Current psychology letters
Behaviour, brain & cognition

20, Vol. 3, 2006 | 2006
Varia

Age and emotional salience of stimuli alter the expression of visual recognition memory

Andrew Brown, Astri Robinson, Jane S. Herbert and Olivier Pascalis

Electronic version
URL: http://journals.openedition.org/cpl/1165
ISSN: 1379-6100

Publisher
Centre PsyCLÉ

Electronic reference
Andrew Brown, Astri Robinson, Jane S. Herbert and Olivier Pascalis, « Age and emotional salience of stimuli alter the expression of visual recognition memory », *Current psychology letters* [Online], 20, Vol. 3, 2006 | 2006, Online since 05 March 2007, connection on 30 April 2019. URL : http://journals.openedition.org/cpl/1165

Age and emotional salience of stimuli alter the expression of visual recognition memory

Andrew Brown, Astri Robinson, Jane S. Herbert and Olivier Pascalis

Received April 13, 2006

Revised January 9, 2007

Accepted January 11, 2007

On line March 5, 2007

Visual recognition memory refers to the ability to encode, store and retrieve a representation of a visual stimulus such that it can subsequently be recognised by the participant to be distinct from a novel stimulus. The visual paired comparison (VPC) task has, over the past 40 years (Fagan, 1974; Fantz, 1964), afforded insight into the cognitive ability of human infants. It has been used to investigate infant perception (Slater, Morison, & Rose, 1984), categorisation (Quinn, 2002) and, most commonly, visual recognition memory (for review see Pascalis & de Haan, 2003).

The VPC task is an ideal procedure to examine developmental changes in visual recognition memory because it can be used in a similar way throughout the lifespan, including across developmental transitions such as the onset of independent locomotion and the preverbal to verbal shift during infancy. In a typical VPC procedure, the infant is presented with a static image for a set period until habituation occurs. Following a delay, the same image is presented simultaneously with a new static image. In the absence of prior exposure to either of the images, infants spend an equal amount of time looking at them both during the test. A significant looking time towards one of the images at test is taken to indicate memory for a previously seen image. The most commonly observed response that indicates recognition memory is a novelty preference. That is, if an infant remembers the habituation image they spend proportionally more time attending to the novel image. Indeed, the assumption of an intrinsic preference for novelty is central to the rationale of the VPC, which was initially based on the work of Sokolov (1963). In brief, Sokolov postulated that an *engram* is formed when a stimulus is attended to, which is

strengthened with sustained or repeated exposure. Once sufficient exposure has occurred to develop a strong engram, the stimulus no longer attracts the infant's attention. Over time, as the original stimulus is forgotten, the engram will dissipate and the infant will attend to the previously familiar stimulus as novel.

Over the last 30 years, however, there has been a small but consistent number of studies in the infant VPC literature reporting familiarity preferences: preferential looking towards the familiar stimulus at test (Pascalis & de Haan, 2003). For example, full encoding, which is allowing enough familiarization time for each age group, appears to be a prerequisite for novelty preferences; shorter familiarisation periods are more likely to result in a familiarity preference being expressed (Slater, 1995). Furthermore, younger infants habituated with complex stimuli show a similar familiarity preference (Sophian, 1980). These findings suggest that events occurring at the time of encoding impact on the direction of attentional biases in the VPC. Furthermore, as the delay between the familiarisation and test periods increases from one day to one week and then to one month, the preference expressed fluctuates from novelty to null and then to familiarity (Bahrick & Pickens, 1995; Courage & Howe, 1998).

This changing expression of visual recognition memory complicates the interpretation of results from a relatively simple looking task. Rather than having a single behaviour that demonstrates evidence of memory (a novelty preference), there are now two apparently contradictory behaviours (a novelty preference and a familiarity preference) that can both be claimed to provide evidence of recognition memory. It is important that we investigate further the factors which may result in different response patterns, and develop a hypothesis as to when and why different patterns of responding can be expected.

The majority of papers reporting familiarity preferences have examined procedural variations during encoding that have influenced response expression. However, there is some evidence to suggest that the social and emotional demands placed on the infant by mnemonic tasks may also be an important factor. Rose, Futterweit, and Janowski (1999) took a baseline measure of affect in 5-, 7- and 10-month-old infants prior to administering a variant of a VPC task. Infants' who displayed positive affect, defined by smiling or laughing at a photo of a baby, prior to the experimental task tended to make longer and less frequent looks to the test images. These infants were also slower to display learning than infants displaying neutral affect. This response is analogous to showing a null preference rather than a novelty preference in the standard VPC task.

The interplay between infant affect and learning was also observed by Nachman, Stern, and Best (1986). Seven-month-old infants were habituated to a puppet presented in a window in front of them. The presentation of the puppet was intended to engender either positive or neutral affect. In the positive condition, the puppet played 'peek-a-boo' with the infant, and the experimenter brightly intoned 'peek-a-boo!' at every presentation. In the neutral condition, the puppet was moved slowly from side to side and remained in the infant's view. At each return to the centre position in the neutral condition, the experimenter monotonously intoned 'peek-a-boo'. The positive affect group showed a familiarity preference that increased in strength between the 2 minute and 1 week tests. In contrast, the neutral affect group showed a novelty preference that again increased in strength over the 2 minute and 1 week test. Taken together, the findings from Rose et al. (1999) and Nachman et al. (1986) suggest that positive effect prior to or during learning

may be an important factor in how memory is subsequently expressed in a standard VPC task.

Gross, Hayne, Herbert, and Sowerby (2002) have recently shown that interactive stimuli, rather than affect per se, may also alter the expression of memory. Six-month-old infants experienced a habituation period comprising of a 60-second interaction with a glove puppet held by an experimenter. Unlike the Nachman et al. (1986) study, the experimenter was in full view of the infant during the habituation phase. The VPC task was then conducted with "live" puppets rather than more traditional static images. A null preference was observed. Interestingly, however, when a subsequent deferred imitation test was conducted infants demonstrated recall memory for the actions they saw performed with the puppet.

Why, when infants can obviously remember the puppet they have seen previously as in the Gross et al. (2002) study, did they fail to demonstrate the expected novelty preference? In both Gross et al. (2002) and Nachman et al. (1986), the interactive and somewhat social component of the habituation phase provided by a "live", moving, puppet compared to a static visual image, would appear to attenuate the attentional bias for novelty that is usually observed.

It would seem that the emotional salience of the stimuli at the time of encoding may impact on subsequent performance on the VPC task. This purpose of the present study was to examine the developmental progression of the impact of emotionally salient stimuli on encoding by employing an interactive puppet-based VPC task with infants ranging from 6- to 24-months of age. We predict that habituation with interactive puppets will interfere with the novelty preference usually observed during the recognition test. We also predict that there may be age differences in this effect due to developing social competence across the infancy period. There is, however, little research on the effect of social interaction and affect on visual recognition memory in infants, thus it is difficult to predict how the preference will change and at what age it will happen.

MethodParticipants

Eighty infants participated in this study. There were 16 infants in each age group. Independent groups of 6-month-old (*M*=186 days; *SD*=8 days), 9-month-old (*M*=276 days; *SD*=6 days), 12-month-old (*M*=368 days; *SD*=6 days), 18-month-old (*M*=549 days; *SD*=5 days), and 24-month-old (*M*= 731 days; *SD*=7 days) infants were tested. Half of the infants at each age were female. A further 20 children were tested but excluded from the sample because of fussiness (6-month-old infants, *n*=4; 9-month-old infants, *n*=1; 12-month-old infants, *n* =5; 18-month-old infants, *n*=3; 24-month-old infants, *n*=2), exhibiting a side bias, as defined by more than 90 % looking to one side during the test (6-month-old infants, *n*=3; 12-month-old infants, *n*=1), and experimental error (6-month-old infants, *n*=1). None of the infants were born more than 3 weeks premature or had experienced birth complications. The infants were recruited through parent and baby groups in the local area which were either community based or run by Health Visitors, through posters in primary care settings, and through visits to a maternity hospital. The infants were all White and from families of moderate to high socio-economic status.

Stimuli

The familiarisation stimuli were 4 commercially available fabric glove puppets; a sheep, a dog, a dragon, and a group of piglets (see figure1). The puppets were all approximately 25cm in height but differed in shape and colour. Stimuli were presented in a randomised and counterbalanced order over both familiarisation and test periods.

Colour photographs of the puppets were used as test stimuli. The test stimuli were back-projected onto a 45cm x 32cm screen positioned approximately 60cm in front of the infant. A camera positioned centrally above the screen recorded the infant's eye movements between the two items.

Figure 1

Examples of the stimuli used in our study.

Procedure

All infants were tested in baby research laboratory at the University of Sheffield at a time of day that was defined by the caregiver as an alert/play period. The experimenter interacted with the caregiver and the infant in a reception room for approximately 5 minutes until the infant appeared comfortable with the experimenter. During this time informed consent was obtained from the caregiver.

Familiarisation: During the familiarisation period the infant sat on their caregiver's lap on a chair in the experimental room and the experimenter knelt in from of them. The experimenter then revealed a glove puppet and proceeded to use the puppet in an interaction with the child and caregiver. The actions and language used were chosen to suit the age and mood of each child, and were intended to, as far as possible, constitute natural, interactive play. The total familiarisation period was approximately 60 seconds. Two criteria were used to define completed familiarisation. First, the infant had to have fixated on the puppet for at least 20 seconds. It was important to stipulate minimum fixation on the puppet because infants often spent time looking at the experimenter. In addition, this fixation had to have occurred when the puppet was facing the infant and was an appropriate distance from the infant to be fully within their visual field (approximately 60cm). The puppet's position was important because many infants wanted to hug the puppet resulting in the infant not seeing the same view of the puppet as used in the test photographs. Second, the infant had to appear relaxed and to enjoy the interaction; this was quantified through laughter or smiles. Only one child (a 24-month-old female) failed to meet these two criteria because she appeared to be frightened of the puppet. In most cases infants fixated on the puppet for longer than 20-seconds. At the end of the familiarisation session, the puppet was removed from the infant's sight.

Recognition: The recognition test occurred immediately after the familiarisation in the same room. The experimenter turned the caregiver's chair so that the caregiver and the infant were facing the screen on which the test photographs would be presented. The recognition test began once the infant was looking towards the screen. During the test, a photograph of the familiar puppet was presented alongside a randomised photograph of a new puppet. A static set up was chosen as it is very difficult to move both puppets in the same way, at the same speed.

There were two 5-second test trials separated by a delay of approximately 2-seconds. In the second test trial the lateral position of the puppets was reversed. The infant could not see the experimenter during the recognition test.

Results and Discussion

A between-measures analysis of variance (ANOVA) revealed no effect of gender or interaction between gender and age, on proportional fixation times. The groups were therefore collapsed across gender. Table 1 shows the length of time spent fixating the novel image as a percentage of the total fixation time.

The effect of interaction on the expression of recognition memory was then examined at each age. A series of two-tailed paired t-tests demonstrated that infants who were 6-, 9-, or 12-months of age at time of testing demonstrated a null preference; 18- and 24-month-old infants demonstrated a familiarity preference ($p < 0.05$ and $p < 0.01$ respectively; see Table 1).

Table 1

Mean percentage of looking time to the novel stimulus as a function of age. A score of 50% indicates equal looking at the novel and familiar stimulus. Scores significantly less than 50% indicate a familiarity preference.

Age	% fixation to novel stimulus (SD)	Two-tailed paired t-test
6 months	51.52 (13.62)	n.s.
9 months	50.77 (11.33)	n.s.
12 months	48.14 (12.79)	n.s.
18 months	42.46 (14.12)	$p < 0.05$
24 months	33.12 (14.49)	$p < 0.01$

Consistent with previous research involving positive interaction in lieu of the traditional, emotionally neutral habituation procedure, 18- and 24-month-old infants in the present study displayed a familiarity preference when tested for recognition memory immediately after the habituation. Younger infants also exhibited a disruption to the traditional novelty preference, exhibiting a null preference.

A number of alternative explanations could account for the present results. It could be argued based on previous research (Richards, 1997; Slater, 1995) that disruption to the novelty preference is a reflection of insufficient encoding time with a dynamic stimulus. However, the 20-second minimum habituation period employed here has been robustly demonstrated to be sufficient to elicit novelty preference in our lab from 6-months of age

. To fully address this issue, it will be necessary to replicate our study recording the familiarization period to determine the exact amount of familiarization time each age group had during the habituation period. This explanation however fails to account for the changing preference across age.

The representational nature of the test stimuli might also be a contributing factor in the changing preferences across age. In the present study the habituation stimuli were 'live', 3-dimensional puppets while the test stimuli were static photographs of these objects. The dimensional change 3D to 2D is unlikely to be a problem at the age tested: by 6-months of age dimensional changes between habituation and test periods do not cause a disruption of the novelty preference (Rose, 1977) and even 3-day old infants do recognize picture of their mother (Walton, Bower and Bower, 1992). The motion versus static difference between learning and recognition test may however have interacted with the recognition ability even if by 12 months of age we can be sure that infants will have had a lot of experience of similar changes. It will be interesting to determine the real impact of motion-static changes on the recognition ability for the youngest age group (6- and 9-month-olds). For example, it is possible that the null preference observed in Gross et al. (2002) with 6-month-old infants may, at least partially, reflect the stimuli being presented with different motion patterns at learning and test.

We propose here an alternative account for the lack of a novelty preference at younger ages and the familiarity preference at older ages: the changing preference may be a reflection of the developing connectivity between emotion regulation and memory processing systems. The rationale of the VPC is based on the assumption of an automatic orientation to novel for neutral stimuli. However, the orienting response appears to be affected by the emotional salience of the stimuli. A growing body of research suggests that emotional events may be remembered for substantially longer than memories for more neutral events. For example, 5-month-old infants who participated in a mildly emotionally negative interaction (a still face experiment) exhibited some evidence of memory for participation 16 months later (Bornstein, Arterberry, & Mash, 2004). The substantial retention interval for the interpersonal interaction suggests that there may be interplay between emotion and memory even at a very young age.

What do the results of the present study contribute to our understanding of the VPC task and the brain systems underlying recognition memory? The brain regions involved in visual recognition memory as measured with the VPC have been a topic of considerable recent research. The hippocampus proper and surrounding hippocampal formation have been robustly demonstrated to be necessary for successful completion of tests of visual recognition memory (for review see Nelson, 1995; Pascalis & de Haan, 2003). However, the brain structures involved in the VPC task have been discerned using neutral stimuli such as unfamiliar faces or everyday objects. When the stimuli are more interactive or interesting, and thus likely to elicit positive affect, it is probable that the amygdala may also be activated (for a review of amygdala functioning see Aggleton, 2000). Given that the amygdala is known to modulate hippocampal activity (McGaugh, 2004), it is possible that social interaction during encoding may facilitate learning and alter the duration or expression of memory. Based on the present results, we propose that there may be developmental changes in these structures, or the interconnections between them, occurring between 12- and 18-months of age. An account of developing ability in social domains seems to fit the age at which differences in memory performance are observed in the present study.

Social referencing is the ability to extract emotional information from others to provide information about objects in the world. This ability develops in the second year of life and encompasses both the ability to use such information to allow safe objects to be approached, and also the ability to regulate or inhibit behaviour in the presence of negative emotional reaction. For example, 14-month-old infants, but not 11-month-old infants are able to inhibit exploratory responses to novel objects when an unfamiliar adult expresses disgust (Hertenstein & Campos, 2004). By 15- to 20-months of age, infant show greater fear response and more avoidance behaviour to rubber snakes and spiders when they were paired with negative maternal facial expressions (Gerull & Rapee, 2002). In the second year of life, infants not only learn to respond to events on the basis of adults expressed emotions, they also become competent at regulating their own emotions. For example, Blackford and Walden (1998) found that 11- to 15-month-old girls displayed a relationship between temperamental fear and emotional regulation, whereas 16- to 22-month-old girls did not. The infant's own affective state was thus more able to be controlled, and their behaviour more able to be based on external information, in the older age group.

Based on the present results, we suggest that the developing ability to use emotion to regulate behaviour might be accompanied by a comparable development in the ability to suppress the infant's own emotional response and subsequently allow encoding and recognition memory to operate without unconstructive interference. By 18-months of age, infants are able to suppress preference to novelty and to express a familiarity preference to an emotionally salient stimulus; prior to this, the competition between attention to novelty and to emotional salience may be muddied by an inability to sufficiently process a stimulus eliciting positive affect. It is likely that preference for positive emotional stimuli becomes more salient than a preference for novelty by this age; positive affect begins to form the basis by which the world is most appropriately explored. The emotional salience of a stimulus will undoubtedly evolve during development and the type of stimulus eliciting orientation toward familiarity or toward novelty will differ with the age group studied.

Acknowledgements

This research was supported by a University of Sheffield project studentship to AB and an ESRC studentship to AR. The authors would like to thank the infants and parents who participated in this project.

BIBLIOGRAPHY

Aggleton, J. P. (2000). The amygdala: a functional analysis. Oxford: Oxford University Press.

Bahrick, L. E., & Pickens, J. N. (1995). Infant Memory for Object Motion across a Period of Three Months: Implications for a Four-Phase Attention Function. *Journal of Experimental Child Psychology*, *59*, 343-371.

Blackford, J. U., & Walden, T. A. (1998). Individual differences in social referencing. *Infant Behavior & Development*, *21*, 89-102.

Bornstein, M. H., Arterberry, M. E., & Mash, C. (2004). Long-Term Memory for an Emotional Interpersonal Interaction Occurring at 5 Months of Age. *Infancy*, *6*, 407-416.

Courage, M. L., & Howe, M. L. (1998). The Ebb and Flow of Infant Attentional Preferences: Evidence for Long-Term Recognition Memory in 3-Month-Olds. *Journal of Experimental Child Psychology*, *70*, 26 - 53.

Fagan, J. F. (1974). Infant Recognition Memory: The Effects of Length of Familiarization and Type of Discrimination Task. *Child Development*, *45*, 351 - 356.

Fantz, R. L. (1964). Visual Experience in Infants - Decreased Attention to Familiar Patterns Relative to Novel Ones. *Science*, *146*, 668.

Gerull, F. C., & Rapee, R. M. (2002). Mother knows best: Effects of maternal modelling on the acquisition of fear and avoidance behaviour in toddlers. *Behaviour Research and Therapy*, *40*, 279-287.

Gross, J., Hayne, H., Herbert, J., & Sowerby, P. (2002). Measuring Infant Memory: Does the Ruler Matter? *Developmental Psychobiology*, *40*, 183-192.

Hertenstein, M. J., & Campos, J. J. (2004). The Retention Effects of an Adult's Emotional Displays on Infant Behavior. *Child Development*, *75*, 595-613.

Manns, J. R., Stark, C. E. L., & Squire, L. R. (2000). The visual paired-comparison task as a measure of declarative memory. *Proceedings of the National Academy of Sciences of the United States of America*, *97*, 12375 - 12379.

McGaugh, J. L. (2004). The Amygdala Modulates the Consolidation of Memories of Emotionally Arousing Experiences. *Annual Review of Neuroscience*, *27*, 1 - 28.

Nachman, P. A., Stern, D. N., & Best, C. (1986). Affective Reactions to Stimuli and Infant's Preferences for Novelty and Familiarity. *Journal of the American Academy of Child Psychiatry, 25*, 801-804.

Pascalis, O., & de Haan, M. (2003). Recognition Memory and Novelty Preference: What Model ? In H. Hayne & J. F. Fagen (Eds.), *Progress in Infancy Research - Volume 3* (Vol. 3, pp 95-119). Mahwah, NJ: Lawrence Erlbaum Associates.

Pascalis, O., de Haan, M., & Nelson, C. A. (2002). Is face processing species-specific during the first year of life ? *Science*, *296*, 1321-1323.

Pascalis, O., de Haan, M., Nelson, C. A., & de Schonen, D. (1998). Long-term recognition memory for faces assessed by visual paired comparison in 3- and 6-month-old infants. *Journal of Experimental Psychology - Learning, Memory and Cognition*, *24*, 249-260.

Quinn, P. C. (2002). Category representation in young infants. *Current Directions in Psychological Science*, *11*, 66-70.

Richards, J. E. (1997). Effects of Attention on Infants' Preference for Briefly Exposed Visual Stimuli in the Paired Comparison Recognition Memory Paradigm. *Developmental Psychology*, *33*, 22-31.

Robinson, A. J., & Pascalis, O. (2004). Development of flexible visual recognition memory in human infants. *Developmental Science*, *7*, 527-533.

Rose, S. A. (1977). Infant's transfer of response between two-dimensional and three-dimensional stimuli. *Child Development*, *48*, 1086-1091.

Rose, S. A., Futterweit, L. R., & Janowski, J. J. (1999). The Relation of Affect to Attention and Learning in Infancy. *Child Development*, *70*, 549 - 559.

Slater, A. (1995). Visual Perception and Memory at Birth. In C. Rovee-Collier & L. P. Lipsitt (Eds.), *Advances in Infancy Research* (Vol. 9, pp. 107-162). Norwood, NJ: Ablex.

Slater, A., Morison, V., & Rose, D. (1984). Locus of Habituation in the Human Newborn. *Perception*, *12*, 593-598.

Sokolov, E. N. (1963). Higher Nervous Function - Orienting Reflex. *Annual Review of Physiology*, *25*, 545.

Sophian, C. (1980). Habituation is Not Enough: Novelty Preferences, Search, and Memory in Infancy. *Merrill-Palmer Quarterly*, *26*, 239-257.

Walton.G.E., Bower.N.J.A. & Bower.T.G.R. (1992). Recognition of familiar faces by newborns. *Infant Behavior and Development,* 15, 265-269

ABSTRACTS

Recognition memory is typically demonstrated in the Visual Paired Comparison (VPC) task when infants display a preference for looking at a novel stimulus compared to a stimulus which they have been recently habituated. Events occurring during the habituation period may, however, alter the expression of a visual preference from novelty to familiarity. The present study examined the effect of emotionally salient habituation stimuli on the expression of recognition memory. Eighty infants aged between 6- and 24-months were habituated to an interactive glove puppet. Visual recognition memory was tested immediately with static pictures of the familiar and a novel puppet. The expected novelty preference was notably absent in 6-, 9- and 12-month-old infants. Eighteen- and 24-month-old infants exhibited a visual preference for the familiar stimulus. Familiarity preferences appear to be an important measure of recognition memory that evolve with age and social competence across the infancy period.

Il y a reconnaissance visuelle quand dans une tâche de comparaison visuelle par paires des enfants en bas âge préfèrent regarder un stimulus nouveau plutôt qu'un stimulus auquel ils viennent d'être familiarisés. Les événements qui se produisent pendant la période de familiarisation peuvent toutefois modifier l'expression de la préférence visuelle au détriment de la nouveauté et en faveur de la familiarité. Notre recherche avait pour but d'examiner l'effet de stimuli familiers à forte saillance émotionnelle sur l'expression de la reconnaissance visuelle. 80 jeunes enfants de 6 à 24 mois ont été familiarisés à une marionnette manuelle interactive. Le test de reconnaissance a été effectué tout de suite après la phase de familiarisation au moyen d'images inanimées représentant la marionnette familière ou une nouvelle. Les enfants de 6, 9 et 12 mois ne présentent pas de préférence significative en faveur du nouveau alors que les enfants de 18 et 24 mois présentent une préférence pour le stimulus familier. La préférence en faveur du familier s'avère être donc un moyen de mesure important de la reconnaissance visuelle, laquelle évolue en fonction de l'age et de la compétence sociale au cours de la première enfance.

INDEX

Keywords: Infant, Memory, Affect, Social Interaction

AUTHORS

ANDREW BROWN

Department of Psychology

ASTRI ROBINSON

University of Sheffield

JANE S. HERBERT

Department of Psychology

OLIVIER PASCALIS

University of Sheffield