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Waiting by mistake: Symbolic representation of rewards modulates intertemporal choice in capuchin monkeys, preschool children and adult humans ☆

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ABSTRACT

In the Delay choice task subjects choose between a smaller immediate option and a larger delayed option. This paradigm, also known as intertemporal choice task, is frequently used to assess delay tolerance, interpreting a preference for the larger delayed option as willingness to wait. However, in the Delay choice task subjects face a dilemma between two preferred responses: "go for more" (i.e., selecting the larger, but delayed, option) vs. "go for sooner" (i.e., selecting the immediate, but smaller, option). When the options consist of visible food amounts, at least some of the choices of the larger delayed option might be due to a failure to inhibit a prepotent response towards the larger option rather than to a sustained delay tolerance. To disentangle this issue, we tested 10 capuchin monkeys, 101 preschool children, and 88 adult humans in a Delay choice task with food, low-symbolic tokens (objects that can be exchanged with food and have a one-to-one correspondence with food items), and high-symbolic tokens (objects that can be exchanged with food and have a one-to-many correspondence with food items). This allows evaluating how different methods of representing rewards modulate the relative contribution of the "go for more" and "go for sooner" responses. Consistently with the idea that choices for the delayed option are sometimes due to a failure at inhibiting the prepotent response for the larger quantity, we expected high-symbolic tokens to decrease the salience of the larger option, thus reducing "go for more" responses. In fact, previous findings have shown that inhibiting prepotent responses for quantity is easier when the problem is framed in a symbolic context. Overall, opting for the larger delayed option in the visible-food version of the Delay choice task seems to partially result from an impulsive preference for quantity,

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rather than from a sustained delay tolerance. In capuchins and children high-symbolic stimuli decreased the individual's preference for the larger reward by distancing from its appetitive features. Conversely, the sophisticated symbolic skills of adult humans prevented the distancing effect of high-symbolic stimuli in this population, although this result may be due to methodological differences between adult humans and the other two populations under study. Our data extend the knowledge concerning the influence of symbols on both human and non-human primate behavior and add a new element to the interpretation of the Delay choice task. Since high-symbolic stimuli decrease the individual's preference for the larger reward by eliminating those choices due to prepotent responses towards the larger quantity, they allow to better discriminate responses based on genuine delay aversion. Thus, these findings invite greater caution in interpreting the results obtained with the visible-food version of the Delay choice task, which may overestimate delay tolerance.

1. Introduction

When faced with trade-offs between options available at different times (intertemporal choices), individuals have to forsake smaller immediate rewards if they wish to obtain larger benefits in the future. For example, an animal should ignore a smaller quantity of food in order to reach a larger one that lies farther away, a child should refrain from touching a desirable but forbidden object to get the treat promised by the parents, and a young man should opt for a more austere lifestyle now to save money for his old age.

Delay tolerance is generally regarded as a highly adaptive trait (Stevens & Stephens, 2009) and has been investigated both ontogenetically and phylogenetically. In tasks in which children are required to wait for a certain delay to obtain a highly desirable treat (rather than an immediately available less preferred alternative), delay tolerance improves in the course of development (Thompson, Barresi, & Moore, 1997) and performance at age four is predictive of patterns of social competence, resistance to temptations, and academic achievements during adolescence (Mischel, Shoda, & Rodriguez, 1989).

From an evolutionary perspective, delay tolerance has often been considered one of the features distinguishing humans from other animals (Frederick, Loewenstein & O'Donoghue, 2002; Roberts, 2002; Tobin & Logue, 1994). When choosing between a smaller immediate reward and a larger delayed reward, humans apparently tolerate delays of weeks or months, whereas animals usually tolerate delays of seconds or minutes at most. However, animal studies are scarcely comparable to human studies, since the former have used almost exclusively small real food rewards, whereas the latter mostly used large hypothetical monetary rewards. Such key differences in amounts and types of reinforcer make any comparison potentially misleading. For instance, humans have repeatedly been showed to be less willing to wait for food than for money (e.g., Estle, Green, Myerson, & Holt, 2007; Kirby & Guastello, 2001; Odum, Baumann, & Rimington, 2006; Odum & Rainaud, 2003; Petry, 2001; Rosati, Stevens, Hare, & Hauser, 2007). Moreover, in the only study that directly compared delay tolerance of humans, chimpanzees, and bonobos for real food rewards by using a common experimental paradigm (Rosati et al., 2007), people were less willing to wait for food rewards than chimpanzees.

In both humans (children and adults) and non-human animals two main categories of delay tolerance tasks are usually employed, Delay choice tasks and Delay maintenance tasks. In Delay choice tasks the subject is presented with the choice between a smaller (or less preferred) reward now and a larger (or more preferred) reward that will be available later; once the choice is made, there is no possibility to reconsider it (e.g., Addessi, Paglieri, & Focaroli, 2011; Green, Fry, & Myerson, 1994; Lawyer, Williams, Prihodova, Rollins, & Lester, 2010; Mazur, 1988; Moore, Barresi, & Thompson, 1998; Stevens, Hallinan, & Hauser, 2005; Thompson et al., 1997; Tobin, Chelonis, & Logue, 1993). In Delay maintenance tasks (e.g., Mischel et al., 1989) the subject must maintain a course of action in the face of continual competition from an available, tempting alternative. In these tasks, after the initial choice of delaying gratification, the immediate reward remains available throughout the delay; thus, the decision to wait for the larger (or more preferred) reward needs to be sustained during the entire delay, since the subject can reverse the initial choice at any time by picking the smaller or less preferred item. Tests of delay maintenance initially developed for children (Mischel et al., 1989; Toner & Smith, 1977) have been modified for use with non-human animals (e.g., Anderson, Kuroshima, & Fujita, 2010; Beran, 2002; Beran & Evans, 2006; Evans, Beran, Paglieri, & Addessi, 2012; Grosch & Neuringer, 1981; Killeen, Smith, & Hanson, 1981; Pelé, Micheletta, Uhlrich, Thierry, & Dufour, 2011).

Surprisingly, when both Delay maintenance and Delay choice tasks were administered to the same group of children, no significant correlation in performance was found between tasks (Schwarz, Schrager, & Lyons, 1983). Existing evidence suggests a lack of correlation between delay choice performance and delay maintenance skills in adult humans as well. A recent meta-analysis of 282 multimethod samples to examine the convergent validity of delay tolerance measures found only a very moderate degree of convergence among different types of tasks, including both Delay choice and Delay maintenance tasks (Duckworth & Kern, 2011). Similarly, in non-human primates, the same species can perform relatively well in Delay choice tasks but rather poorly in Delay maintenance tasks.