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Theory and Method in Developmental Research

Distinguishing Novelty and Familiarity Effects in Infant Preference Procedures

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This paper considers possible problems researchers might face when interpreting the results of studies that employ variants of the preference procedure. Infants show a tendency to shift their preference from familiar to novel stimuli with increasing exposure to the familiar stimulus, a behaviour that is exploited by the habituation paradigm. This change in attentional preference with exposure leads us to suggest that researchers interested in infants' pre-experimental or spontaneous preferences should beware of the potentially confounding effects of exposing infants to familiarization trials prior to employing the preference procedure. The notion that infant attentional preference is dynamic also calls into question the use of the direction of post-familiarization preference *per se* when interpreting the knowledge or strategies available to infants. We look into the results of a cross-modal word learning study to show how the interpretation of results may be difficult when infants exhibit a significant preference in an unexpected direction. As a possible solution to this problem we propose that significant preferences in both directions should be sought at multiple intervals over time.

Key words: infant perception; preference method; habituation–dishabituation method; cross-modal learning; familiarity effect; novelty effect

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Studying infant perception and cognition is notoriously difficult. Their frequently shifting state of arousal aside, babies have limited motor and communication skills, abilities we rely on heavily when measuring the performance of older children and adults. The preference method devised by Robert Fantz (1958) has therefore been considered a methodological breakthrough in infancy research, with its strengths in its minimal response demands (infants are required simply to turn or look towards or away from the stimuli presented) and its wide scope of application (vision, audition, olfaction, and cross-modal processing).

In Fantz's original preference method (also referred to as the preferential looking paradigm or head-turn preference procedure), infants were simultaneously presented with a pair of contrasting stimuli and the duration of their visual fixation on each was compared. If an infant looked reliably longer at one of the stimuli, it could be inferred that she could discriminate the two stimuli and that she had an attentional or perceptual preference for the longer-fixated stimulus. Using this method, a number of studies have shown that infants have spontaneous or pre-experimental preferences for certain types of stimuli. For example, infants prefer to fixate socially or emotionally significant stimuli, which tend to be those that are also familiar to them. Thus, infants prefer their own mother's face to a stranger's, their native language to a foreign language, and so on (see Burnham and Dodd, 1999 for a summary). A similar preference for what is familiar or expected is often seen in intermodal preference procedures, where infants prefer to fixate a visual stimulus that matches an auditory stimulus (word, sentence, or naturally co-occurring sound) over one that mismatches (e.g. Golinkoff *et al*., 1987; Spelke, 1976). In other contexts, infants have been shown to exhibit several less easily interpretable preferences (e.g. for curvilinear over rectilinear patterns; Slater, 1995). Differential attention to the contrasted stimuli in the preference method therefore allows researchers to draw two types of inference: that the stimuli have been discriminated, and that the direction of infants' preferential attention reflects the relative salience of the stimuli for infants, where salience is determined by affective and physical properties of the stimuli, their familiarity or novelty, and their 'fit' or 'misfit' with cross-modal information.

It follows that when two equally salient stimuli are presented in the preference method, infants will fail to exhibit an attentional preference even when they are capable of discriminating between them. The habituation–dishabituation method has proven to be useful in cases where the infant's discriminatory ability and/or formation of recognition memory is the concern of the investigator and no *a priori* attentional preference for one stimulus over another is expected. This method was first used with heart rate and sucking as response measures (heart rate: Canestrini, 1913; sucking: Bronshtein *et al*., 1958; both as cited in Kessen *et al*., 1970) and later with visual fixation (e.g. McCall and Kagan, 1970). In this technique, which capitalizes on infants' natural decline in attention to a repeatedly experienced stimulus over time ('habituation'), the infant is presented with a new stimulus after multiple successive presentations of a contrasting stimulus. If the infant discerns the difference between the old and new stimulus, she will dishabituate, or show recovery of attention to the new stimulus. If the infant does not discriminate the two stimuli, her attention will not recover. Successful dishabituation therefore also requires infants to form a recognition memory of the old stimulus, against which the new stimulus can be compared.

As outlined above, the preference and habituation–dishabituation methods were originally distinct experimental paradigms that capitalized on two different response patterns observed in infants (pre-experimental preference on the one

hand vs induced habituation/dishabituation on the other). Over the years, however, several procedural variations to the preference method have been introduced, many of which include features of the habituation–dishabituation method. As a consequence, the differences between the methods and therefore the behaviours they induce are no longer clear-cut. For example, in the 'familiarization-novelty preference procedure' (also referred to as the familiarization method), infants are familiarized with one (type of) stimulus prior to a preference trial in which the familiarized stimulus is paired with a novel stimulus. Following the logic of the habituation paradigm, if infants are given sufficient familiarization with the original stimulus, they should demonstrate a novelty preference in the test trial, and this is often found to be the case (e.g. Saayman *et al.*, 1964; Quinn and Eimas, 1986; Rieth and Sireteanu, 1994; Tyrrell *et al.*, 1991). However, systematic manipulations of the number and length of familiarization trials have suggested that brief exposure to the original stimulus can lead to a familiarity preference at test, which is only replaced by a novelty preference upon further exposure to the familiarized stimulus (e.g. Wagner and Sakovits, 1986; Hunter and Ames, 1988; see Figure 1). This attentional shift is thought to occur when the encoding of the familiar stimulus is complete, or when there is no discrepancy between the internal representation of the stimulus and the stimulus input (cf. Solokov, 1963; also see Pascalis and de Haan, 2003 for a summary of studies on attentional shifts in the reverse direction with increasing retention time). This view of attentional preferences as dynamic provides a possible explanation for reports in the literature of what appear to be conflicting results. A well-cited example is seen in Jusczyk and Aslin (1995) vs Saffran *et al.* (1996). Both studies used the familiarization method to test word segmentation abilities in infants of a similar age, but the former found a familiarity effect and the latter a novelty effect. While it should be noted that these two studies differed in a number of ways (e.g. Jusczyk and Aslin used real speech stimuli while

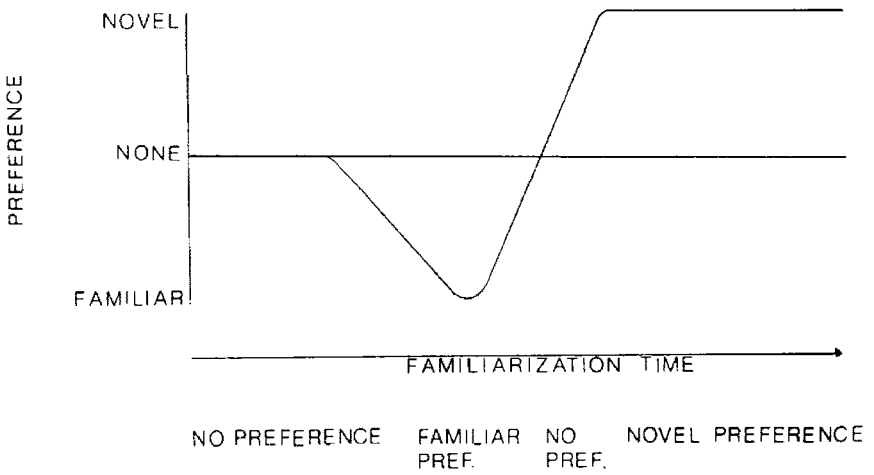

Figure 1. Hunter and Ames' (1988; Figure 2) model of the effect of familiarization time on an infant's preference for a novel vs familiar stimulus. The *X*- and *Y*-axis represent the amount of familiarization time and subsequent preference at test, respectively. Figure taken from *A multifactor model of infant preferences for novel and familiar stimuli*, by Michael A. Hunter and Elinor W. Ames. Copyright © (1988) by Ablex Publishing Corporation. Reproduced with permission of Greenwood Publishing Group, Inc., Westport, CT.

Saffran *et al*. used synthesized speech), the different amounts of familiarization they provided and the observed differences between their results are consonant with the model of infant attentional preferences presented above.

The direction of a looking preference is largely irrelevant when infants' discrimination ability or recognition memory is of primary interest; any deviation from random behaviour indicates that a difference between the stimuli has been detected. However, models of infants' attentional preferences such as Hunter and Ames' (1988) show that random looking behaviour should also not be equated with a failure to discriminate. Figure 1 shows that, as familiarization time increases, individual infants will pass through a period between preferring familiarity and preferring novelty when both attract their attention equally, which will appear as random looking (however, see Roder *et al*., 2000). In addition, some infants will progress through the sequence of preferences more rapidly than others; if data are averaged across a group of infants, looking preferences may appear to be random at certain time points, despite individual infants showing clear familiarity or novelty preferences (cf. Bogartz and Shinskey, 1998 for empirical support). Various factors affect the speed with which infants encode the familiarized stimulus and therefore progress through the sequence. For instance, it is well documented that the same amount of familiarization/habituation can result in different looking behaviour by infants of different ages; the older the infant, the more quickly they will develop a novelty preference (e.g. Hunt, 1970). At the same time, progression through the sequence of preferences is slowed by increases in stimulus complexity, stimulus salience or task difficulty (e.g. contrasting highly similar stimuli; requiring associative or cross-modal processing; Hunter and Ames, 1988; Wagner and Sakovits, 1986). The amount of familiarization should therefore be carefully considered in the design of such studies, although determining the optimal amount of exposure for an individual infant, let alone a group of infants, is clearly not an easy task (see Bogartz, 1965 and Olson and Sherman, 1983 for a discussion of different habituation/familiarization criteria).

When the direction of infants' attentional preferences at test is of theoretical interest, the implications of models such as Hunter and Ames' (1988) are even more critical. In some cases, identifying whether an obtained preference is due to a familiarity or a novelty effect can have profound consequences for the hypothesis under investigation. Baillargeon *et al*.'s (1985) violation-of-expectation task provides a good example. Baillargeon *et al*. interpreted infants' longer looks towards a physically impossible event in this study as a novelty effect and, as a result, concluded that 5-month olds possess knowledge of object permanence and solidity. Recently, however, some researchers (Bogartz *et al*., 2000; Cashon and Cohen, 2000; Schilling, 2000) have suggested that infants' preference for 'novelty' in this study may instead have been a preference for familiarity, since infants saw a component of the impossible test event during the preceding habituation trials, and, as described above, pre-test exposure can lead to a familiarity effect (for a full discussion of the validity of this interpretation of Baillargeon *et al*.'s results, see *Infancy 1*[4]; also see Bogartz and Shinskey, 1998 for a reinterpretation of Kellman and Spelke, 1983 in a similar vein). Correct interpretation of infants' preference in this experiment is clearly important, as Baillargeon *et al*.'s conclusions about infants' knowledge of the physical world rest on infants' behaviour being driven by the impossibility and therefore novelty of the test event.

Problems of interpretation may also arise when the direction of infants' preferences violates our expectations of what constitutes an indication of

learning. Studies exploring infants' rapid learning of word-image associations (e.g. Schafer and Plunkett, 1998) typically present infants with individual word-image pairings during a training or familiarization phase. Infants' learning of the newly trained pairings is then assessed by comparing the lengths of their visual fixation on each of two images when they hear phrases prompting them to look at one of them, e.g. Look at X. The expectation of such studies, based on infants' established preference for visual stimuli that match known words in the standard intermodal preference procedure, is that any learning that occurs during the familiarization phase will result in preferential fixation of the matching image at test. The claim has even been made that significant preferences for the mismatching image are never found using the intermodal preferential looking paradigm (Hollich *et al*., 1998). It is important to establish the validity of this claim, as theoretical conclusions can rest upon it.

For example, Houston-Price (2002) used an adaptation of the preference procedure to investigate 18-month-old infants' ability to use object movement as a cue to the meanings of two novel words. The study consisted of a series of sixteen alternating training and test trials, throughout which two images were displayed. During each training trial, one of the novel labels was heard, and one potential referent moved (the 'target') while the other remained stationary. During each test trial, one of the labels was heard while both images remained stationary. Infants unexpectedly showed a strong overall preference for mismatching ('non-target') images on test trials. This finding highlights the importance of interpreting infants' looking behaviour correctly. If, as Hollich *et al*. claim, comprehension is always demonstrated in a preference for the matching image in preferential looking procedures, infants' behaviour in Houston-Price's study must then indicate that, during training, they had attached the new labels to the stationary objects, and not to the moving objects as expected. However, infants' behaviour is also consistent with a second interpretation. If infants had indeed attached the new labels to the moving images during training, as intended, their behaviour at test would then reflect their preference for mismatching auditory-visual pairings, i.e. a 'novelty preference'. In either case, the study demonstrates that infants are able to use the relative movement of two images to determine a novel word's reference, but a better understanding of infants' attentional preferences is clearly needed if the precise strategy employed by infants in this study is to be established.

If the predictions of models such as Hunter and Ames' (1988) are transferred to the cross-modal learning situation, it could be argued that different levels of familiarization to stimuli during the learning phase should lead to different patterns of behaviour at test. When relatively little prior exposure to the stimuli of interest is provided, a preference for matching or familiar pairings might be expected, while greater exposure to the stimuli should increase the likelihood of finding a preference for mismatching or novel pairings. In the majority of cross-modal studies that use the preferential looking method, comprehension of words that are already known to the infant is assessed during only one or two test trials, and without the need for a familiarization or training phase (e.g. Golinkoff *et al*., 1987). A preference for the match would be expected in these circumstances. In contrast, familiarization or training trials are an inevitable feature of learning experiments. Where these studies are highly repetitive, and provide infants with the opportunity to habituate to the familiarized stimulus pairs, as might have been the case in Houston-Price (2002), a novelty preference might be expected at test (cf. Ballem and Plunkett, 2002[1] and Jolly, 2003[2] for further evidence of preferences for mismatching pairings in cross-modal learning studies).

The idea that evidence of cross-modal learning might be found in a preference for the mismatch or novel pairing is not a new one, but forms the basis of the 'habituation-switch' paradigm. Stager and Werker (1998) investigated young infants' ability to learn non-word-object associations by repeatedly presenting two word-object pairings until infants habituated to them. Infants' looking times to a further presentation of a habituated pair were then compared to their looking times to a 'switch', or mismatching pair, and their preference for the switch pair was interpreted as evidence that they had formed the required associations. Slater *et al*. (1999) used a similar technique to study infants' learning of associations between non-words and simple drawings, in two conditions. In one condition, the presentation of the speech stimulus during familiarization was contingent upon the infant's fixation on the visual stimulus to be associated with it; in the other, the speech stimulus was played whenever the paired visual stimulus was displayed, regardless of the infant's direction of gaze. During the test phase, upon hearing the non-words infants in the contingent condition (who would have experienced more non-word-image pairings) looked longer at the mismatching image than at the matching image, while those in the non-contingent condition showed no preference for either image.

Thus, it is apparent that cross-modal learning does in some circumstances lead infants to prefer mismatching, or novel pairs of stimuli. While the switch paradigm is typically used with infants much younger than those who participate in cross-modal learning studies employing the preference procedure, the view that infant attentional preference is dynamic suggests that a novelty effect may also be observed in cross-modal learning tasks using the preference procedure, depending on the amount of training received prior to the test trials.

If an attentional shift from what is familiar to what is novel is *always* found as the encoding of a familiar stimulus (or stimulus pair) is completed, given that infants can discriminate the new from the old stimulus, then the pattern of change in preference over time should provide crucial information regarding the identity of the obtained effect, where it is at issue. That is, what appears to be a preference for novelty might be confirmed as such if it is found to be preceded by a period of preference for the alternative stimulus (or stimulus pair). Alternatively, an effect's true status as a familiarity preference would be revealed if it is found to be followed by, rather than preceded by, a preference for the alternative. For example, in Houston-Price's (2002) case, if a period of preferential looking towards the named target could be found prior to the period of preference for the non-target, this would support the claim that infants had attached the label to the moving image during training as intended. Conversely, if they had attached the label to the still image during training rather than to the moving one, and the obtained effect was therefore a familiarity preference, one would expect to find a period of preferential gaze towards the target following the period of preferential gaze towards the non-target.

To use the predictions of the Hunter and Ames (1988) model in this way, infants' preferences must be examined repeatedly over time. To this end, Houston-Price (2002) recorded infants' looking behaviour during alternating test and training trials, and compared their mean looking times during each block of four consecutive test trials against chance. For the duration of the experiment, infants showed a preference in one direction only: their preference for the non-target increased and then decreased over time, following an inverted U-shaped curve that departed from and returned to the baseline. Assuming that novelty effects take place only after familiarity effects, the lack of evidence for an early period of preference for the alternative image suggests that the observed effect

was in this case a familiarity effect. That is, it is likely that infants had attached the label to the still picture, rather than the moving one, as expected. Although exactly the same conclusion would be drawn from Hollich *et al*.'s (1998) contention that word comprehension is always expressed in a preference for a matching word and referent, there is an important difference between Hollich *et al*.'s prediction and that of the dynamic model of attentional preference. The latter predicts a subsequent reversal of preference, the presence of which is necessary for the true status of the obtained effect to be confirmed. Whether such a reversal would have been seen, had Houston-Price's experiment consisted of more trials, remains an open question. It is worth noting, however, that the inverted U-shape that was found in this study does conform to the first half of the infant attentional profile depicted by Hunter and Ames' (1988) model.

The dynamic attentional preference model has generally been accepted as a plausible explanation for the seemingly contradictory outcomes of infant perception studies to date. However, as Roder *et al*. (2000) point out, few attempts have actually been made to trace the shift in preference demonstrated by individual infants over time. If the familiarity-novelty preference sequence does turn out to be a ubiquitous feature of an individual infant's attentional profile, we would point researchers towards seeking significant preferences in both directions over time when the identity of that preference matters.

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Notes

1. Paper presented at the Developmental Section Meeting of the British Psychology Society, Sussex, UK.
2. Poster presented at the Biennial Meeting of the Society for Research into Child Development, Florida.

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