CULTURAL INFLUENCES ON CHILDREN'S PROBABILISTIC THINKING

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Context

Probabilistic thinking is a subject that has been widely researched, mainly from a psychological point of view. So far research has been mostly 'culture free', despite indications of the important influence of culture on probabilistic thinking, on mathematics, and on cognition in general .

Objectives

This research **alms** to discover the relationship between children's understanding of probability prior to teaching, and relevant influences in their 'culture', Le. their beliefs, experience and language.

Method

The first stage of the research included interviews. These were conducted for two main purposes:

a) Building communication: clarifying main concepts used; trying out and modifying items from previous research and new items; trying out interview techniques.

b) Trying an holistic approach: looking for patterns linking the different fields of the child's probabilistic thinking, and between these and the child's culture (operationally defined as his language, his beliefs and his experience). These patterns could lead to hypotheses, with the intention of further validation in the second stage of research.

38 pupils were interviewed, all in their first year of high school (11-12 years old), from two inner-city schools in Manchester. 22 were of English origin, 11 of non-English origin and 5 of mixed origin. Each interview lasted for about 45 minutes.

The interviews were not uniform, due to the need to develop suitable questions and interview techniques, and due to the flexibility needed when an interesting aspect of the child's thinking emerged, needing clarification.

Although some quantitative analysis was done, the main emphasis remained qualitative, due to the small numbers and non representative sample. The perspective was basically a case-study perspective, trying to arrive at some cautious generalisations.

Results

Clarification of concepts: chance

The pupils' understanding of what is meant by 'chance', 'things happening by chance' or 'luck' was very varied.

Chance was sometimes understood as the **possibility, or opportunity of** something happening, that is, nothing to do with randomness, but in the meaning of 'having a chance'. Examples:

Chess is analysed as a game of chance, because "you've got to try, and you've got a chance of winning and a chance of not winning." Trivia "has less chance, because you can't always get the questions right." Computer games - "that's chance, because you can always start again" .Football- "if you're in a difficult position, that's chance. My partner gets it in, I don't". (INTERVIEW NO 1)

Could you tell me what do we mean when we speak of "things happening by chance" in our lives?
Uke - chance to become something.
What do you mean by that?
When you leave school and go to college or university, to become something. (INTERVIEW NO 24)

Others defined chance as something to do with **uncertainty,** again, not necessarily involving randomness. Something that happens by chance might mean that you don't know the result. Example:

I.: What would be something that does NOT happen by chance?
R.: When you know what's going to happen.
Later weather is discussed.
R.: I'd agree that was chance, cause you wouldn't know. (INTERVIEW NO 31)

Another interpretation of chance is - something that **just happens, without planning or Intention.** Examples:

I.: Could you tell me what do we mean when we speak of "things happening by chance" in our lives 1
K.: It's like walking down the road and a stone fell out, kicked out on the road and you fell over. That would be by chance. Just happens by accident.
I.: What are things that happen not by chance?
K.: It's planned. It doesn't happen by chance. Like the U.N. people don't by chance arrive or send troop. You have to plan it.

K.: A road accident? By chance I suppose. Because ... unless the driver is trying to kill the person, or the person that gets run over is trying to kill himself. It's usually by accident if you stepped into the road in the wrong time; or two cars skid - it's usually by chance. (INTERVIEW NO 22)

Luck

Luck, being lucky, being unlucky, were very often associated with **something good** or bad that happened, not necessarily random. Examples:

The discussion is about a computer game called 'lemmings':
I've got a sister, she's younger than me. She's not very lucky. You've got to use a mouse and she can't use a mouse properly. So she's always killing these lemming. (INTERVIEW NO 21)

Example of luck: I got 39 out of 39 in a maths test. (INTERVIEW NO 6)

Sometimes luck involved an **unexplained,** perhaps **supernatural** factor:

About dice: My sister is very lucky. She gets 6 eight times in a row. I sometimes get a 6 straight away, sometimes I wait for ages ...
About tossing two dice: There is more chance to get different numbers. But my mum is good in getting the same number. (INTERVIEW NO 2)

Attributions

After clarifying what the child means by the terms 'chance' and 'luck', it was attempted to understand to what areas of life does he think these terms apply, Le. where does he use them as attributions? This is important as an independent goal, of seeing how chance is mapped in the children's general view of the world. It is also important to see if random devices commonly used by researchers and teachers (dice, coins, counters, etc.) are seen so also by the children. This will be discussed in the next section.

When discussing the broader issue, several contexts were used, such as road accidents, the weather and success in sports, and their relationship to chance was discussed. The variation in views was quite broad. Road accidents were sometimes seen as known in advance or even planned by God; they are mostly seen as controllable by people's behaviour; some saw chance as playing a role. Weather was again sometimes seen as controlled by God, others saw it as causally determined, and the largest number saw it as related to chance. Sports, for instance winning in football, were mostly seen as dependent on skill, sometimes seen as dependent on chance, with some children combining the two in this way: if the groups involved are similar in ability - then chance is the crucial factor, if one group is better than the other - then it is a matter of skill.

It was also observed a few pupils used God as their major attribution, others tended to use causal attributions, and a few used chance a lot. As it will be shown later, these seemed to be types of reasoning modes, used along a lot of their responses. But many pupils, perhaps the majority, could not be described as revealing a certain type of reasoning, but rather used a mixture of types.

Model of dice, coins, etc.

Common devices used in probability teaching and research are dice, coins, counters, etc. It is often taken for granted that children see these devices as random. But, relating to their previously discussed system of attribution, do the children really see these devices as random?

Quite a number of children thought, in different degrees of certainty, that these results depend on how you throw, or handle, these different devices. This was especially so with coins. 8 children clearly thought the result depended on how you toss the coin. Some associated this with cheating; others - with experience; others could not explain why, but suggested some people are luckier than others. Specifically - quite a number of children prefer tails when tossing a coin (9 of the 12 asked, as compared to 1 that preferred heads and 2 that did not prefer either), some quoting the sentence 'tails tails never fails'. Most of these had no rational explanation for this, with exceptions such as explaining that 'heads' sticks out, and so it is heavier, causing the 'tails' result to be the more frequent.

Another assumption teachers and researchers sometimes take for granted with some of these common random devices is that they are seen as equiprobable. But some heuristics caused the children to see things differently. One such heuristic is 'availability' (estimating odds according to memories of similar past experiences see Kahnemann, Siovic & Tversky, 1982). Many children remember from their experience with board games waiting a long time for a 6 on the dice, often needed to begin a game. This makes them conclude that 6 is hard to get on the dice (17 pupils). For example:

When you want a number - it's harder to get it. It also depends if you cheat. If you do it slowly, the number might just come. If you're in a rush to get a number, if you're in a game, you throw and throw and don't get the number. If you're playing_ on your own, you just throw it, and it comes on the number you wanted. (INTERVIEW NO 5)

Sometimes this view does not emerge immediately, but only after some probing.

Another heuristic used, mainly in the context of coins, is 'representativeness' (expecting a sample to be representative of its parent population - see Kahnemann, Siovic & Tversky, 1982). This was used by 14 pupils:

After five heads on the coin, W. expects a tail. In fact, he expects: probably it will be heads, tails, heads, tails, heads, tails, and keep going like that. (INTERVIEW NO 9)

Some children used equiprobability - by did so automatically, reflecting the 'equiprobability bias' (expecting random events to be equiprobable by nature see Lecoutre, 1992) :

I.: Does a road accident happen by chance?
K.: You've got a 50-50 chance and not chance of it, because there's the chances that somebody will crash into you, and you've got the chance that you'll crash into them, half-half. (INTERVIEW NO 31, K.)

This 'equiprobability bias' was quite common in children's answers. One of the items that might be reflecting it was - a lottery in a maths class with 13 boys and 16 girls. 10 out of 23 pupils answered that to pick a boy in this class was just as likely as a girl. Part of the explanations seemed to reflect a 'natural' implication that chance is normally equiprobable, although mostly this was not explicit.

The 'outcome approach' (Le. the inclination to view probability as 'operative', as attempting to predict the outcome of an event - see Konold, 1989) was also common in the interviews. In fact - a majority of the children revealed this approach to some extent. For example - in Konold's weather problem (1989) they would tend to think that if after a prediction of 70% chance of rain it did not, in fact, rain - then the probabilistic prediction was wrong.

Links between culture and probability

The crucial question in this study is - does culture seem to playa significant role in the building of a child's probabilistic thinking? Although, due to the nature of the interviews this is not easy to generalise definitely, I claim that such a role exists. Examples of influences that appeared in the interviews are:
6 children with a high level of superstltlousness, leading to views of dice and coins as not equiprobable, without any explanation, and to crude, unrefined probabilistic thinking.
A child with a strong influence of religion (see discussion below).
3 children with a strong tendency to causality and determinism, in areas normatively seen as involving randomness.
A child whose world of chance was dominated by tricks and suspicion.
A child with a view of chance that was extremely 'equiprobable', as in Lecoutre (1992).

In interview no 2 religion seems to have a strong impact on the boy's feelings toward chance, resulting in a mixture of rational and irrational elements in his analysis of probabilities. G.'s father is head of a Nazarene theological college, serving in the past as a missionary in Africa. G. sees some chance events as not really chance:

When I was in Africa a poisonous snake almost killed my sister. By chance I came outside so I could tell someone. But it was not luck, it was God. He saw that my sister didn't die. That wasn't chance ...Fruit machine, that's chance. I don't thing God would like that..
I don't gamble .. I'm against it. You just get ripped off. Most places are fixed.

So some things may look like chance, but are actually acts of God. Others - have a touch of evil in them.

This could explain G.'s answers about probabilities, reflecting a duality of fairly correct theory with irrational ideas. Dice are seen, on one hand, as unpredictable:

You can't say what you will get. I sometimes get a 6 straight away, sometimes I wait for ages.

But on the other hand :

My sister is very lucky. She gets 6 eight times in a row ...

About two dice:

There is more chance to get different numbers. But my mum is good in getting the same number.

So certain people (the 'good' people?) have better chances than ordinary ones. In a question involving combinatorics G. reveals quite advanced combinatorics, but still gives an unexplained preference:

I.: What number would bet on when summing results of two dice, a 3 or a 6?
G.: I'd bet on a 6, because there are three possibilities to get it (3,3 ; 4,2 ; 5,1) and 3 has only one chance (2,1)
I.: And if you'd have to choose 3 or 11?
G.: It'll be difficult because both have one possibility. But I prefer 5,6.

So, to sum up, G. reflects a duality of rational with irrational ideas that seem to be influenced by religious belief. The hypothesis that probabilistic thinking is influenced by religious belief will be one of those investigated in the second stage of the research (questionnaires).

This example demonstrates, in my opinion, the influence culture, in its broad interpretation, has on children's probabilistic thinking. This is not to say that culture is the main influence. As shown in previous research (Green, 1982), ability is by far the major factor effecting probabilistic thinking. But culture does seem to be an additional factor, leading to several types of reasoning. The types that have been presented are probably not all existent types, and most children probably reflect not a 'pure' type of thinking, but some kind of individual combination. But this might be the link between culture and probabilistic thinking.

References

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