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Scientific Reasoning in a Belief Context: A Developmental Study

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There is disagreement concerning the age at which scientific reasoning abilities develop in children and the factors that affect task performance. Traditionally, young children have been characterised as intuitive scientists who develop hypotheses in order to arrive at conclusions (Inhelder & Piaget, 1958). These naïve beliefs, based on everyday experiences, are often scientifically invalid. According to Kuhn (1989), this results from an inability to co-ordinate theory and evidence, which does not develop until at least 11 years of age. However, there is evidence to suggest that children much younger than this are capable of simple scientific thinking (e.g. Ruffman et al., 1993). Although factors such as task complexity have been investigated, there has been little investigation into the impact of existing beliefs on scientific thinking, even though it has been widely noted that these beliefs contaminate the reasoning process. An additional factor is the effect of outcome on the reasoning process. Tschirgi (1980) found that children are more likely to use a scientifically appropriate reasoning strategy when attempting to identify the cause of a bad outcome. Our aim was to investigate the impact of existing beliefs on scientific thinking within the real-world context of oral health.

Method

71 children took part in the study. The sample consisted of 27 4/5 year olds, 19 7/8 year olds and 25 10/11 year olds. The participants were each interviewed to determine their oral health knowledge, beliefs and practice. Participants were presented with a set of pictures relating to three causal variables (what type of drink was consumed, whether they brushed their teeth and whether they visited the dentist) and shown an outcome of these behaviours (healthy or unhealthy teeth). They were then told that the individual whose teeth they were shown had a hypothesis about which variable was the cause of their good or bad oral health. Participants were asked to identify which causal behaviours should be changed and which would change the same in order to test this hypothesis. In one condition, the hypothesis presented was consistent with the children's own beliefs (intuitive), in another condition it was inconsistent with their beliefs (counter-intuitive). Each child was presented with two scenarios, one in which the outcome presented was good (healthy teeth) and one in which the outcome was bad (unhealthy teeth).

Results

For the 'good outcome' scenario, there was a main effect of condition (intuitive vs counterintuitive) ($\chi^2(1) = 20.583$, $p=0.00$) with all age groups more likely to answer correctly on the intuitive version of the task. There was also a main effect of condition for the 'bad outcome' scenario ($\chi^2(1) = 12.346$, $p=0.00$), but the direction was reversed; children were more likely to pass the counterintuitive version of the task. There was no effect of age for either the good or bad outcome scenarios. There was an interaction between condition and outcome ($F(1, 59) = 34.173$, $p=0.00$).

Discussion

The results show that the plausibility of the evidence with respect to prior knowledge affects the strategies children use in hypothesis-testing. There was an additional effect of outcome (good vs bad). When the information presented was intuitive and the outcome was good (e.g. positive oral health behaviours lead to healthy teeth), or when the information was counter-intuitive and the outcome was bad (e.g. positive oral health behaviours lead to unhealthy teeth) children were able to choose scientifically appropriate tests of the stated hypothesis (i.e. manipulate one variable). In the opposing cases they chose inappropriate tests such as changing all the variables. These findings suggest that context and knowledge play an important role in children's reasoning.

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