DOES THE NATURE AND AMOUNT OF POSTERIOR INFORMATION AFFECT PRESCHOOLER'S INFERENCES

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Children as young as 5 have been found to possess basic notions of probability, in contradiction to the piagetian perspective. In the current pilot study, preschoolers (N=25) participated in a probability task of single events, with alterations in the given posterior information. Children took into account the new sets of information and responded differently in each condition, depending on the nature and the amount of information. Such findings stress the importance of designing probability tasks in accordance to the children's cognitive capacities and probabilistic understanding.

Key words: preschoolers, posterior probability, design of probability tasks.

INTRODUCTION

The development of probabilistic thinking is a topic of much interest during the last decades from many perspectives, i.e. mathematical, cognitive, and educational.

Early research carried out mainly by Piaget and Inhelder (1951) supported that children undergoing the pre-operational developmental stage (4-7 years old) have no intuitions of randomness and no conceptions of chance and probability. Under this traditional perspective, probabilistic concepts develop as complementary to logical operational structures which emerge in relation to age (Kreitler & Kreitler, 1986). At the age of 5, children cannot differentiate certain from random events.

On the other hand, Fischbein (1975) suggested that young children possess a particular intuition of chance and probability in the sense that they possess 'primary intuitions' which are 'cognitive acquisitions derived from the experience of the individual, without the need for any systematic instruction' (Fishcbein et al, 1971).

Based on this intuitive perspective, young children show a minimal understanding of randomness and can identify the most/least likely outcomes (Way, 2003). Preschoolers have been found to understand the probability of an event (Jones et al, 1997; Falk& Wilkening, 1998), to make use of random sampling and base rate information (Denison et al, 2007), to realize part-part comparisons in order to estimate probability (Spinillo, 2002), to make use of probabilistic evidence in order to infer about causal strength (Kushnir& Gopnik, 2005). Preschoolers are able to compute prior probabilities in order to predict an uncertain event.

In the current study preschoolers were tested onto whether they can take into account and manipulate posterior probability. Posterior probability is a revised probability that integrates new available information. What happens when children are asked to consider new specific information in order to make judgments about the outcome of a probabilistic task? According to a study carried out by Girotto & Gonzalez (2008), even kindergartners were found to be able to use posterior information in order to update their evaluations about random outcomes. Young children made optimal decisions while integrating new information into prior information of single events.

The general hypothesis is that preschoolers are expected to take into consideration the extra-posterior information while building-up their inferences. The nature and amount of information that characterizes each condition (base rate vs category) is expected to affect children's responses: the more precise information (condition 2 vs condition 1), the more accurate judgments.

METHODOLOGY

This pilot study took place in a public kindergarten in a town of Western Greece, in 2008. The random sample consisted of both girls and boys. In this study we did not consider age and gender effects due to the small sample. Participants (N=25), aged 5 to 6, were asked to make predictions in a two-stage procedure: at a first point they were asked to infer given *prior* information and then they were asked to infer again by taking into account new, available *posterior* information.

The probabilistic task consisted of animal cards that depicted ducks and mice. In every condition the sample space was invariably 8 and cards were distributed unequally in 2 identical boxes. Among the 8 cards there was one lucky-card that had a sticker on it. Once children found that particular card in the correct box, they gained a sticker themselves. The lucky animal in all cases was a duck -participants were aware of that from the beginning of the task- and consequently mice were used as 'noise'.

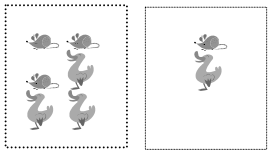
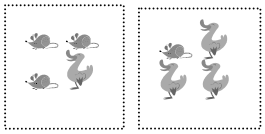
		1st stage of choice (based on prior information)	**2nd stage of choice (based on posterior information)**
1st condition: base rate		No info provided about the content.	Aware that one box has 6 animal-cards vs the other box with 2.
2nd condition: category		Aware that both boxes have 4 cards each.	Aware that the distributions are 3:1 and 1:3

Table 1: Design of the probabilistic task.

The design of the task (Table 1) comprised 2 conditions with differences in the nature and amount of information and 2 stages of provided information that affected participants' choice. In both conditions, participants began with information that didn't favor any box; both boxes had equal chances to carry the lucky-animal (level of probability, 50:50). Then, posterior information would provide additional evidence about in which box the lucky-duck might be.

In precise, in the 1st condition, children were given as prior information nothing, they were just asked to choose one box at random. As posterior information, they were informed that one particular box contained 6 whereas the other 2 cards.

In the 2nd condition, information was more detailed both in the prior and the posterior stages. In the beginning, preschoolers were aware that both boxes had 4 cards each, and after, they were given as posterior information each box's distributions of the sample spaces (3:1 vs 1:3).

Children participated in pairs in a separate room of the school. They were given instructions about the task and were motivated by the fact that they would win stickers. During the game, cards remained on the table reminding them the given information. At a 1st level, participants were asked to select orally the box they believed contained the lucky animal-card. As soon as they pointed to a box and before drawing a card of their choice, they were given new information orally by the experimenter about where the lucky card might be. Based on this new information, children either reconsidered their prior choice and switched box or made new predictions in order to succeed the desired outcome, i.e. the lucky –card. All participants carried out the 2 conditions in the same order.

Children recorded by themselves their final choices on specially designed sheets, independent of the actual outcome. These recorded sheets were used for further analysis.

RESULTS

Overall, children made correct predictions; they gave in total 36 correct answers out of 50. For the purposes of the current study, 'correct' is the answer that relates to the box with the higher probability of hiding the lucky animal. The predictions that related to the less probable box were scored as 'incorrect'. Such coding is used just for the analysis of the current results, as there is no such 'correct- incorrect' in probability tasks.

From the descriptive analysis (Table 2) it can be seen that in condition 1, children predicted the correct box by 60% and in condition 2 they responded correctly by 84%, in terms of selecting the more probable box.

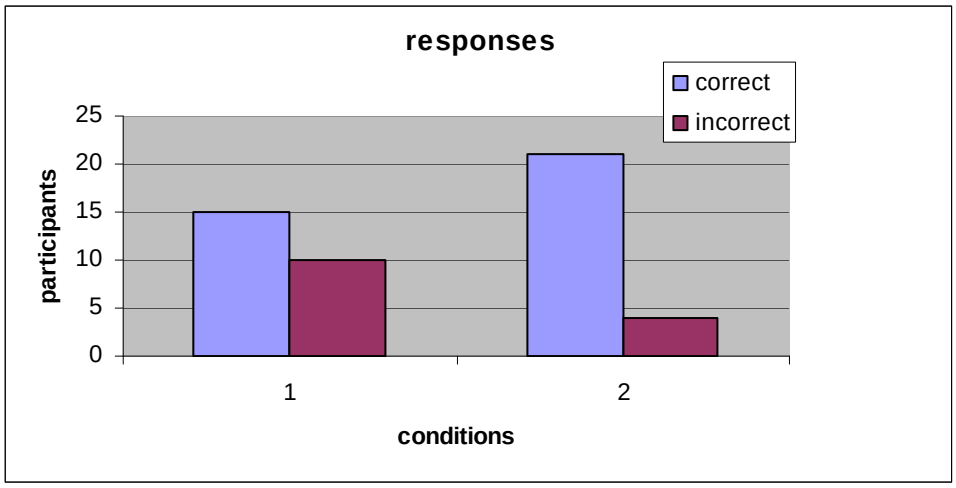


Table 2: Overall responses in cases 1&2.

The differences in the available information of each condition affected children's responses. Concerning the nature and the amount of information, it was found by the paired-sample t-test analysis concerning proportions, that there is a significant difference between conditions 1 and 2, $t(25) = 2.295$, $p<0.05$. There is a significant difference between the means of the two conditions. This implies that children's inferences in tasks that relate to posterior probability get affected by the kind and the range of information provided as new.

DISCUSSION

The results of this pilot study support that preschoolers may participate in probabilistic tasks successfully and integrate any available information, while forming their inferences in more than one stage. These results comply with the findings of Girotto& Gonzalez (2008). Among these lines, young children correctly revise their decisions when given new sets of information about single, non-repeatable events.

The baseline for both conditions was that the sample space was 8 and the lucky animal was a duck. The amount of given information was more complex and detailed in condition 2 and was not of equivalent difficulty as in condition 1. Thus, in this 2nd condition preschoolers were found to be able to make more correct predictions in terms of choosing the more probable set of given information. Overall, children showed the capacity to consider and handle information while participating in a probabilistic task.

However, the limited sample considers an issue for further research. Another limitation that could be taken into account refers to the children's participation in pairs. If children conducted the task individually would they make the same predictions? Or do they get influenced by their classmates? In addition, more

conditions, randomization of the boxes, more variations in the given information (i.e. qualitative) and other stimuli such as cards with different themes or pictures could lead to different interpretations.

In this game, children made more correct predictions when given more detailed and precise information about the sample space (i.e. condition 2 vs condition 1). This has a methodological significance that should be considered while designing probabilistic tasks. Children express and develop probabilistic ideas, depending on the design of the given activity (Papaparistodemou& Noss 2004; Pratt, 2000). The nature and the amount of information are important factors that affect children's probabilistic thinking.

Opposed to the piagetian perspective, young children before the age of 7 can make inferences and handle more than 2 combinations in order to participate in probability tasks. Recent studies have shown that children as young as 4 demonstrate an understanding of probabilities and expected value, adjust preferences based upon probability, understand basic notions of probabilistic thinking (Acredolo et al, 1989; Schlottmann, 2001; Way, 2003; Nikiforidou& Pange, 2007) and possess specific concepts and skills associated with probabilistic reasoning (Langrall& Mooney, 2005).

Furthermore, preschoolers make use of additional information and reveal a capacity to proceed in posterior probabilities (Girotto& Gonzalez, 2008) or in a two-stage choice task. Future research has to focus in this direction; in setting all the factors that are cognitively equivalent to young children's probabilistic thinking. The types of random generators, the mathematical structure of sample space, the type of responses, the nature of comparison or estimation (Way, 2003), the sort and amount of given information should be taken into consideration while designing probability tasks for preschoolers, who are characterized by intuitive and non-formal thinking.

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