e-xtension Dr. Julia Russell's Psychology Column

Hard-to-find classics 6: Gibson & Walk (1960)

Reference

Gibson E & Walk RD (1960) The Visual Cliff. Scientific American, 202: 64-71.

Introduction

Every parent's and babysitter's nightmare – the infant hovering at the top of the staircase. Few take the plunge but is this because they learn rapidly through their lesser mistakes and stay put or are they born being able to detect the perils of a steep fall? Eleanor Gibson had much this thought while picnicking at the Grand Canyon. She feared their children might simply crawl off the edge while her husband (the renowned psychologist James J Gibson) maintained that they could detect the drop as well as an adult. With Richard Walk, Eleanor Gibson created a novel way to investigate the innate depth perception of young babies (and animals). Walk's interest stemmed from his work on fear of heights using a 'mock tower' training device for paratroopers at Fort Blenning air base. Together, Gibson & Walk tested whether youngsters would crawl over an apparent cliff – if the neonates did it could be assumed that the ability to see depth was not inborn. If they did not, this would support a nativist view – that perceptual abilities are innate.

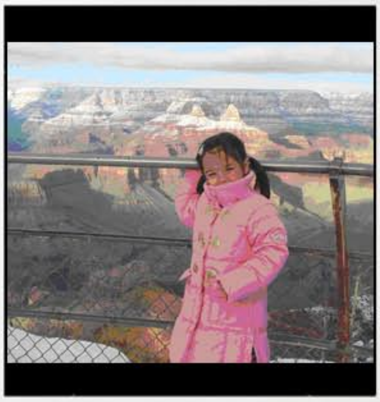

Figure 1 An older child is unlikely to crawl over the edge at the Grand Canyon – but what about an infant?

Figure 2 The Visual cliff

Gibson & Walk were not, however, the first to explore the development of depth perception. One earlier study by Lashley & Russell (1934) investigated the development of space perception in rats by rearing some in darkness from birth.
When tested on their ability to jump onto a nearby food platform, there was little difference between the experimental rats and those reared normally in the light. This suggested that the perceptual skills required to guide motor behaviour might be innate rather than learned.

Aim

To investigate the ability of newborn animals and human infants to detect depth.

Experiment 1: Procedure

Their apparatus consisted of a 'bridge' either side of which was a sturdy glass platform. One side of this had a chequered pattern immediately under the glass (the 'shallow side'). On the other side of the bridge was a 'cliff' – the chequered pattern was beneath a vertical drop (see Figure 2).

As newborn human babies cannot crawl, 36 babies aged 6 - 14 months were used. Each baby was placed on the bridge and the baby's mother called to them over the apparent cliff and over the shallow side.

Experiment 1: Findings

Gibson and Walk found that, even when encouraged to do so by their mothers, 92% of the babies refused to cross the cliff - even if they patted the glass.

However, in defence of Eleanor Gibson's original fears, the infants were at risk – many backed over the glass on the deep side before setting out across the shallow side or when turning around on the bridge!

Experiment 1: Conclusion

As the infants were able to detect the danger from the 'cliff' side, Gibson & Walk concluded that their depth perception might be innate – it was at least present as soon as they could crawl. However, as human infants take several months to crawl it is possible that they had learned their ability to perceive depth during this time. Experiment 2 aimed to explore this possibility using animals.

Experiment 2: Procedure

Using the same apparatus, Gibson & Walk tested chicks, lambs and kids (young goats) all less than 24 hours old. They also used an adjustable floor on the deep side of the cliff so that the test could start with it in the high (and therefore safe) position but could be suddenly lowered once the animal was on it. This gave them the opportunity to observe the animal's response and to see whether it learned from the experience of not 'falling downwards'.

Other species were also tested, including rats (which were additionally tested with a raised bridge) and kittens, which were several weeks old before they could be tested. Some kittens were tested after being reared in the dark. The rats were also tested with apparatus providing fewer visual cues by replacing the chequered pattern with a uniform grey surface to see whether the pattern was essential to perceiving depth.

Experiment 2: Findings

No chick, lamb or kid crossed to the deep side. When the deep side was suddenly lowered, the animals froze into a defensive position. Even with repeated experience of this procedure, the animals did not learn that it was safe to stand on the glass.

The rats used their whiskers to feel the glass so would walk across to the deep side unless the bridge was raised so they couldn't reach it with their whiskers. The kittens, like the other species, showed a marked preference for the shallow side. When reared in the dark until 27 days, however, this difference was not apparent and they crawled or fell as often onto the deep as the shallow side, neither did they show the typical freezing response when placed directly onto the deep side. However, after a week in the light their behaviour was just like that of light-reared kittens.

In the absence of the visual pattern the rats showed no preference for the shallow side.

Experiment 2: Conclusion

Animals are able to judge depth as soon as they are mobile, whether that is immediately after birth/hatching or somewhat later. Although this is dependent on visual experience (ie being kept in the light) the time taken to recover from this deprivation is very short compared to the length of deprivation. Together, the findings suggest that depth perception is an innate process.

Comments

The procedure was a rigorously controlled laboratory test so offered a reliable – but also safe - measure of depth perception. As it was possible to eliminate or control the influences of other senses (such as touch from the rats' whiskers) they ensured it was a valid test of visual perception. The consistency of the results over a range of species including humans adds credibility to the findings. However, the sample of human infants was quite small and the age range rather large – some were likely to have been crawling for sometime before they were tested.

Although the mothers were present and gave informed consent there was still a potential ethical issue. Simply looking at the drop, or being encouraged to cross it by their mothers, may have distressed the babies – they didn't know the glass was there to save them.

The investigation of the nature-nurture issue in perception didn't end with Gibson & Walk's research. This only explored the plasticity of infant perception, so the question of whether adult perception could adapt was not considered. This has, however, been investigated in several different ways. Stratton (1896) and Kohler (1962) used complex optical apparatus to change their view of the world, eg by inverting it using prisms. In these situations the world at first seems upside down, or muddled, but over time the brain adapts to the change and normal perception returns. When the apparatus is removed, it again takes time to revert. Other, less dramatic, changes to perception can be induced by shifting the field of view slightly to one side then testing depth perception, eg by the ability to point accurately to a target. In such situations people adapt readily – within about an hour – but only if they are able to actively interact with their environment. Participants who are pushed around in wheelchairs failed to learn to cope with the visual distortion (held 7 Bossom, 1961). Findings such as these tell us that, at least in some respects, depth perception is learned.

Recent research has continued to investigate perceptual development. Tondel & Candy (2007) showed 2-5 month old babies an image of a fast-moving clown. They could track the clown's movement, even when it was moving at 50 cm/second suggesting that tracking is an innate perceptual skill. Pei et al (2007), however, found that although infants (like Gibson & Walk's rats) use patterns to help in their depth perception they are not as effective as adults in this respect. So, while some perceptual processes are present at birth, our perceptual abilities are affected by experience.

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Questions

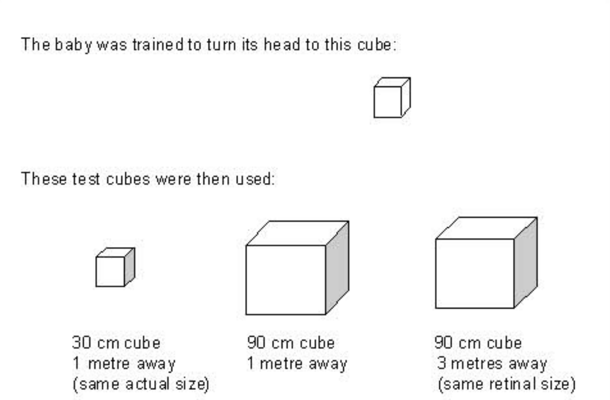
1. Gibson & Walk recognised two important features of their apparatus. They say of the visual cliff that it 'makes it possible not only to control the optical and other stimuli (auditory and tactual, for instance) but also to protect the experimental subjects.'

a) i) Describe one control measure employed by Gibson & Walk.

ii) Describe one aspect of the experimental setting that was not controlled by Gibson & Walk and suggest why this might have been important.

b) Explain why the advantages identified in the quote, one practical and one ethical, are so important in this instance.

2. Bower (1966) wanted to know whether very young babies had size constancy. If they had, they should recognise an object regardless of its distance from them even though it would make a bigger image on the retina when close up and a smaller one when further away. He tested babies aged between 6 to 20 days old. They were taught to turn their heads to a 30 cm cube (at a distance of 1 m) and each baby's response was tested to other sizes of cube and other distances. The babies' responses were measured using switches on pads on either side of the head.



Bower made the following predictions about his results:

i) The first test cube, identical to the training one, should elicit the most responses

ii) If the empiricist (learning) hypothesis is correct (that babies neither perceive depth nor have size constancy) the third test cube should elicit as many responses the first.

iii) If the nativist hypothesis is correct (that babies are born with depth perception and size constancy) the second test cube should elicit as many responses as the first.

The results were as follows:

First cube: 58 responses; second cube: 54 responses; third cube: 22 responses.

a) Choose a suitable graph for these results and plot them.

b) Draw a conclusion from the results.

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Activities

1. For this demonstration you will need a safe place to walk around, a partner, a small object like a book, a cup of water, a sink and a small mirror. Take the mirror and hold it level with your forehead. Looking upwards, tilt the mirror until you can see ahead of you by looking into it. Try doing each of the following looking only in the mirror:

- lifting the object up and down – what appears to be happening?
- watch someone else lifting the object up and down – does it look the same?
- if you feel confident enough, walk around somewhere safe – what do you notice as you move? Try looking around you, what happens as you move your head?
- pour some water out of a cup into the sink – does it seem to be going upwards or downwards?.

These will give you a flavour of the experiences of participants in visual distortion studies.

You could devise a test of adaptation to a simple task. Try out some different spatial tasks using the mirror and find one that is quite difficult. How long do people take to overcome the visual distortion?

2. Look up one of the following and write a presentation for you class:

- Gregory RL & Wallace JG (1963) Recovery from early blindness – a case study. Experimental Psychology Society Monograph, no. 2 (full text: http://www.richardgregory.org/papers/recovery_blind/contents.htm)
- Marotta JJ, Keith GP & Crawford JD (2004) Task-Specific Sensorimotor Adaptation to Reversing Prisms, Journal of Neurophysiology, 93: 1104-10. (abstract: http://jn.physiology.org/cgi/content/abstract/93/2/1104; full text: http://jn.physiology.org/cgi/reprint/00859.2004v1.pdf)
- Yoshimura H (2002) Re-acquisition of upright vision while wearing visually left–right reversing goggles. Japanese Psychological Research, 44: 228 (http://www.blackwell-synergy.com/links/doi/10.1111/1468-5884.t01-1-00024)

3. Test you knowledge of the visual cliff with this online quiz:
http://claweb.cla.unipd.it/home/nwhitteridge/Tests/test101audioc.htm

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Bower TGR, Broughton JM & Moore MK (1970) Infant responses to approaching objects: an indicator of response to distal variables. Perception & Psychophysics, 9: 193-6.

Held R & Bossom J (1961) Neonatal deprivation and adult rearrangement: complementary techniques for analysing plastic sensory-motor co-ordinations. Journal of Comparative & Physiological Psychology, 54 (1): 33-37.

Kohler I (1962) Experiments with goggles. Scientific American, 206: 62-72.

Lashley KS & Russell JT (1934) The mechanism of vision. XI. A preliminary test of innate organization, Journal of Genetic Psychology, 45: 136-144.

Pei F, Pettet MW & Norcia AM (2007) Sensitivity and configuration-specificity of orientation-defined texture processing in infants and adults. Vision Research, 47: 338-48.

Stratton GM (1897) Vision without inversion of the retinal image. Psychological Review, 4: 341-60.

Tondel GM & Candy TR (2007) Human infants' accommodation responses to dynamic stimuli. Investigative Ophthalmology & Visual Science, 48, 949–956.