schools. *Australian Journal of Guidance and Counselling* **6** 45–55.
- Owens L, Shute R & Slee P (2000) 'Guess what I just heard!': Indirect aggression among teenage girls in Australia. *Aggressive Behavior* **26** 67–83.
- Peichel C, Prabhakaran B & Vogt T (1997) The mouse ulnaless mutation deregulates posterior hoxd gene expression and alters appendicular patterning. *Development* **124** 3481–3492.
- Rays G & Bear G (1997) Relational aggression and peer relations: gender and developmental issues. *Merill Palmer Quarterly* **43** 87–106.
- Richardson D & Green L (1999) Social sanction and threat explanations of gender effects on direct and indirect aggression. *Aggressive Behavior* **25** 425–434.
- Sellen DW (1995) *The Socioecology of Young Child Growth Among the Datoga Pastoralists of Northern Tanzania* (p390). University of California at Davis In Graduate Group in Ecology and Program in International Nutrition.
- Sellen DW (2003) Nutritional consequences of wealth differentials in East African pastoralists: the case of the Datoga of Northern Tanzania. *Human Ecology* **31** (4) 529–570.
- Snyder K (2005) *The Iraqw of Tanzania: Negotiating Rural Development*. Boulder, CO: Westview Case Studies in Anthropology.
- Sutton J & Smith P (1999) Bullying as a group process: an adaptation of participant role approach. *Aggressive Behavior* **25** 97–112.
- Tomikawa M (1978) Family and daily life: An ethnography of the Datoga pastoralists of Mangola. *Senri Ethnological Studies* **1** 1–36.
- Tomikawa M (1979) The migrations and inter-tribal relations of the pastoral Datoga. *Senri Ethnological Studies* **5** 1–46.
- Underwood M, Galen B & Paquette J (2001) Top ten challenges for understanding gender and aggression in children: Why can't we all just get along? *Social Development* **10** 248–266.
- Van Hoogdalem A, Singer E, Bekkema N & Sterck E (2008) Young children who intervene in peer conflicts in multicultural child care centers. *Behaviour* **145** 1653–1670.
- Walker S, Richardson D & Green L (2000) Aggression among older adults: the relationship of interaction networks and gender role to direct and indirect responses. *Aggressive Behavior* **26** 145–154.
- Winter E & Molyneux L (1963) Population patterns and problems among the Iraqw. *Ethnology* **2** (4) 490.
- Woodburn J (1968) An introduction to Hadza ecology. In: R Lee & I DeVore (Eds) *Man the Hunter* (pp49–55). Chicago: Aldine.
- Woodburn J (1982) Egalitarian societies. *Man* (New Series) **17** (3) 431–451.