Does Early Care Affect Joint Attention in Great Apes (Pan troglodytes, Pan paniscus, Pongo abelii, Pongo pygmaeus, Gorilla gorilla)?

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The ability to share attention with another is the foundation on which other theory of mind skills are formed. The quality of care received during infancy has been correlated with increased joint attention in humans. The purpose of this study was to assess the effects of care style (responsive or basic) and caregiver type (ape or human) during the first 6 months on joint attention in 4 great ape species (Pan troglodytes, Gorilla gorilla, Pongo spp., and Pan paniscus). Great apes engaged in joint attention with conspecifics and humans regardless of the style of early care they experienced from either a great ape mother or human caregiver. This finding suggests that joint attention is a robust ability in great apes that is resilient against at least some differences in early care. Future studies using additional measures of early care quality are recommended.

Keywords: joint attention, gaze following, theory of mind, attachment theory, great apes

Joint attention refers to a suite of sociocognitive skills that involve sharing attention with others at some level (Butterworth & Jarrett, 1991; Carpenter, Nagell, & Tomasello, 1998; Scaife & Bruner, 1975; Tomasello, 1995). Between 9 and 12 months of age, human infants develop the ability to interact with other individuals around objects of interest, also referred to as triadic engagement (Tomasello, 1995). The emergence of coordinated joint attention occurs between 12 and 15 months, in which infants take an active role in collaborating with others during extended social interactions, such as reengaging an adult in a cooperative task (Bakeman & Adamson, 1984; Carpenter et al., 1998; Tomasello, 1995). The emergence of these skills is important because it represents a shift in the ability of infants to comprehend the perceptions of others to an understanding of others’ intentions (Tomasello, Carpenter, Call, Behne, & Moll, 2005). Because joint attention emerges early in development during a similar period in which attachment relationships form (Ainsworth, 1973; Bowlby, 1969), some studies have explored the potential effect of caregiver sensitivity on joint attention abilities in human infants (Goldsmith & Rogoff, 1997; Hobson, Patrick, Crandell, Perez, & Lee, 2004; Raver & Leadbeater, 1995). These studies have suggested that responsive care is correlated with increased joint attention skills (Goldsmith & Rogoff, 1997; Hobson et al., 2004; Raver & Leadbeater, 1995).

One method of operationalizing joint attention in human infants is the spontaneous alternation of gaze between an object and a social partner’s face and eyes (Carpenter et al., 1998; Mundy et al., 2003; Seibert, Hogan, & Mundy, 1982). According to Carpenter et al. (1998), it is important that the infant complete the full gaze alternation cycle, beginning with an examination of the object, looking at the partner, and then returning her attention to the object again, because this behavior indicates an awareness of the partner’s attention on the object in relation to her own. However, Carpenter et al. cautioned that gaze alternation is not the only behavioral means through which joint attention may be assessed, and the production of the behavior does not indicate joint attention in all contexts. For example, an infant may alternate gaze between an object and her partner’s face after the partner makes a loud noise. Because the infant’s alternation of gaze was motivated by a noise rather than the desire to engage socially around an object, the behavior cannot be interpreted as joint attention (Carpenter et al.).

There is a growing consensus that great apes can follow the attention of others in complex ways (Brauer, Call, & Tomasello, 2005; Okamoto-Barth, Call, & Tomasello, 2007; Tomasello, Call, & Hare, 1998; Tomasello & Carpenter, 2005). For example, great apes follow the gaze of humans around barriers and to distant locations (Brauer et al., 2005; Tomasello & Carpenter, 2005; Tomasello, Hare, & Agetta, 1999). In addition, apes sometimes...
check back with the human partner if their line of sight led to an area of little interest (Brauer et al., 2005). Okamoto-Barth et al. (2007) found that of the four great ape species tested, chimpanzees and bonobos followed an experimenter’s gaze to a target significantly more often when a clear barrier was positioned in front of the person’s line of sight compared to an opaque barrier. Chimpanzees demonstrated a similar understanding of human attention in an earlier study using various visual barriers (Povinelli & Eddy, 1996). Although the ability of apes to follow the attention of human partners has been well studied, only one study investigated the ability of great apes to follow the gaze of conspecifics ( Tomasello et al., 1998). Tomasello et al. (1998) demonstrated that chimpanzees reliably followed the gaze of conspecifics during experimental trials.

There is still some controversy, however, regarding apes’ ability to share attention in a triadic or coordinated fashion. For example, Tomasello and Carpenter (2005) found that chimpanzees raised in a human cultural environment were not capable of coordinating attention with humans either in a role reversal task or an object paradigm task (see Call & Tomasello, 1996, for a discussion of enculturation). Carpenter, Tomasello, and Savage-Rumbaugh (1995) found that human children spent the highest amount of time engaged in joint attention compared with mother-raised bonobos and chimpanzees, with the performance of bonobos and chimpanzees raised in a human cultural environment falling between these two groups. In a follow-up to a study on object manipulation in children and nonhuman great apes (Vaubacl & Bard, 1983), Bard and Vaubacl (1984) found that the two adult humans in the study frequently manipulated objects in ways that engaged their own infants, whereas ape mothers rarely acted on the objects while in the presence of their offspring. In the rare instances in which ape mothers did manipulate objects, the ape infants did not coordinate attention with the mother. However, when human adults handled the objects, the ape infants were more likely to attend to their actions. Finally, Okamoto-Barth and Tomonaga (2006) found that although chimpanzee infants engaged in increased mutual gaze with their mothers after 2 months of age and followed human gaze at 1 year of age, they did not engage in coordinated attention around objects with human partners.

Although the early histories of the apes in the previous studies were acknowledged and described at varying levels of detail (i.e., whether the apes were mother-raised, raised in human cultural environment, etc.), there has not been a systematic study of the relationship between joint attention and the quality of care apes received during infancy. Investigation of this phenomenon is warranted because studies with human infants have suggested that responsive care is correlated with increased joint attention skills (Goldsmith & Rogoff, 1997; Hobson et al., 2004; Raver & Leadbeater, 1995). Therefore, the purpose of the present study was to investigate the effects of early care during the first 6 months of life on the ability of great apes to engage in two types of joint attention: gaze following and coordinated attention around an object. We employed an integrative approach to study this problem. First, the effects of both care style (responsive or basic) and caregiver type (great ape mother or human) on joint attention were assessed. Second, great apes were given the opportunity to engage in joint attention with both conspecific and human social partners. We hypothesized that great apes that received responsive care from either great ape mothers or humans would engage in joint attention more often than those who received basic care. We also predicted that apes that received responsive care from great ape mothers would share attention more often with a conspecific social partner, whereas apes that received responsive care from humans would share attention more often when tested with a human partner. Because all four types of great ape participated in the study, we also sought to elucidate any species differences in the ability to engage in joint attention with both conspecifics and humans.

**Method**

**Subjects**

Twenty-four great apes participated in the study, including 7 chimpanzees (Pan troglodytes), 7 gorillas (Gorilla gorilla), 7 orangutans (Pongo spp.), and 3 bonobos (Pan paniscus). Subjects included 12 females and 12 males ranging in age from 3 years to 49 years. The subjects were socially housed at five separate institutions. Participation in the study was voluntary for the apes. Great ape participants were categorized as having experienced one of four types of early care during the first 6 months of life: responsive care from the mother (RCM), basic care from the mother (BCM), responsive care from humans (RCH), or basic care from humans (BCH; see Table 1).

Individuals who participated in the routine care of subjects during the first 6 months of life (e.g., animal care staff, nursery care staff, etc.) were asked to select a suite of behaviors that best described the caregiver’s (great ape mother or human) general level of responsiveness toward the participant during that period.

**Table 1 Participants Grouped According to Category of Early Care**

<table>
<thead>
<tr>
<th>Species</th>
<th>Age (years)</th>
<th>Sex</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pongo abelii</td>
<td>12</td>
<td>Female</td>
</tr>
<tr>
<td>Gorilla gorilla</td>
<td>10</td>
<td>Male</td>
</tr>
<tr>
<td>Pan troglodytes</td>
<td>7</td>
<td>Female</td>
</tr>
<tr>
<td>Pan troglodytes</td>
<td>7</td>
<td>Male</td>
</tr>
<tr>
<td>Gorilla gorilla</td>
<td>7</td>
<td>Male</td>
</tr>
<tr>
<td>Pongo pygmaeus</td>
<td>10</td>
<td>Male</td>
</tr>
<tr>
<td>Pan paniscus</td>
<td>10</td>
<td>Female</td>
</tr>
<tr>
<td>Pan paniscus</td>
<td>7</td>
<td>Male</td>
</tr>
<tr>
<td>Basic care from mother (BCM)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pan troglodytes</td>
<td>13</td>
<td>Female</td>
</tr>
<tr>
<td>Gorilla gorilla</td>
<td>16</td>
<td>Male</td>
</tr>
<tr>
<td>Gorilla gorilla</td>
<td>14</td>
<td>Male</td>
</tr>
<tr>
<td>Basic care from humans (BCH)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pongo spp.</td>
<td>29</td>
<td>Male</td>
</tr>
<tr>
<td>Pan troglodytes</td>
<td>43</td>
<td>Female</td>
</tr>
<tr>
<td>Gorilla gorilla</td>
<td>25</td>
<td>Female</td>
</tr>
<tr>
<td>Pongo spp.</td>
<td>30</td>
<td>Female</td>
</tr>
<tr>
<td>Pan paniscus</td>
<td>21</td>
<td>Female</td>
</tr>
<tr>
<td>Gorilla gorilla</td>
<td>24</td>
<td>Male</td>
</tr>
</tbody>
</table>

All species were represented in each care condition, with the exception of Pongo spp., which were only included in the basic care conditions. The apes were divided into four groups based on the type of care they received during the first 6 months of life: responsive care from the mother (RCM), basic care from the mother (BCM), responsive care from humans (RCH), or basic care from humans (BCH).
Individuals were allowed to select from two suites of behavior, one of which was characterized as responsive care and the other as basic care (see Table 2). For an ape’s early care experience to be categorized as either responsive or basic, the caregiver must have routinely demonstrated all of the behaviors in the suite. For example, if an ape mother frequently accepted participant-initiated bids for contact, but infrequently cradled the infant, it was determined that the ape’s early care experience was too ambiguous to be categorized for the purpose of the study and, therefore, she was not included as a subject. Data obtained from individuals who participated in the routine care of participants during the first 6 months were verified by at least one additional source, including official institutional records, interviews with other people who contributed to the care of the participants, and rearing history descriptions from journal articles and books.

**Stimuli**

Participants were exposed to multidimensional stimuli that were mounted on wooden blocks (7 cm × 7 cm × 1.5 cm) in three experimental conditions. Each stimulus had a unique and colorful stationary item mounted on the wooden platform, such as brightly painted buttons, blocks, and plastic pieces of varying shapes and sizes. A total of 18 stimuli were presented in random order to each participant.

**Procedure**

Participants were tested under four experimental conditions: (a) following the gaze of a human (GFH), (b) following the gaze of a conspecific (GFC), (c) coordinated attention around an object with a human (CAH), and (d) coordinated attention around an object with a conspecific (CAC). Conditions were presented to subjects in a counterbalanced order. One subject, an orangutan that received basic care from human caregivers (BCH), did not participate in the GFC experiment because the conditions necessary for trials to begin did not emerge. The human experimenters (E1) who administered the tasks in the GFH and CAH conditions were familiar to the apes. Familiarity was defined as routine interaction with the apes in the context of animal care or cognitive testing. The rationale for testing participants with a familiar human was to optimize their motivation to follow and share attention during experimental tasks. The first author, E2, trained all E1 individuals in the experimental procedure to ensure that tasks were administered uniformly. In addition, E2 filmed trials while standing behind or next to E1. E2 supplemented the video data with written notes on the apes’ performance as well (Bethell, Vick, & Bard, 2007).

E1 was instructed not to verbally interact with subjects once a trial began until the ape engaged in the particular joint attention behavior under study, or if this did not occur, until after the trial concluded. A maximum of 12 trials (2 blocks of 6 trials) was conducted for each condition, the order of the trial type was randomized, and equal numbers of experimental and control trials were administered when the conditions were present and the ape chose to participate. Interblock intervals ranged from 30 min to 24 hr. Trials in which the ape left the testing area or otherwise became distracted or disengaged for extended periods were not used in the quantitative analyses. Likewise, trials in which a behavior and a potential confound occurred simultaneously, such as looking up when a loud noise suddenly occurred in that area, were not scored.

**Condition 1: Following the gaze of a human (GFH).** The first condition, which tested the ability of the great ape participants to follow the gaze of a human partner, was modeled after a study conducted by Brauer et al. (2005). Subjects were tested alone or while they were at least 3 m away from conspecifics. E1 was positioned approximately 1 m away from the wire mesh of the enclosure for testing. Participants either approached the testing area unsolicited or were asked to approach by E1. Trials began once the participant was within 1 m of the wire mesh and facing E1. During experimental trials, E1 looked straight above for 10 s (using eyes and head, body facing toward the participant). E1

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**Table 2**

*Criteria for Assigning Participants to Early Care Groups*

<table>
<thead>
<tr>
<th>Mother maintained frequent, direct physical contact with participant</th>
<th>Mother engaged in moderate to infrequent direct physical contact with participant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mother frequently accepted participant-initiated bids for contact</td>
<td>Mother frequently rejected participant-initiated bids for contact</td>
</tr>
<tr>
<td>Mother regularly cradled and carried participant</td>
<td>Mother cradled and carried participant infrequently</td>
</tr>
<tr>
<td>Mother regularly allowed participant to nurse on demand</td>
<td>Mother frequently rejected participant’s bid to nurse on demand</td>
</tr>
<tr>
<td>Mother inspected participant’s body and encouraged development of motor skills</td>
<td>Mother infrequently inspected participant’s body or encouraged development of motor skills</td>
</tr>
<tr>
<td>Mother comforted participant if he/she became distressed</td>
<td>Mother provided moderate to little comfort to participant if he/she became distressed</td>
</tr>
<tr>
<td>Mother accepted and initiated play with participant</td>
<td>Mother engaged in moderate to little play with participant</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Caregivers maintained frequent, direct physical contact with participant</th>
<th>Caregivers did not maintain frequent, direct physical contact with participant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caregivers had frequent opportunities for social engagement with participant outside of routine care</td>
<td>Caregivers had limited opportunities for social engagement with participant outside of routine care</td>
</tr>
<tr>
<td>Caregivers frequently held, carried, and played with participant</td>
<td>Caregivers had limited opportunities to hold, carry, and play with participant</td>
</tr>
<tr>
<td>Contact with participant often available for 24 hr</td>
<td>Contact with participant limited to an 8-hr day or less</td>
</tr>
</tbody>
</table>
looked directly at the participant for 10 s in control trials. If the participant moved away from the testing area, E1 asked the ape to return before proceeding to the next trial. A behavior was scored as gaze following if the ape looked up in the direction of E1’s gaze within 10 s with both head and eyes simultaneously or eyes alone. Twenty percent of scorable trials in this condition were randomly selected and scored by an independent observer who was blind to the trial type. Interobserver reliability was calculated using Cohen’s kappa at .91 (Bakeman & Gottmann, 1986).

Condition 2: Following the gaze of a conspecific (GFC). The purpose of the second condition was to assess the ability of participants to follow the gaze of conspecifics. This task was modeled after a study conducted by Tomasello et al. (1998). E1 tested participants in this condition when the subjects were in their social group and within 3 m of at least one conspecific. Social group size ranged from two to seven members and was composed of individuals from a range of age and sex classes. Trials began when the ape was facing away from E1 and one or more conspecifics were at least partially facing the subject and E1 simultaneously. During experimental trials, E1 held up a stimulus within the line of sight of one or more of the conspecifics that were in the position described above. E1 held the stimulus by the base and with a fully extended arm to maximize the object’s visibility. The maximum distance between E1 and the subject was 6 m. In control trials, E1’s hand was held in the same position as in experimental trials, but with no object present. The maximum trial length was 60 s.

A behavior was scored as gaze following if the ape followed the conspecific’s line of sight (by directing the head and eyes in the direction of the conspecific’s gaze) within 10 s. Twenty percent of scorable trials in this condition were randomly selected and scored by an independent observer who was blind to the trial type. Interobserver reliability was calculated using Cohen’s kappa at .87 (Bakeman & Gottmann, 1986).

Condition 3: Coordinated attention with a human around an object (CAH). The purpose of the third condition was to investigate the capacity of great apes to coordinate attention with a human partner around an object. This condition is a modified version of one of the joint attention tasks outlined in the Early Social Communications Scales, a common protocol used to assess joint attention and other sociocognitive behaviors in human infants (Mundy et al., 2003). E1 tested participants alone or while they were at least 3 m away from conspecifics. E1 was positioned approximately 1 m away from wire mesh for testing. Trials began once the participant was within 1 m of the wire mesh and facing E1. During experimental trials, E1 held the stimulus in his hand approximately 25 cm below the ape’s eye level while looking directly at the ape’s face. The stimulus was held far enough away from the wire mesh, approximately 1 m, so that participants could not touch the stimulus during trials. A behavior was scored as coordinated attention if the participant initiated attention with E1 by alternating gaze between the stimulus, E1’s face, and then back to the stimulus within a 10-s period. Based on a cautionary point offered by Tomasello (1995) regarding a potential confound of apes associating hands with food as opposed to engaging in social attention around an object, experimenters used an empty hand held in the same orientation as in experimental trials as a control condition. We predicted that apes would alternate gaze with the experimenter more often when an interesting object around which to socially engage was present compared with when an object was absent.

The maximum trial length was 60 s. Twenty percent of scorable trials in this condition were randomly selected and scored by an independent observer who was blind to the trial type. Interobserver reliability was calculated using Cohen’s kappa at .94 (Bakeman & Gottmann, 1986).

Condition 4: Coordinated attention with a conspecific around an object (CAC). The purpose of the final condition was to assess the ability of apes to coordinate attention with a conspecific around an object. Trials began once the participant and the conspecific were within 1–3 m of each other and 1 m away from the wire mesh and facing E1. Participants were paired with a compatible conspecific in this condition on the basis of E1’s recommendation. During experimental trials, E1 presented a stimulus in front of the dyad with the entire body turned away from the pair. Specifically, E1 held his hand directly over his shoulder so that the object was visible to the dyad. In control trials, E1’s position was the same as in experimental trials, but no stimulus was present. The maximum trial length was 60 s. A behavior was scored as coordinated attention if the participant initiated attention with the conspecific by alternating gaze between the stimulus, the conspecific’s face, and back to the stimulus within 10 s. Twenty percent of scorable trials in this condition were randomly selected and scored by an independent observer who was blind to the trial type. Interobserver reliability was calculated using Cohen’s kappa at .83 (Bakeman & Gottmann, 1986).

Scoring and Data Analysis

E2 scored all trials using digital video files. The dependent variable scored was whether or not joint attention occurred in each of the four conditions: GFH, GFC, CAH, and CAC. The percentage of trials in which joint attention occurred was calculated for each individual in each condition. A preliminary analysis was conducted to confirm that apes were engaging in joint attention more often in experimental trials compared with control trials in each condition. Apes rarely engaged in joint attention during control trials; therefore, a nonparametric test was used in this analysis because the assumption of normality was violated.

To analyze the possible effect of early care (RCM, BCM, RCH, BCH) on the occurrence of joint attention in each condition (GFH, GFC, CAH, CAC), we used the difference between the percentage of joint attention occurrences during experimental trials and control trials. There were no instances in which a participant produced joint attention more often in control trials compared with experimental trials. A weighted analysis was used to control for the fact that not all apes completed the same number of experimental trials and control trials in each condition. A preliminary analysis indicated that these data were normally distributed and met the homogeneity of variance assumption. Therefore, a parametric test was used to analyze these data. Because all four types of great ape were included in the study, we also conducted an analysis on the occurrence of joint attention in each condition on the basis of species type. The preliminary analysis indicated that these data were also normally distributed and met the homogeneity of vari-
ance assumption. Therefore, a parametric test was used to analyze these data as well.

**Results**

Overall, the great apes in the present study engaged in joint attention significantly more often in experimental trials compared with control trials in all four conditions, Wilcoxon signed-ranks test: GFH (U = 115.5, p < .0001), GFC (U = 68.0, p < .0001), CAH (U = 105.0, p < .0001), and CAC (U = 76.5, p < .0001).

Figure 1 illustrates the median percentage of joint attention in experimental and control trials in each condition. The following behaviors were produced in each condition: (a) CAC: gaze alternation with a conspecific, (b) CAH: gaze alternation with a human around an object, (c) GFH: following the gaze of a human, and (d) GFC: following the gaze of a conspecific.

**Gaze Following: Effect of Care Style, Caregiver, and Social Partner**

To assess the effects of care style, caregiver, and social partner on gaze following, we employed a 2 (care style: responsive, basic) × 2 (caregiver: mother, human) × 2 (social partner: human, conspecific) repeated measures analysis of variance (ANOVA). The analysis revealed no main effects of care style, F(1, 19.4) = 2.97, p = .10, caregiver, F(1, 19.4) = 0.0003, p = .99, or social partner, F(1, 21) = 0.37, p = .55. In addition, there were no significant interactions among these factors.

**Coordinated Attention: Effect of Care Style, Caregiver, and Social Partner**

To assess the effects of care style, caregiver, and social partner on coordinated attention around an object, we conducted a 2 (care style: responsive, basic) × 2 (caregiver: mother, human) × 2 (social partner: human, conspecific) repeated measures ANOVA. The analysis revealed no significant main effects of care style, F(1, 21.1) = 0.23, p = .64, caregiver, F(1, 21.1) = 0.06, p = .81, or social partner, F(1, 22.6) = 2.25, p = .15. In addition, there were no significant interactions among these factors.

**Species Differences**

To assess any species differences in gaze following, we conducted a 4 (species: bonobo, chimpanzee, gorilla, orangutan) × 2 (social partner: human, conspecific) repeated measures ANOVA. Figure 2 illustrates a significant interaction between species and social partner in the gaze-following task, F(3, 20.8) = 4.83, p = .01, partial η² = .461. Post hoc t tests using Bonferroni’s correction procedure demonstrated that bonobos responded to human social partners significantly more often than did chimpanzees, p = .0003, and gorillas, p = .0043, and orangutans responded to human social partners significantly more than did chimpanzees, p = .0077. There were no other significant pairwise comparisons regarding attention to human gaze. Bonobos were the only species that demonstrated a significant difference in their ability to follow the gaze of humans more than they did conspecifics, p = .0071.

To assess any species differences in coordinated attention around an object, we conducted a 4 (species: bonobo, chimpanzee, gorilla, orangutan) × 2 (social partner: human, conspecific) repeated measures ANOVA. There were no main effects regarding species differences, F(3, 22.5) = 0.71, p = .55, or social partner, F(1, 22.1) = 1.93, p = .18, on coordinated attention around an object. This analysis did not yield any significant interactions among these factors, F(3, 22.3) = 1.04, p = .39. However, preplanned pairwise tests indicated that gorillas engaged in joint attention significantly more often with humans compared with other gorillas, p = .03 (see Figure 3).

**Discussion**

The present study demonstrated that all four types of great ape engaged in joint attention (gaze following and coordinated attention) around an object with humans and conspecifics regardless of whether they received responsive or basic care from great ape mothers or humans during the first 6 months of life. This finding may appear somewhat surprising in light of studies suggesting that responsive care during early infancy may affect the propensity of human infants to engage in joint attention (Goldsmith & Rogoff, 1997; Hobson et al., 2004; Raver & Leibbeater, 1995). Assessments of joint attention in the previous studies all occurred within the first 2 years of life. Therefore, it is possible that any limitations in the ability of great apes that received basic care to engage in joint attention with others could have been mediated by environmental factors that occurred in the postinfancy period. For example, studies with human children have reported improved performance on basic cognitive tests after the subjects transitioned from an institutional setting to a home environment (O’Connor, Rutter, Beckett, Keaveney, & Kreppner, 2000; Rutter, 2006). O’Connor et al. (2000) offered that a combination of a normalized caregiving environment and the resilience of the children played a role in mediating the effects of early institutional care. Although it is plausible that one or more environmental factors mediated any
possible negative effects of basic care on the ability of great apes to engage in joint attention, the present study cannot address this issue directly because participants’ joint attention skills were not assessed during early infancy.

However, given that great ape participants with variable backgrounds in the study did engage in joint attention with conspecifics and human social partners, we suggest that joint attention is a robust ability in great apes that is resilient against at least some differences in early care. This interpretation is supported by findings from a similar study demonstrating that chimpanzees raised under different care styles demonstrated few differences in basic cognitive capacities overall (Bard & Gardner, 1996). The idea that joint attention is a robust ability in great apes makes sense from an evolutionary perspective. Following another’s gaze can provide information about salient features in the environment, such as the location of food or predators (Emery, 2000; Whiten, 1991). The ability to engage in some form of coordinated attention could also benefit long-lived individuals who must navigate complex and dynamic social environments. The capacity of great apes to engage in more complex theory of mind skills, such as deception, would...
not be possible if the basic cognitive processes on which these skills are built, including joint attention, were sensitive to subtle variations in the environment (Brune & Brune-Cohrs, 2006; Parker & Russon, 1996; Whiton & Byrne, 1997).

Although the primary focus of the present study was to examine the relationship, if any, between early care and joint attention in great apes, some species differences were found and are discussed briefly. The present study found that gorillas were less sensitive to human gaze than bonobos. Because of the small number of bonobos in the present study (n = 3), statements regarding their joint attention abilities compared with the other ape species must be interpreted with caution until more data are available. Additional comparisons across the four types of great ape were not consistent (Brauer et al., 2005; Okamoto-Barth et al., 2007). Methodological differences across these studies, including the present study, may explain inconsistencies in species’ performance on joint attention tasks. For example, Brauer et al. (2005) tested apes’ ability to follow the gaze direction of a human to a location behind a barrier. Okamoto-Barth et al. also incorporated barriers into the experimental design, but they used the barriers to block the experimenter’s line of sight rather than the apes’ line of sight to a target. Okamoto-Barth et al. suggested that this design measured a more complex gaze-following ability because great apes had to choose among different locations as possible targets of the experimenter’s gaze. The present study did not include any barriers in the gaze-following task. Therefore, it is possible that differences in species’ sensitivities to gaze, if any, are dependent on the particular gaze-following behavior being assessed.

There are two additional points that must be considered regarding the interpretation of the major finding from the present study. First, joint attention may be operationalized in different ways, and some have argued that certain joint attention behaviors, such as coordinated attention, is qualitatively different in humans compared with nonhuman great apes (Carpenter et al., 1995, 1998; Tomasello, 1995; Tomasello & Carpenter, 2005). For example, Carpenter et al. (1995) found that human infants alternated gaze with adults more frequently and for longer periods than apes. In addition, Tomasello and Carpenter (2005) pointed out that episodes of joint attention between humans are often characterized by infant smiling, and that this is an indicator that the infant’s attention toward the adult is motivated by a real desire to share a mutually interesting experience. In contrast, the absence of smiling in apes during these social exchanges suggests that they are merely monitoring what action their partner may take next (Tomasello & Carpenter). However, Tomasello and Carpenter did not directly address the issue that apes may indicate a desire to share attention using communicative gestures other than smiles. Despite the fact that apes have failed to demonstrate triadic engagement or coordinated attention based on some definitions (Tomasello & Carpenter), several studies (Bard, 1990; Gomez, 1990, 1991, 1996; Leavens & Hopkins, 1998; Russell, Adamson, & Bard, 1997), including the present one, suggest that apes are capable of at least some basic form of coordinated attention. Tomasello (1995) defined joint attention as a social phenomenon in which two individuals, in his example a human adult and human infant, are aware that they are attending to a common object or event. He suggested that mutual knowledge is present if both individuals simultaneously attend to a particular item and the subject alternates gaze between the object and the social partner’s face and eyes. This exchange is most convincingly described as joint attention if the subject spontaneously initiates attention with a social partner, as opposed to the adult soliciting the subject to attend to the object (Carpenter et al., 1998; Tomasello). Based on these fundamental criteria, our data demonstrate that great apes are capable of engaging in basic coordinated attention with others.

Second, we acknowledge that there are certain limitations associated with using archival data to categorize apes’ early care. Although various mechanisms were employed to ensure the verifiability of the early care data, it is possible that these retrospective data were not sufficiently detailed or precise to unambiguously reflect apes’ early caregiving experiences. Therefore, we suggest that the present finding regarding the relationship between early care and joint attention in great apes be interpreted with caution. We propose that future studies use alternative means to measure early care in great apes. For example, Weaver and de Waal (2002, 2003) used both quantitative and qualitative measures over a 24-month period to assess the relationship between attachment security and social behavior in capuchin mother-infant pairs. These types of prospective measures may provide more definitive information about the effects of early care on joint attention in great apes. Environmental factors that may mediate the effects of early care on joint attention over time in great apes should also be considered. Finally, longitudinal studies that include periodic assessments of the relationship between early care and joint attention at multiple developmental stages may be particularly informative about the impact of early care on cognition in great apes.

References


