



## Original Article

The predator-avoidance effect: an evolved constraint on emerging theory of mind<sup>☆</sup>Bruce J. Ellis<sup>a,\*</sup>, Ashley C. Jordan<sup>a</sup>, Jason Grotuss<sup>b</sup>, Adriana Csinady<sup>c</sup>, Thomas Keenan<sup>d</sup>, David F. Bjorklund<sup>b</sup><sup>a</sup> University of Arizona, Tucson, AZ, USA<sup>b</sup> Florida Atlantic University, Boca Raton, FL, USA<sup>c</sup> Florida Keys Community College, University of Debrecen, Key West, FL, USA<sup>d</sup> Niagara College, Ontario, Canada

## ARTICLE INFO

## Article history:

Initial receipt 7 August 2013

Final revision received 10 February 2014

## Keywords:

Theory of mind

Executive function

Evolutionary cognitive psychology

Predator-avoidance

False belief

## ABSTRACT

The present research examined whether children's ability to impute false belief is overridden or impaired by content that activates an early-developing, prepotent motivational system: predator avoidance. In three studies, children aged 3 to 8 years completed variants of a false-belief test, including analogous predator-avoidance and playmate-avoidance scenarios, in which passing the test meant having the focal character get caught by the pursuer. The proportion of correct answers in the playmate-avoidance scenario was reliably greater than in the predator-avoidance scenario, though this effect largely dissipated by 7 to 8 years of age. Enhanced predatory stimuli significantly increased the frequency of false-belief errors in the predator-avoidance scenario (Study 3). Analysis of children's justifications revealed that predator-avoidance false-belief errors were overwhelming motivated by a desire for the prey to avoid the predator (Study 2). The predator-avoidance effect was *not* an artifact of children generally performing better in playmate than predator-prey scenarios (Studies 1 and 3), the predator-avoidance scenario simply evoking strong emotions (Study 3), or differences between children in their knowledge of predator-prey relationships (Study 1) or executive-function abilities (Study 2). Findings support the hypothesis that activation of the predator-avoidance system generates prepotent response patterns that impair or override full consideration of the mental states of the prey characters in false-belief stories.

© 2014 Elsevier Inc. All rights reserved.

Although humans may not be the only species to display some understanding of the psychological states of others (for evidence in chimpanzees, see, [Buttelmann, Carpenter, Call, & Tomasello, 2007](#); [Horner & Whiten, 2005](#); [Tomasello, Call, & Hare, 2003](#)), *Homo sapiens'* ability to “read the minds” of others is unsurpassed in the animal world. This ability, termed *theory of mind*, is critical for human psychological functioning and refers to our aptitude for understanding the functioning of the mind, particularly the knowledge that one's thoughts, beliefs, and desires motivate behavior, and that others also have thoughts, beliefs, and desires that do not necessarily correspond with (and may, in fact, contradict) our own (i.e., belief-desire reasoning, [Wellman, 1990](#)). Theory of mind allows us to engage in what some researchers refer to as *mindreading*, the ability to understand and interpret the actions of others as being fundamentally driven by mental states ([Baron-Cohen, 2005](#)). Importantly this ability, by extension, allows humans to predict others' actions, a skill that is invaluable for engaging in intentionally deceitful behavior and keeping mental tabulations of our social exchanges with others. Because of humans' universal reliance upon theory of mind to predict

and exert control over the behavior of ourselves and others, some researchers have argued that it reflects a compelling selection pressure for the evolution of human social cognition, and that theory of mind may have evolved, in part, as an adaptive response to the need to cooperate and compete with conspecifics in our daily interactions (e.g., [Bjorklund & Pellegrini, 2002](#); [Geary, 2005](#); [Tomasello, 2009](#)).

Humans are not born with a fully functioning theory of mind, however. Most children develop adult-like abilities (i.e., solving first-order false-belief tasks) by about 4–5 years of age, with little variation worldwide (e.g., [Avis & Harris, 1991](#); [Sabbagh, Xu, Carlson, Moses, & Lee, 2006](#); for discussion of cultural variation in theory of mind, see [Lillard, 1998](#); [Liu, Wellman, Tardif, & Sabbagh, 2008](#)). Nevertheless, there is evidence that infants and young children can display *implicit* understanding of false belief using anticipatory-looking and violation-of-expectation tasks (e.g., [Clements & Perner, 1994](#); [Kovács, Téglás, & Endress, 2010](#); [Onishi & Baillargeon, 2005](#); see [Baillargeon, Scott, & He, 2010](#) for a review), suggesting that the roots of theory of mind run deep in human ontogeny.

## 1. Competition between evolved mechanisms

Theory of mind, and sociality in general, have been proposed to have undergone substantial selection pressure over human evolution and to develop universally when biologically typical children experience a species-typical environment (see e.g., [Baron-Cohen,](#)

<sup>☆</sup> All data sets used in this research can be obtained from the corresponding author.

\* Corresponding author. John and Doris Norton School of Family and Consumer Sciences, University of Arizona, McClelland Park, 650 North Park Ave, Tucson, AZ 85721-0078, USA.

E-mail address: [bjellis@email.arizona.edu](mailto:bjellis@email.arizona.edu) (B.J. Ellis).

2005; Bjorklund & Pellegrini, 2002; Tomasello, 2009). However, such reasoning can be overridden or impaired when put in conflict with competing evolutionary-relevant stimuli or events (Keenan & Ellis, 2003). The current research examined whether children's performance on a false-belief task is disrupted by task content that activates an early-developing, prepotent motivational system—predator-avoidance—in which the correct answer to the false-belief task runs counter to escaping the predator.

The suite of mechanisms underlying theory of mind are evolutionarily recent and, in its most developed form (i.e., solving higher-order false-belief tasks), is seemingly unique to humans (Herrmann, Call, Hernández-Llorde, Hare, & Tomasello, 2007; Krachun, Carpenter, Call, & Tomasello, 2010). Moreover, a certain level of higher-order, executive functions, which themselves have undergone substantial selection pressure in human phylogeny (see e.g., Causey & Bjorklund, 2011; Geary, 2005; Mithen, 1996; Read, 2008), may be necessary for children to pass false-belief tasks (Keenan, 2000; Perner & Lange, 2000; Carlson, & Moses, 2001). For example, children's ability to engage in acts of deceptive pointing relies heavily on the capacity to inhibit the prepotent disposition of responding truthfully (i.e., pointing to the correct location of an object; Carlson, Moses & Hix, 1998).

By contrast, predator-avoidance mechanisms are phylogenetically ancient and found in all prey species. Because death or injury from predators has posed a persistent and pervasive threat to young children throughout the course of human evolution (reviewed in Barrett, 1999), natural selection should have favored early, reliably developing psychological mechanisms in children for predator avoidance (e.g., Barrett, 2005; Keenan & Ellis, 2003; cf. Bowlby, 1969). Although theory of mind could conceivably enhance predator-avoidance strategies, effective predator avoidance does not depend on inferring the mental states of predators. Rather, the activation of predator-avoidance mechanisms should be mandatory, fast, and unconscious when children either sense or suspect a predator (Keenan & Ellis, 2003). Stories that have children take the perspective of prey animals being stalked by predators should activate affect, cognitions, and behaviors that are directed at evading capture. Basic decision rules, such as “prey should move away from predators,” should come online and operate in reference to the current position of the animals in the story. Reality should become highly salient to young children in this context and may swamp their emerging ability to understand and act on the knowledge that other individuals have knowledge and beliefs that are different from their own. In total, the predator-avoidance system in this context may conflict with more general reasoning processes (theory of mind reasoning) by generating default or prepotent responses that impair or override the child's ability to make false-belief attributions.

Following this logic, Keenan and Ellis (2003) developed a version of the false-belief task in which children ages 3–4 years predicted the action of animals that were engaged in predator-prey interactions (e.g., a lion hunting a zebra), during which one of the animals acquired a false belief about the location of the other. For example, in one scenario the lion failed to see the zebra move from a hiding place by the trees to a hiding place by the rock, and children were asked to predict where the lion would go to find the zebra. In another version, the zebra had a mistaken belief about the lion's location, and the children were asked to predict which path the zebra would take to try to avoid the lion. In addition, children completed structurally identical tasks involving either seeking or avoiding a playmate in a game of tag.

If children act in accordance with the predator-avoidance mechanism, they will save the prey animal in the story but fail the false-belief test; that is, they will neglect or fail to consider that the character will act in accordance with its *beliefs* about reality, not in accordance with the current reality of the predator's position. However, if children take into account the character's beliefs, they will recognize that the prey animal will take the path that it *falsely*

believes will avoid the predator's position—thus leading to its demise. Performance on the playmate-avoidance task (avoiding being caught in a game of tag) is structurally identical to the predator-avoidance task, the principal difference being the “correct” answer (from a theory-of-mind perspective) does not result in loss of life. Thus, if children's performance on avoidance tasks in general is governed solely by the ability to solve false-belief problems, children should behave similarly on the predator and playmate versions. If, however, a predator-avoidance mechanism is activated when a protagonist faces the possibility of death if the “wrong” decision is made, children's false-belief performance should be better (more successful) on the playmate-avoidance than on the predator-avoidance task.

As predicted, Keenan and Ellis (2003) found that the proportion of correct answers when reasoning about a prey animal avoiding a predator (the predator-avoidance task; Study 1: 28%; Study 2: 22%) was significantly lower than the proportion of correct answers when reasoning about one playmate avoiding another (playmate-avoidance task; Study 1: 52%; Study 2: 51%). (Note that performance on avoidance false-belief tasks is considerably lower than on conventional false-belief tasks, with only about 35% of 4- and 5-year-olds typically passing the avoidance tasks; Cassidy, 1998; Leslie & Polizzi, 1998.) Importantly, Keenan and Ellis (2003) showed that the predator-avoidance effect (1) was not due to the logical structure of the tasks (performance was equivalent across playmate-seeking and playmate-avoidance conditions) and (2) was not an artifact of children performing worse on predator than on playmate stories (performance was equivalent across playmate- and prey-seeking conditions). These data provided preliminary support for the hypothesis that activation of the predator-avoidance system generates prepotent response patterns that impair or override full consideration of the mental states of the prey characters in false-belief stories.

## 2. Goals and overview of the current research

The purpose of the current research was to further test this hypothesis by attempting to (1) replicate the predator-avoidance effect cross-nationally, increasing the generalizability of the findings; (2) collect data on older children to identify the upper age range of the effect; (3) empirically examine two possible alternative explanations for the predator-avoidance effect; (4) evaluate whether children who failed the predator-avoidance false-belief task were actually motivated by predator avoidance (i.e., the desire to keep the prey animal in the story from getting caught); and (5) test the hypothesis that increasing the salience of predation will cause a higher proportion of children to fail the predator-avoidance false-belief test (i.e., to directly test whether predation threat causes the effect).

Studies were conducted in New Zealand, the United States, and Hungary to test the core hypothesis that children will perform significantly worse on the predator-avoidance than playmate-avoidance tasks. By contrast, we did not expect differences in performance on the prey-seeking vs. playmate-seeking tasks. This is because young children do not yet face the adaptive problem of capturing prey (i.e., hunting behaviors are not performed until later in the life course, when the necessary mental and physical abilities for hunting develop). Taking the perspective of a predator chasing prey, therefore, should not activate any specialized or prepotent response patterns in young children that differ, for example, from response patterns involved in chasing a playmate.

There are at least two plausible alternative explanations for the predator-avoidance effect. First, variation in performance on the predator-prey tasks could be influenced by variation in young children's understanding of predator-prey relationships (e.g., “What happens if someone eats you?”). Thus, Study 1 attempted to replicate the predator-avoidance effect while controlling for predator-prey knowledge. Second, variation in performance on the false-belief tasks

متن کامل مقاله

دریافت فوری ←

**ISI**Articles

مرجع مقالات تخصصی ایران

- ✓ امکان دانلود نسخه تمام متن مقالات انگلیسی
- ✓ امکان دانلود نسخه ترجمه شده مقالات
- ✓ پذیرش سفارش ترجمه تخصصی
- ✓ امکان جستجو در آرشیو جامعی از صدها موضوع و هزاران مقاله
- ✓ امکان دانلود رایگان ۲ صفحه اول هر مقاله
- ✓ امکان پرداخت اینترنتی با کلیه کارت های عضو شتاب
- ✓ دانلود فوری مقاله پس از پرداخت آنلاین
- ✓ پشتیبانی کامل خرید با بهره مندی از سیستم هوشمند رهگیری سفارشات