

cognitive processes used by a given subject in a way that is consistent with Byrne's model, Piaget also claimed that some were generated because children observed or deduced possibilities that were in fact inconsistent with these cognitive processes. These possibilities become sources of disequilibrium that can only be made "rational" by adjusting the characteristics of the cognitive processes. In other words, this idea assumes that imagination can sometimes go beyond available cognitive processes and result in a reconfiguration of what is considered to be rational.

Direct evidence for any such process remains anecdotal, although anyone who has listened to a child work out a complicated problem will find it quite convincing. There are, however, examples of this kind of process in the development of science that make very useful analogies. For example, Newtonian mechanics postulated that velocities are linearly additive, which is of course a very intuitively rational concept. The Michelson-Morley experiment provided empirical data that was simply inconsistent with Newtonian theory (Michelson & Morley 1887). In other words, the results of this experiment were not possible within what was considered to be rational at that time. It was not until Einstein's special theory of relativity that an explanation of this result was (eventually) accepted: In this theory, velocities are not linearly additive, which has replaced Newtonian rationality. Einstein derived this theory, not by empirical work, but by a series of thought experiments, that is, by imagination, that allowed him to go beyond Newtonian rationality.

Thus, what I suggest here is that Byrne's analysis fairly represents a major part of the work done by the imagination, which is to examine possibilities in a way that is consistent with what a person's "rational" processes allow as being possibly true. However, it neglects the potentially critical role of the imagination in constructing possibilities that are not rational, but that suggest the necessity of revising our definition of what is rational.

Thinking developmentally about counterfactual possibilities

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Abstract: Byrne implies that working memory development underpins children's ability to represent counterfactuals as possibilities at 3 to 4 years of age. Recent findings suggest that (1) developments in the ability to consider alternatives to reality in children of this age are underpinned by improvements in inhibitory control, not working memory, and (2) children do not develop an understanding of counterfactuals as possibilities until mid-childhood.

Based on an impressive amount of data from a sustained research program over many years, Byrne (2005) presents an exciting theoretical framework for how we think about alternatives to reality. We focus on two points: (1) counterfactuals as dual possibilities, and (2) the cognitive processes involved in counterfactual thinking; and we comment on them from a developmental perspective.

Counterfactuals as dual possibilities. Based on her work with adults, Byrne claims that counterfactuals are represented as dual possibilities. Given that children first start to pass explicit tests of counterfactual thinking at around age 3 or 4 years, it seems reasonable to infer that children also represent counterfactuals as possibilities at this age. However, in one recent study 4-year-olds who could correctly answer a question that referred to a

counterfactual event of the type, "What if X had happened, how would the world be?" were unable to acknowledge that at a previous point in time either the counterfactual or actual event *could* have occurred (Beck et al. 2006). Our interpretation of this finding is that when children first start to think counterfactually they think only about what did not happen, but do not relate it to, or represent, the actual world explicitly. Thus, early counterfactual thinking might not involve thinking about possibilities, even though it does involve thinking about what might have been.

Cognitive processes. Throughout the book Byrne suggests that differences in working memory may be responsible for both individual differences and developmental changes in counterfactual thinking. Byrne argues, quite reasonably, that pre-school children find counterfactual conditionals, "What if X had not happened, how would the world be?" more difficult than simple causal conditionals, "What if X happens, how will the world be?" (see Riggs et al. 1998) because counterfactuals make the greater working memory demands (we also know that working memory develops substantially in the pre-school years). While the case for adult variation in counterfactual thinking (and working memory) is supported by empirical evidence, there is little or no evidence to suggest that working memory underpins early developments in counterfactual thinking.

Recently, we tested Byrne's idea (Beck et al. submitted). We asked 3- and 4-year old children counterfactual conditional questions of the sort used by Riggs and colleagues (1998) and also gave them a battery of executive function tasks. We found that once receptive vocabulary and age were taken into account, working memory did not predict counterfactual thinking ability. Rather, we found that inhibitory control predicted success on counterfactual conditional tasks, independently of age, language, and working memory (though, interestingly, inhibitory control did not predict success on counterfactual syllogistic reasoning tasks).

Current evidence suggests that developments in counterfactual thinking continue after the pre-school years and comes from the literature on regret (Guttentag & Ferrell 2004). Children's evaluations of who will feel regretful are not influenced by counterfactual possibilities until they are at least 7 years old. Given that children do not make the comparison between how things are and how things could have been suggests to us that they are not holding both possible worlds in mind. We agree with Byrne that working memory should be implicated in counterfactual thinking when one holds in mind both the counterfactual and the actual possibility; and for this reason we predict that developments in working memory underpin the ability to understand counterfactual emotions.

In short, we are in agreement with Byrne that mature counterfactual thinking requires representing dual possibilities. But we do not think this ability develops at around 3 or 4 years of age. At this age there are developments in the ability to consider alternatives to reality, but this ability appears to be related to improvements in inhibitory control, not working memory. Recent evidence suggests that representing counterfactuals as possibilities (what we might think of as genuine or adult-like counterfactual thinking) develops later, in middle childhood, which may well be driven by developments in working memory (though inhibitory control may also play a role).

Byrne's framework will prove to be immensely helpful to developmental psychologists who question when and how children engage in imaginative reasoning, including object substitution pretence, counterfactual conditional reasoning, and syllogistic reasoning with false premises. Furthermore, the book raises a number of other topics for future developmental research programs. However, we also believe that a developmental perspective on many of these issues will provide a richer and ultimately more comprehensive account of what it means to be able to consider alternatives to reality.