Waiting for a better reward:
Anticipatory and regulatory strategies in parrot delay of gratification

Carla Sebastián-Enesco[1], Nerea Amezcua-Valmala[1], Federica Amici[2,3]

1 UCM Research Group on Social, Developmental, and Social Psychobiology, Universidad Complutense de Madrid, Spain

2 Human Biology and Primate Cognition Research Group, Institute of Biology, Leipzig University, Leipzig, Germany

3 Department of Comparative Cultural Psychology, Max Planck Institute for Evolutionary Anthropology, Leipzig, Germany

Abstract

The ability to delay gratification (DoG) is commonly taken as a core indicator of self-control and future-oriented decision-making. In both human and non-human cognition, DoG performance is typically operationalized by the maximum waiting time for a delayed reward or by success across progressively increasing delay intervals. More recent work, mainly in developmental psychology, has highlighted the importance of examining what individuals do during the waiting period itself, arguing that spontaneous self-regulatory strategies deployed while waiting can inform not only *whether* individuals succeed but also *how* individuals succeed (Neuenschwander & Blair, 2017). Behaviors observed during waiting are usually distinguished according to their functional relation to the delayed incentive. Some behaviors remain directly oriented toward the reward, such as sustained attention to or attempts to access it and are often described as *anticipatory* or motivational strategies. Other behaviors are not directed at the incentive and instead appear more plausibly related to sustaining waiting by modulating arousal or attention. These behaviors are typically described as *regulatory* or volitional strategies, for instance through engagement in alternative activities (Duckworth & Steinberg, 2015; Metcalfe & Mischel, 1999). Importantly, beyond this functional heterogeneity, findings from human studies suggest that success in delay tasks is not uniquely associated with the deployment of a particular strategy. Instead, it seems to depend on how motivational and regulatory strategies interact during the waiting period (Neuenschwander & Blair, 2017). Taken together, these findings challenge a unidimensional view of self-regulation and provide a more nuanced understanding of delay behavior.

Despite these advances, this strategy-based approach to self-control has been explored almost exclusively in humans, leaving open the question of whether these patterns are specific to our species or instead reflect more general features of delayed decision-making. The present study is situated within this broader

question. We focus on parrots, a taxon that, despite its phylogenetic distance from humans, shows behavioral and cognitive capacities that in several respects resemble those described in primates (Lambert et al., 2018). The still limited body of research suggests that parrots perform well in domains central to self-control research, including problem solving, future-oriented behavior, and behavioral flexibility (Rössler & Auersperg, 2023). Rather than focusing solely on whether parrots are able to wait, the present study examines how waiting is sustained. To this end, we extend a strategy-based analysis of delay behavior to a non-human species, asking whether systematic patterns in waiting behavior—such as differences between anticipatory and regulatory strategies, and their interactions—can be identified beyond the human lineage.

We tested 8 macaws (*Ara spp.*) in an intertemporal choice task adapted from established DoG paradigms. In each trial, subjects could choose between an immediately available low-value food reward and a preferred high-value reward available after a delay. Delay intervals increased incrementally across sessions, and individuals advanced to longer delays only if they met predefined performance criteria. As in prior DoG research, performance was assessed in terms of success across increasing delays, and we additionally examined patterns of early abandonment ("giving up"), defined as consumption of the immediate option before reaching the maximum tested delay. Beyond these outcome measures, we analyzed subjects' behavior during the waiting period using a newly developed ethogram designed to capture functionally distinct coping strategies. Specifically, we distinguished three broad classes of behaviors: (i) reward-oriented behavior, which involves attentional, postural, or motor orientation towards the inaccessible delayed reward; (ii) motor self-regulation, encompassing a set of body activities ranging from localized movements (head, body) to pacing around; and (iii) self-maintenance, including all kind of self-referential behaviors (e.g., preening, beak cleaning). For reward-oriented behavior and motor self-regulation, behaviors were further organized into hierarchical levels of increasing intensity, allowing us to examine not only whether particular strategies were deployed, but also how their intensity varied as task demands increased.

Overall performance followed a sigmoidal curve, with high success up to a delay threshold followed by an abrupt drop—rather than a progressive discounting. This pattern mirrors recent accounts in humans and nonhuman primates showing that the subjective value of a delayed reward remains relatively stable until a temporal boundary is reached, after which persistence collapses sharply (Green & Myerson, 2004). Notably, when individuals gave up waiting, they typically did so early in the trial, suggesting a rapid, categorical decision about whether to persist rather than a gradual erosion of self-control over time.

Several patterns emerged from the behavioral analyses. Increasing delay demands were not associated with a uniform increase across all classes of coping behavior. Motor self-regulation showed a systematic shift toward higher-intensity forms as delays increased, suggesting a growing reliance on bodily regulation during prolonged waiting. In contrast, orientation toward the delayed reward did not show

a monotonic increase with longer delays: lower-intensity orientation (e.g, facing or pointing toward the reward) remained relatively stable across delay conditions, higher-intensity reward-directed behaviors (e.g., active pecking) increased at intermediate delays but dropped sharply at longer delays. Self-directed behaviors were comparatively infrequent and remained stable across delays.

Taken together, these findings suggest that as waiting demands increase, individuals rely more on strategies plausibly related to arousal modulation, while sustained anticipatory engagement with the delayed reward appears to break down under high delay demands. This pattern mirrors developmental findings showing that delay behavior is supported by qualitatively different strategies that respond differently to increasing temporal demands, rather than by a single, uniformly increasing form of self-regulation.

References

Duckworth, A. L., & Steinberg, L. (2015). Unpacking self-control. *Child Development Perspectives, 9,* 32–37. doi: 10.1111/cdep.12107

Green, L., & Myerson, J. (2004). A discounting framework for choice with delayed and probabilistic rewards. *Psychological bulletin*, *130*(5), 769. doi: 10.1037/0033-2909.130.5.769

Lambert, M. L., Jacobs, I., Osvath, M., & von Bayern, A. M. (2019). Birds of a feather? Parrot and corvid cognition compared. *Behaviour*, *156*(5-8), 505-594. doi: 10.1163/1568539X-00003527

Metcalfe, J., & Mischel, W. (1999). A hot/cool-system analysis of delay of gratification: Dynamics of willpower. *Psychological Review, 106,* 3–19.

Neuenschwander, R., & Blair, C. (2017). Zooming in on children's behavior during delay of gratification: Disentangling impulsigenic and volitional processes underlying self-regulation. *Journal of Experimental Child Psychology, 154,* 46-63. doi: 10.1016/j.jecp.2016.09.007

Rössler, T., & Auersperg, A. M. (2023). Recent developments in parrot cognition: a quadrennial update. *Animal cognition, 26(1),* 199–228. https://doi.org/10.1007/s10071-022-01733-2