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Andersen, M. M., Kiverstein, J., Miller, M., & Roepstorff, A. (2022). Play in predictive minds: A cognitive theory of play. *Psychological Review*. Advance online publication. <https://doi.org/10.1037/rev0000369>



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ISSN: 0033-295X

Psychological Review

<https://doi.org/10.1037/rev0000369>

## Play in Predictive Minds: A Cognitive Theory of Play

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In this article, we argue that a predictive processing framework (PP) may provide elements for a proximate model of play in children and adults. We propose that play is a behavior in which the agent, in contexts of freedom from the demands of certain competing cognitive systems, deliberately seeks out or creates surprising situations that gravitate toward sweet-spots of relative complexity with the goal of resolving surprise. We further propose that play is experientially associated with a feel-good quality because the agent is reducing significant levels of prediction error (i.e., surprise) faster than expected. We argue that this framework can unify a range of well-established findings in play and developmental research that highlights the role of play in learning, and that casts children as Bayesian learners. The theory integrates the role of positive valence in play (i.e., explaining why play is fun); and what it is to be in a playful mood. Central to the account is the idea that playful agents may create and establish an environment tailored to the generation and further resolution of surprise and uncertainty. Play emerges here as a variety of niche construction where the organism modulates its physical and social environment in order to maximize the productive potential of surprise.

**Keywords:** play, learning, predictive processing, surprise, niche construction

Why do humans play? For well over 100 years, this question has attracted the attention of researchers from a wide range of disciplines. This may be because play, despite its omnipresence, is one of the few human universals that does not seem to have an obvious immediate benefit to the player visible to outside observers (Martin & Caro, 1985). In spite of this mystery and the longstanding scientific scrutiny it has attracted, play has yet to become a central topic in the field of child development (Lillard, 2015; Pellegrini, 2011a). This may be attributable both to the lack of a unifying theoretical framework for play, and the lack of well-developed methodologies for approaching the phenomenon in general. By its very nature, play is difficult to study: It is spontaneous, and it exists in endless and highly diversified forms (e.g., Sutton-Smith, 1997; Zosh et al., 2018). Historically, this has not only made play very challenging to capture and define (Burghardt, 2011), but has also seriously hampered efforts to systematically study play through well-controlled research paradigms (Gopnik, 2016).

Despite such difficulties, there is overall consensus on a series of play-related issues. For instance, play is generally understood to be a

spontaneous, internally motivated behavior exclusively initiated by individuals who are free from sickness, stress, and hunger (Burghardt, 2005) and, typically, it is experientially associated with positive feelings (Bateson & Martin, 2013). Interspecies biological comparisons have shown that the most playful animal species tend to mature more slowly, and have larger brains, increased intelligence and good learning abilities (Gopnik, 2016). Furthermore, there is widespread agreement that young individuals tend to play more than older individuals (e.g., Bateson & Martin, 2013).

Theories abound as to why humans (and a series of other highly intelligent, often social, animals with prolonged childhoods) play. Many of these theories are evolutionary in nature, and propose ultimate causes for the development of play. For this reason, most of these theories concern how various aspects of play increase the individual's odds of surviving and reproducing. Most such theories assume that because play requires organisms to spend energy and, in many cases, to engage in behavior which is risky and sometimes outright dangerous, play must enhance fitness in other ways (Bateson & Martin, 2013).

Accordingly, the dominant themes across most evolutionary accounts of play are based on the widely held assumption that play helps young animals (including humans) to acquire the skills they need to become more efficient adults. For example, it has variously been hypothesized that play expedites the development of adult musculature (Groos, 1898), improves physical balance (Fagan, 1981), practices coordination and complex movements (Baldwin & Baldwin, 1977), assists in the acquisition of communication skills (Poirier & Smith, 1974), helps to construct a working knowledge of the environment (Bateson, 2017), trains the organism for unexpected situations (Spinka et al., 2001), and helps develop crucial social skills necessary for maintaining social relationships (Bekoff, 1976). Non-adaptive theories also exist: Burghardt's Resource Surplus Theory, for instance, suggests that play may have emerged as a by-product

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This work was supported by the Lego Foundation, The Horizon 2020 European Union ERC Advanced Grant XSPECT (DLV-692739), The H2020 ERC starting grant (679190), and the Netherlands Scientific Organisation grant.

The authors have no known conflict of interest to disclose.

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