2004

Father versus Stranger Face Discrimination by the Human Infant: A Case Study

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Abstract

The ability of infants to discriminate and recognize faces gained recent attention; however, much of the research focused on discrimination of the mother's face from a female stranger's face. This study examined father versus stranger face discrimination using an operant sucking procedure, in which images of fathers and strangers were presented on a computer monitor contingent upon the sucking responses of the infant. Discrimination was determined by computing the difference in the number of responses for each face. Results indicated that 3 infants under the age of 4 months discriminated the father's image from the image of a stranger, consistent with the schema theory of face perception. Future research should include larger sample sizes, and further study the mechanism of infant face discrimination.

Father versus Stranger Face Discrimination by the Human Infant

In recent years, a number of studies demonstrated that infants are capable of face recognition and discrimination at an early age. While there is general consensus that infants can recognize faces, the field of research is continually expanding, incorporating new theories of face recognition, including the primacy hypothesis and familiarity hypothesis. Further, researchers are debating which part of the face utilized for infant face discrimination, as well as whether the experiences of the infants influence their ability to recognize faces.

Additionally, new research methods are continually evolving, incorporating the newfound theories of infant discrimination. These new types of methodologies investigate such factors as the preference for a novel versus familiar stimuli, as well as the way the stimuli is presented. Furthermore, the methods investigate the factors that influence the ability of the infant to perform face discrimination, including the ability of the infant to retain information over time. However, despite the strides in research of infant discrimination, a void exists in the research surrounding the abilities of infants' to discriminate their fathers from strangers.

Major theories of infant face recognition

Walton, Bower and Bower (1992) propose that one factor influencing infant face discrimination is the primacy effect. Since the mother is typically the first face the infant sees in life, they prefer that face overall. This hypothesis is supported by Walton, Armstrong and Bower (1998); newborns shown many

different novel faces preferred the first face presented. An additional theory of infant face discrimination is the familiarity hypothesis, which explains that preferences result from the amount of exposure to a face. In a study conducted by Quinn et al. (2002), infant preference was very much influenced by the gender of the primary caregiver, in that if the primary caregiver of the infant was female, the infant preferred a female. However, there was no testing to see the preference outcome if the primary caregiver was male. While it appears face preference is spurred by the amount of time the infant spends with an individual, there is further research that needs to be explored in this area. This preference for the primary caregiver is further supported by evidence that infants, beginning at two months, show a preference for a novel facial stimulus after repeated presentations (Barrera & Mauer, 1981). This preference would indicate that infants are able to discriminate; however, this finding does not explain the lack of infant discrimination in the newborn stage between fathers and strangers, as in the preliminary study conducted by Walton et al. (1992).

Additionally, some researchers indicate the infants' mechanism for face recognition lies in their recognition of the external characteristics of the face (including hairline contrast as well as the general shape of the face) and not through recollection of the internal features of the face. Pascalis et al. (1995) suggests that the mechanism of face recognition lies in the infants' focus on the outer contours of the face, instead of the internal features. Bushnell (1982) supports the hypothesis proposed by Pascalis with his findings that infants as

young as four to seven weeks of age were able to discriminate the image of their mother versus that of a stranger, without certain primary features (i.e. the eyes); in effect, the lack of a certain distinguishing feature with the consistent state of the outer features still allowed for infant recognition. However, the hypothesis proposed by Pascalis was refuted by findings in the Walton et al. (1992) study, in which the researchers obtained newborn preferences for the mothers using stimuli in which the outer contours of the hairline and parts of the face were not visible. Pascalis's hypothesis is further refuted by the study in which Bartrip, Morton and de Schonen (2001) found that infants as young as five weeks were able to discriminate based on internal facial features, a finding which was also supported in newborns (Walton et al., 1992; Walton et al., 1998).

An additional theory of infant recognition of faces indicates that the development of face discrimination lies in the experiences of the infant, rather than any features of the face. Pascalis et al. (1998) hypothesize that infant discrimination is not based on external facial cues at all; rather it is based upon experiential interaction with the environment, throughout infant development. In essence, this theory proposes that discrimination occurs through schema development, in which the infant develops and overall idea of a face through continuing interaction with different types of faces. They also propose that infant discrimination of faces is totally different from discrimination of other objects, due to the infant preferences for tracking whole, unscrambled faces (Pascalis et al., 1998). Bushnell (2001) supports this idea, indicating that a

multisensory apparatus in the brain is responsible for infant discrimination, based upon the infants' preference for attention from others and the infants' strive to meet that goal. In essence, infants develop focused attention in order to receive attention in return (Bushnell, 2001). The hypothesis for a separate mechanism for face recognition is supported when one realizes that although infants seem to prefer a novel stimulus, they also prefer a novel facial stimulus as opposed to an object (Barrera & Maurer, 1981). Additionally, Field et al. (1985) expands upon this idea by proposing that, due to limited information-processing and arousal-modulation abilities, young infants look at live faces for a shorter amount of time. This arousal-modulation could be influenced by the formation of class concepts, of which faces are a component; infant's appear to classify familiar objects, including faces, in regards to their typical presentations in the world (Fagan, 1972).

Methodological influences on face discrimination

One of the greatest factors influencing the ability of infants to recognize faces lies in the methodology utilized to gather the facial recognition information. While many observers use a live presentation of faces (Bushnell, Sai & Mullin, 1989; Mauer & Salapatek, 1976; Pascalis, de Schonen, Morton, Deruelle & Fabre-Grenet, 1995; Field et al., 1985; Bushnell, 2001; and Bartrip, Morton & de Schonen, 2001), this method of presentation has many drawbacks as well many benefits. The greatest benefit for the use of the live presentation of faces is that the faces are in their most realistic state; they are a three dimensional image most

like that commonly seen in the real world by infants. However, the drawbacks also present many methodological problems. The infants can see the mother's expressions, and therefore mothers may inadvertently offer facial cues. In addition, mothers may present olfactory cues to the infant, causing the infant to respond not to the mother's face but to her smell (Bushnell et al., 1989).

Researchers have controlled for olfactory cues while still using the three-dimensional stimulus by infusing the room with an odor masking agent, in the form of perfume (Bushnell et al., 1989). Another way researchers eliminated the problems associated with live presentations of faces was through the use of human-like face representation; for instance, utilizing face-like masks for the stimuli, thus eliminating the factors of olfactory stimulation as well as facial cues from the stimuli (Fagan, 1972). While this type of stimuli lacks some of the realism present in live presentation of the stimuli (i.e., the stimuli does not consist of real faces), the image is three dimensional and therefore, conforms to some representations that infants would have of faces occurring in the real world.

Pictorial presentations of faces also have drawbacks as well as benefits. Advantages include the ability of researchers to control for olfactory cues as well as the facial expressions of the stimuli; disadvantages to this method include the loss of the three dimensional aspect of the stimuli. Researcher can achieve this alternative to live presentations through color slides (Bushnell, 1982; Pascalis, de Haan, Nelson & de Schonen, 1998) or through a presentation on a computer

monitor (Walton et al., 1998). While some individuals criticized the research for being less "life-like", infants consistently discriminate faces from photographic presentations (Fagan, 1973; Walton et al., 1998; Walton et al., 1992; Barerra & Mauer, 1981).

While some studies had difficulty establishing the actual amount of discrimination, Fantz (1956) theorized that if an infant gazes more consistently at a certain stimulus while ignoring another, then he or she must be able to perceive and differentiate between them. While this definition of discrimination is useful in many ways, there are problems with determining the amount of discrimination. Experimenters struggle with determining the amount of gaze at a stimulus; many researchers employed the pupil fixation as the means of determining gazing (Fagan, 1976; Mauer & Salapatek, 1976; Quin, Yahr, Kuhn, Slater & Pascalis, 2002; Barrera & Mauer, 1981; Pascalis, de Schonen, Deruelle & Fabre-Grenet, 1995; Bushnell, 1982; de Schonen & Mathivet, 1990; Bushnell et al., 1989; Pascalis et al., 1998; Bushnell, 2001; Bartrip, Morton & de Schonen, 2001). The use of an outside observer supplements this method, in order to determine the actual amount of pupil fixation (Bushnell, 2001; Bartrip, Morton & de Schonen, 2001). An alternative method of determining the level of infant fixation on the stimuli is through an operant sucking method, in which the infant has control over the stimuli presentation (Walton et al., 1992; Walton et al., 1998). This method of determining the fixation based upon the infants' control of the stimuli eliminates the question of whether the infant is looking at the stimuli or

not; however, it raises the issue of the ability of infants to conceptualize their control of the stimuli. It brings the question to light of whether the infants are recognizing the stimuli as one that is familiar or discriminating what they perceive to be two different, novel stimuli.

The types of stimuli presented as stimuli also appear to influence face discrimination. One of the factors that seem to show profound importance is the novel nature of the stimuli, whether novel in general (i.e. stranger versus a familiar person) or novel in some particular quality (i.e. the novel factor of the gender the infant normally sees the most). It appears that the preference for novel versus familiar stimuli is a dynamic phenomenon, progressing as the infant ages. Young infants, aged 8-72 hours, preferred to look at a familiar face composite rather than a composite of unseen faces after a familiar exposure of less than one minute (Walton & Bower, 1993). Additionally, infants aged 12-36 hours showed a preference for the familiar mother's face when the alternative was an unfamiliar stranger's face (Walton et al., 1992). An additional factor in the ability of infants to discriminate faces lies in the gender of the stimuli. Research points to the gender of the primary caregiver as one of the primary factors influencing face preference (Quinn et al., 2002). While infants at 5 months do not show discrimination and preference for a novel stimuli of a novel gender, six month old infants give great attention to the novel face of a novel gender, when first habituated to one gender of stimuli and then shown the other (showing a preference for a novel stimuli) (Cornell, 1974). Seven month olds also

show the age distinction for influence of the gender of the primary caregiver; these infants showed a preference for the novel face of the novel gender, when they were first familiarized with a given gender (Fagan, 1976).

While hypotheses abound with regards to the mechanism of facial discrimination, most investigative efforts focus on mother-stranger face discrimination, thus limiting the scope of the stimuli presented to the infant. Additionally, studies demonstrating discrimination of male faces typically use novel faces rather than the father. Fagan (1976) found that infants at age 29 weeks were able to discriminate between two men's faces when they are first habituated to one, and can discriminate between two different poses in men as well as being able to discriminate between men and women.

The ability of infants to retain information over a period of time and access the latter also appears to influence discrimination. Researchers believe that infants show a greater ability to retain information relating to faces than to other objects. Infants at 5 months were able to recognize photographs of novel faces that they had seen two weeks previously; this same recognition was not evident for patterns (Fagan, 1976), and infants three to six months were able to recognize novel faces after both a 2 minute interval as well as a twenty-four hour delay (Pascalis et al., 1998). Evidence also points to the fact that infants are able to recognize faces more readily when they view the faces more frequently. Bushnell (2001) found that infants as young as 2-7 hours were able to discriminate their mother's face from that of a stranger; however, their ability to

discriminate increased with increased time spent with their mother. Bushnell (2001) also found that a delay longer than fifteen minutes was needed to remove recognition memory.

While research has shown that at five weeks infants are able to recognize familiar individuals from internal features (e.g. the face alone; excluding the hairline), they are unable to distinguish their mothers from strangers when matched for outside features at four weeks (Pascalis, 1995; Bushnell, 1982). This indicates that the means of face recognition continually evolves, with many researchers hypothesizing that, initially, recognition of familiar faces emerges from recognition of external features alone (i.e., hair color, face shape or the contours of the face) or through recognition used for normal two dimensional objects (Mauer & Salapeteck, 1976). Researchers debate, however, on the mechanism that infants utilize in order to achieve face recognition. However, this hypothesis does not explain the ability of 12 to 36 hour old infants' ability to discriminate pictures of their mothers from pictures of strangers when the two were matched for hair color, hairstyle, complexion and eye color (Walton et al., 1992). Instead, Walton et al. (1992) hypothesize that a secondary process guides the recognition of faces; this mechanism is completely unlike those for recognizing objects. Findings support the hypothesis that over the course of several months, infants require more and more face-like presentations of objects in order to capture their attention (Bushnell et al., 1989).

Researchers also debated which aspects of the face the infant uses to discriminate faces. Another hypothesis suggests that the discrimination mechanism is continually evolving; infants at two months scan the internal features of the face while those younger utilize the outer areas of the face for recognition (Maurer & Salapatek, 1976).

Current study

This research will explore a more concrete method of measuring fixation, through the implementation of an operant sucking device, in which the infant controls the pictorial presentations of the stimuli by sucking on a pacifier (Walton et al., 1998; Walton et al., 1992).

When one realizes the lack of fathers as the discriminating factor, a new study focus emerges, that of focusing on fathers as the stimuli. Preliminary data on three newborns found a small but insignificant preference for the father versus a stranger among 3 infants between the ages of 22 hours and 36 hours (Walton et al., 1992). Given that there were only small observable differences of father versus stranger discrimination in the newborn period, infants slightly older should demonstrate more discriminative abilities.

This study will expand on the previous work of Walton et al. (1992) by assessing whether infants under the age of five months (20 weeks) are able to discriminate the image of their father from the image of a stranger, when the two are matched for physical features. Additionally, this research will determine

discrimination through the use of an operant sucking device, in order to give the infant more control over the pictorial stimuli seen.

Methods

Participants

Participants were male infants under five months of age and their fathers. A total of three infants were tested; infants were between the ages of eight days and nineteen weeks ($\underline{M}$ = 10.38 weeks). However, the eldest infant was corrected for early birth and was assessed as being sixteen weeks of age.

All testing procedures took place at the Illinois Wesleyan University Psychology research laboratory, located in the Center for Natural Sciences, or at the participants' homes. Criterion for recruitment to the study included healthy babies with birth weights within the normal range. If the infants were more than three weeks premature at birth, the Apgar scores were assessed; only infants with five minute Apgar scores above eight were recruited. Participant infants were healthy and normally developing at the time of the study. After screening babies for the above criteria, researchers obtained informed consent from the parent(s) and participation in the study was on a volunteer basis with no pay.

Participants were recruited from the communities of Bloomington and Normal Illinois as well as surrounding communities. The method recruitment included word of mouth, through announcements in obstetricians' offices, though local churches and through announcements in Psychology classes. Participation was on a volunteer basis and no monetary compensation was

offered. The researcher discussed the study with the parents as part of the recruitment process.

Apparatus.

A 5/16 inch diameter tubing (Tygon R3603) with a 3/16 opening was inserted into the back of a pacifier after the handle had been removed. The alternate end of the tubing was inserted into a pressure transducer, Omega (PX163-120BD5V), which registers pressure changes from -20 to +120 cm H_2O. The pressure transducer was connected to an IBM Thinkpad laptop computer. Pictures of the father and stranger, taken with a digital camera (Sony Digital Mavica Still Camera, MVC-FD5), were loaded into the computer. The luminance of the pictures was equalized through the Paint Shop Pro program. Additionally, the images of the fathers and strangers were trimmed, in order to eliminate outer facial cues, including hairline. The images of the fathers and strangers were matched for complexion, face shape and eye color.

A software program, OASYS, presented the stimulus after an operant suck. OASYS also counted the number of responses and at what time during the experiment the responses occurred. The stimuli were presented on the IBM Thinkpad Laptop.

Procedures.

Prior to the experiment, photographs of the fathers and strangers were taken in differing locations against a neutral background.

Once the baby was quietly alert, the baby was positioned in an upright position in a commercial brand car seat, and secured with straps. The car seat was placed so that the infant's face was 10 inches from the monitor. The baby's head was positioned so that the baby was looking straight ahead toward the middle of the screen. After the pacifier was inserted into the baby's mouth, a five minute test period began, during which time a second researcher began the computer program. The stimulus appeared on the monitor for 400 ms contingent upon each positive pressure change in the baby's suck in the range -20 to +120 cc H_2O. The rise and fall of the pressure was counted as one suck, resulting in delivery of the stimulus by the computer. The sucking rate of less than 1 suck per second generated additional presentations of the same face. In order for the second face to appear, the infants had to pause at least 1 second and then begin sucking again. With each pause in sucking of 1 second or greater, the stimulus alternated to the other picture. There were no auditory stimuli during the experiment and the lights were dimmed to minimize competing visual stimuli.

The first stimulus to appear was either the father's face or stranger's face, randomized across subjects. The faces were both neutral in expression and positioned against a neutral background.

Analysis

For the purposes of this study, discrimination can be evidenced through a difference in responding to the father and the stranger. Infants of various ages may respond to a familiar stimulus differently. It is not necessary for the infant to

prefer the father. Therefore, difference scores are calculated by subtracting the number of responses for the stimulus that received the least number of responses from the number of response for the stimulus that received the greater number of responses. A mean difference score greater than two indicated discrimination. This can be calculated by cycles over the course of the experiment. A cycle is defined as the beginning of a presentation of one stimulus and ending after the presentation of the second stimulus. If on a given cycle, the infant produced 10 sucking responses for the father and 3 sucking responses for the stranger, the difference score was 7. However, preference for familiar or novel faces is important in explaining the mechanisms for face recognition and determining whether the mechanisms for recognizing the father's face are the same as for the mother.

Results

The total number of sucking responses was calculated by counting the number of sucks for each face (the father and the stranger) (see Table 1). In participant 1, the overall sucking response for the stranger stimulus was greater than the overall sucking responses for the father stimulus. In participant 2 and participant 3, the overall sucking response for the father stimuli was greater than the overall sucking responses for the stranger stimuli.

Cumulative totals for the sucking responses over the course of the experiment were calculated, for each participant (see Figures 1, 2 and 3). For participant 1, the trend, over the time period, shows an overall preference for the

novel, stranger stimulus. Participant 2 as well as participant 3 showed an overall preference for the familiar, father stimulus.

The overall pattern of sucking responses was calculated, through a breakdown of sucking responses in thirty second intervals (see Table 2). For participant 1, the trend in the responses to the father (familiar) stimulus was a decrease over the first 90 seconds, followed by a sharp increase, which sustained until the end of the third minute, followed by a sharp decrease, which sustained until the end of the trial. The trend to the stranger (novel) stimulus was a decrease for the first minute, followed by a sharp increase until the end of 90 seconds, followed by a gradual decrease until the end of minute three. This was followed by an increase until the end of minute four, followed by a decrease and then increase at the end of minute five. For participant 2, the trend for the responses to the father (familiar) stimulus was a slight increase followed by a decrease, and then another increase. The trend for the responses to the stranger (novel) stimulus was a decrease followed by satiation, followed by an increase. For participant 3, the trend for the responses to the father (familiar) stimulus was an increase over the first 120 seconds, followed by a decrease over the last minute. The trend for the responses to the stranger (novel) stimulus was an initial dip over the first minute, followed by an increase until the end of 180 seconds. This was followed by a decrease over the last minute of the trials.

A cycle by cycle analysis examined the number of cycles in which the participant sucked more to see the father (familiarity effect), and the number of

cycles in which the participant sucked more to see the stranger (novelty effect) (see Figure 4). This shows, in terms of cycles, if participants sucked more to see a stimulus that is familiar to them versus one that is novel. However, this figure does not indicate magnitude of differences in responding (see Figures 5, 6 and 7). The mean differences in sucking responses for participant 1 was 9.65 (M_{diff} = 9.65, SD = 10.02, 23 cycles,), participant 2 was 3.5 (M_{diff} = 3.5, SD = 3.17, 11 cycles), and participant 3 was 7.5 (M_{diff} = 7.5, SD = 5.59, 33 cycles). Overall, participant 1 showed a novelty effect. Participant 2 showed a familiarity effect. Participate 3 showed an equal number of cycles for both the father and the stranger.

Overall number of sucking responses for the father and the stranger were calculated, as a function of cycles (see Figures 5, 6 and 7). Participant 1 showed a high number of responses for the father in cycles 8 and 9 (35 and 36 responses, respectively), with low responses to the father occurring in a total of 8 cycles, each with a total of 1 sucking response (cycles 1, 5, 9, 17, 18, 20, 21 and 22). Participant 1 showed a high number of responses for the stranger in cycles 2, 3 and 15 (20, 22 and 23 responses, respectively), with a low number of responses to the stranger in cycles 10, 11 and 23 (response of 1 sucking response). Participant 2 showed a high number of responses to the father in cycles 2 and 10 (both with 9 sucking responses) and a low number of responses to the father in cycles 1 and 11 (both with 3 sucking responses). Participant 2 showed a high number of sucking responses to the stranger in cycle 1, with 12 sucking responses, and a low number of sucking responses to the stranger in cycles 2, 4 and 8, each with 1

sucking response. Participant 3 had a high number of sucking responses for the father in cycle 5, with a total of 26 sucking responses; the low number of responses for the father occurred in a total of 6 cycles, each with 1 sucking response (cycles 1, 5, 19, 22, 30 and 31). Participant 3 had a high number of sucking responses for the stranger in cycle 6, with 26 responses; the low number of responses occurred in a total of 11 cycles, each with 1 sucking response (cycles 2, 3, 10, 13, 14, 21, 24, 25, 26, 29 and 33).

Discussion

If there was no discrimination between father and stranger, there would be no differences overall in sucking responses for each face, nor would cycle by cycle differences exist. The sucking pattern would resemble normal displays of non-nutritive sucking, with a series of bursts and pauses in sucking. Additionally, the bursts in sucking responses would be equal in number of sucks (Crooks, 1979). This was not the case for any of the participants. Overall, the hypothesis that infants can discriminate the images of their fathers from images of strangers was supported. Infants under the age of five months were able to discriminate the images of their fathers from images of strangers. Statistical analyses such as *t* tests were not utilized in assessing this data, due to the disparity in ages of the infants. Due to the relatively low sample size, it is impossible to determine whether face discrimination would be demonstrated in all infants. Therefore, findings in this study are limited.

In this study, an eight day old day infant was able to discriminate the image of his father from the image of a stranger; it could be concluded that some infants will be able to discriminate their fathers. Overall, all participants indicated a preference for either the father or the stranger. Likewise, during the course of the experiment, all participants regulated their stimuli viewing, alternating between the father and stranger stimuli. The youngest participant in this study consistently showed a preference for the father. This result is very supportive of the data found in mother/stranger face recognition in babies 12-36 hours, who showed consistent preference for the mother over the course of the experiment (Walton et al., 1992).

Theories of Face Recognition and the Current Study

The data from this study has many implications. One of the major theories of face recognition is the idea of the primacy effect, stating that the infant has more retention for the face that it sees first in life. In most infants, the father is not the first face that an infant sees in life; generally, the first face seen is the mother's. An additional theory of face discrimination is the familiarity hypothesis, which explains that the amount of exposure to a face results in recognition of that face. Past studies of mother/stranger face discrimination in newborns have assumed that the recognized face is the face that is preferred. While the purpose of this study was simply to demonstrate discrimination, the findings of the study are consistent with the notion that the youngest infant did recognize the father's face.

Another major theory of face discrimination indicates that the infants' mechanisms for face recognition lie in recognition of the external features of the face, instead of the internal features. This theory was contradicted by the current study, in that the stimuli were trimmed in order to eliminate most external features, including upper hairline. Further, the father and stranger images were matched in complexion, face shape and eye color. Had infants been utilizing the outer features of the face for discrimination, there would have been no significant sucking difference.

An additional theory of face discrimination hypothesizes that the ability of infants to discriminate lies in the experiences of the infant, in that the infant is forming a schema for faces. According to Walton et al. (1992), the schema should resemble the individual with whom the infant has more experience. In the first hours of life, this is usually the mother. As the infant gains experience with the father, the schema would incorporate more physical attributes of the father. This hypothesis is consistent with data from the current study, in that experiences between the infants and their fathers may have contributed to the ability of the infants to discriminate the images of their fathers from the images of strangers. In order to fully explore this hypothesis, however, the study exploring the formation of prototypes in infants should be replicated with male faces as the stimulus (Walton & Bower, 1993).

Future Implications

The current study also raises many questions. One of the first questions is the difference between father/stranger discrimination and mother/stranger discrimination. While there has been evidence to show that infants are able to discriminate (and prefer) their mother shortly after birth, there is currently no evidence that father/stranger face discrimination develops at the same time; this lack of data needs further exploration (Walton et al., 1992). Although the reason for this is not apparent and has not been tested, it may be as simple as positioning of the infant on a consistent basis from the father's face (i.e. the father may hold the infant farther from his face during the early hours of life). This may explain the lack of discrimination found in the Walton et al. (1992) study, who found no evidence of discrimination.

Additionally, the current study raises questions regarding the differences between discriminating male faces from female faces. The obvious differences are the physical features that differentiate male faces from female faces, including more sloping foreheads and prominent nasal passages on males, and fuller cheeks on females (Burton, Bruce & Dench, 1993).

All of these questions require further investigation into the mechanism of face recognition in infants. Though fathers have been relatively overlooked in the literature, this will hopefully be a starting point for their inclusion in future studies.

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Table 1

Overall Sucking Responses for Father Versus Stranger Stimuli

	Overall Sucking Responses	
Participant	Father	Stranger
1	211	235
2	72	54
3	211	178

Note. Father (*M*= 164.67; *SD*= 80.25),
Stranger (*M*= 155.67; *SD*= 92.54)

Table 2

Time Interval Breakdown: Number of Sucking Responses Per Thirty-Second Interval

		Elapsed Time*									
Participant Number	Stimuli	30	60	90	120	150	180	210	240	270	300
1	Father	24	18	14	41	36	42	28	16	4	4
	Stranger	24	20	42	26	20	6	22	36	16	23
2	Father	12	13	7	8	5	7	0	0	8	11
	Stranger	12	9	7	7	6	0	0	0	7	6
3	Father	13	28	4	40	16	22	25	28	23	12
	Stranger	20	8	39	5	18	22	15	24	14	13

Note. The elapsed time depicted in seconds.

Figure caption

Figure 1. Infant 1: Cumulative Sucking Responses to Elicit the Father Versus Stranger Stimuli

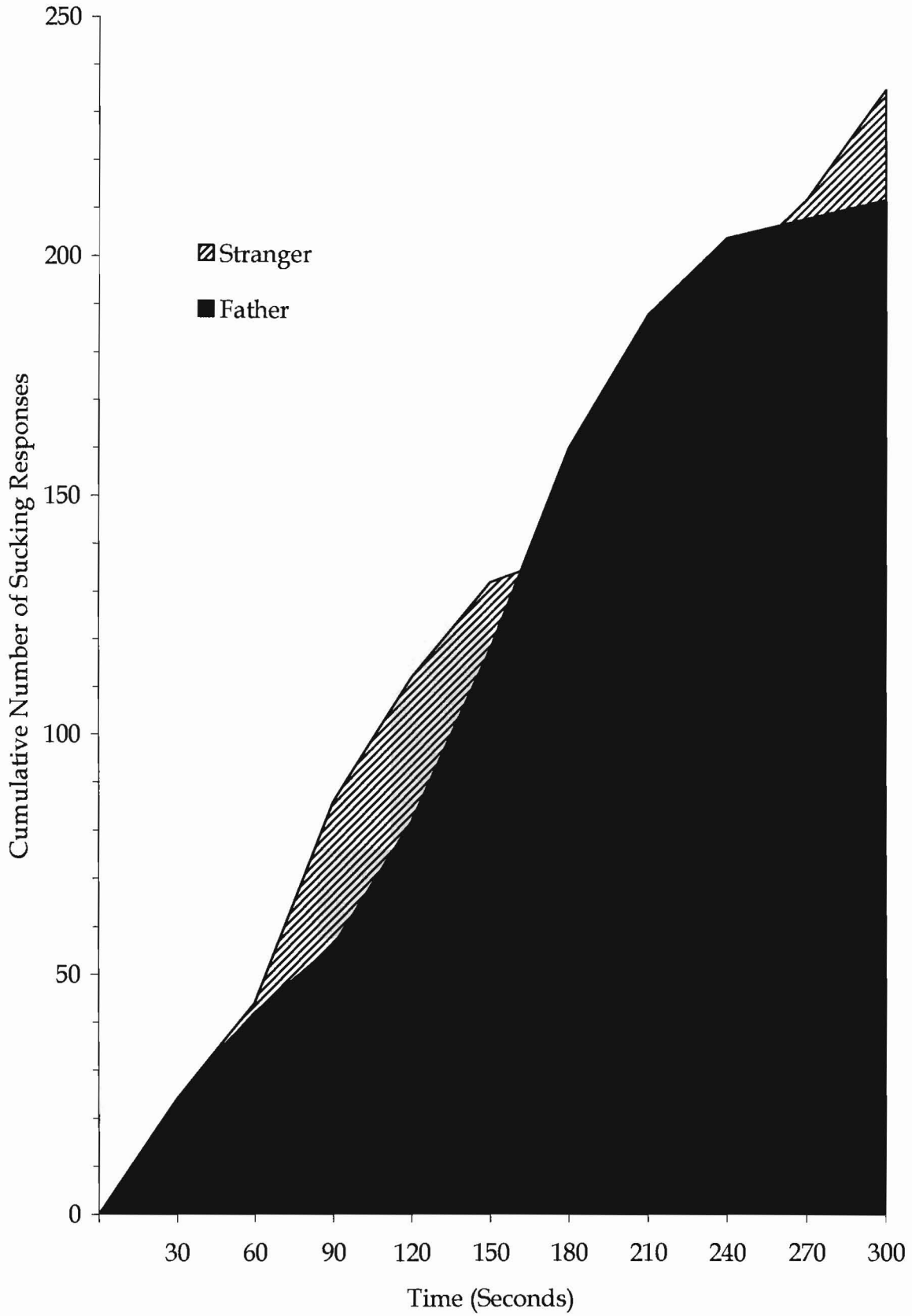

250
200
150
100
50
0
Stranger
Father
Cumulative Number of Sucking Responses
30
60
90
120
150
180
210
240
270
300
Time (Seconds)

Figure caption

Figure 2. Infant 2: Cumulative Sucking Responses to Elicit the Father Versus Stranger Stimuli

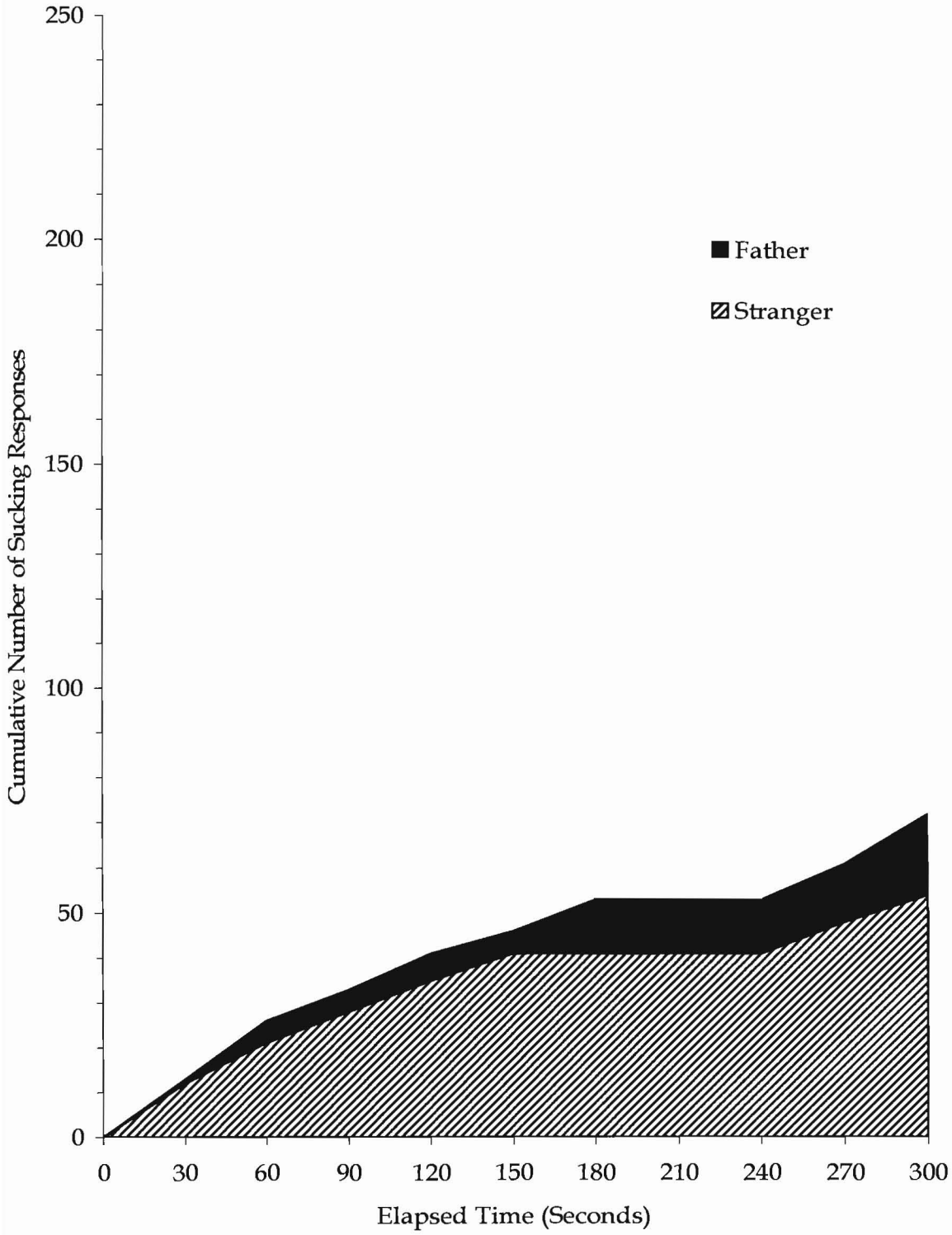

250
200
150
100
50
0
Cumulative Number of Sucking Responses
Father
Stranger
0
30
60
90
120
150
180
210
240
270
300
Elapsed Time (Seconds)

Figure caption

Figure 3. Infant 3: Cumulative Sucking Responses to Elicit the Father Versus Stranger Stimuli

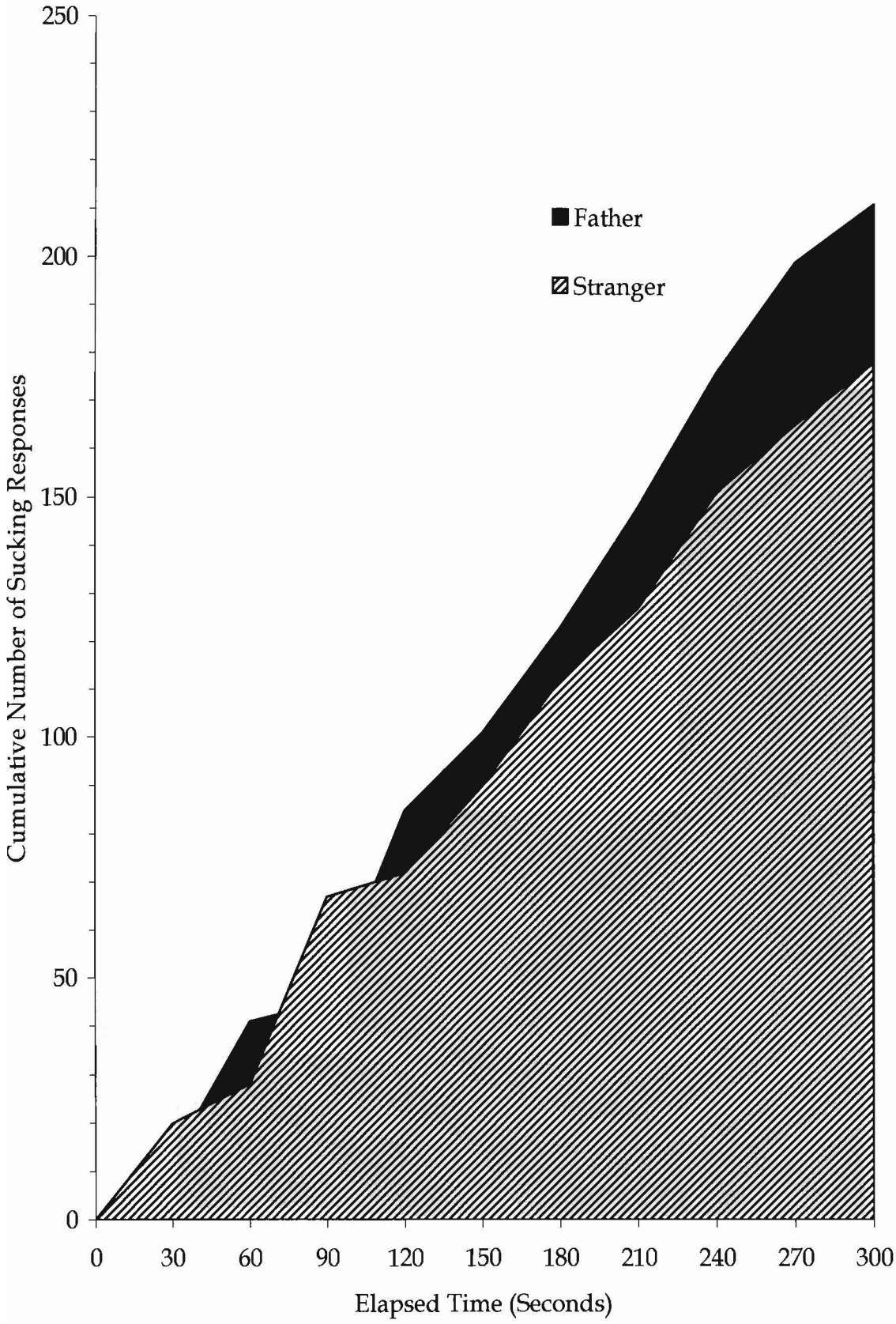

250
200
150
100
50
0
Cumulative Number of Sucking Responses
Father
Stranger
0
30
60
90
120
150
180
210
240
270
300
Elapsed Time (Seconds)

Figure caption

Figure 4. Familiarity Effect and Novelty Effect as Evidenced by an Overall Trend Toward the Father Versus Stranger Stimuli[2].

[2] Familiarity effect = number of sucking responses for the father's face stimuli – number of responses for the stranger's face stimuli.

Novelty effect = number of responses for the stranger's face stimuli - number of sucking responses for the father's face stimuli

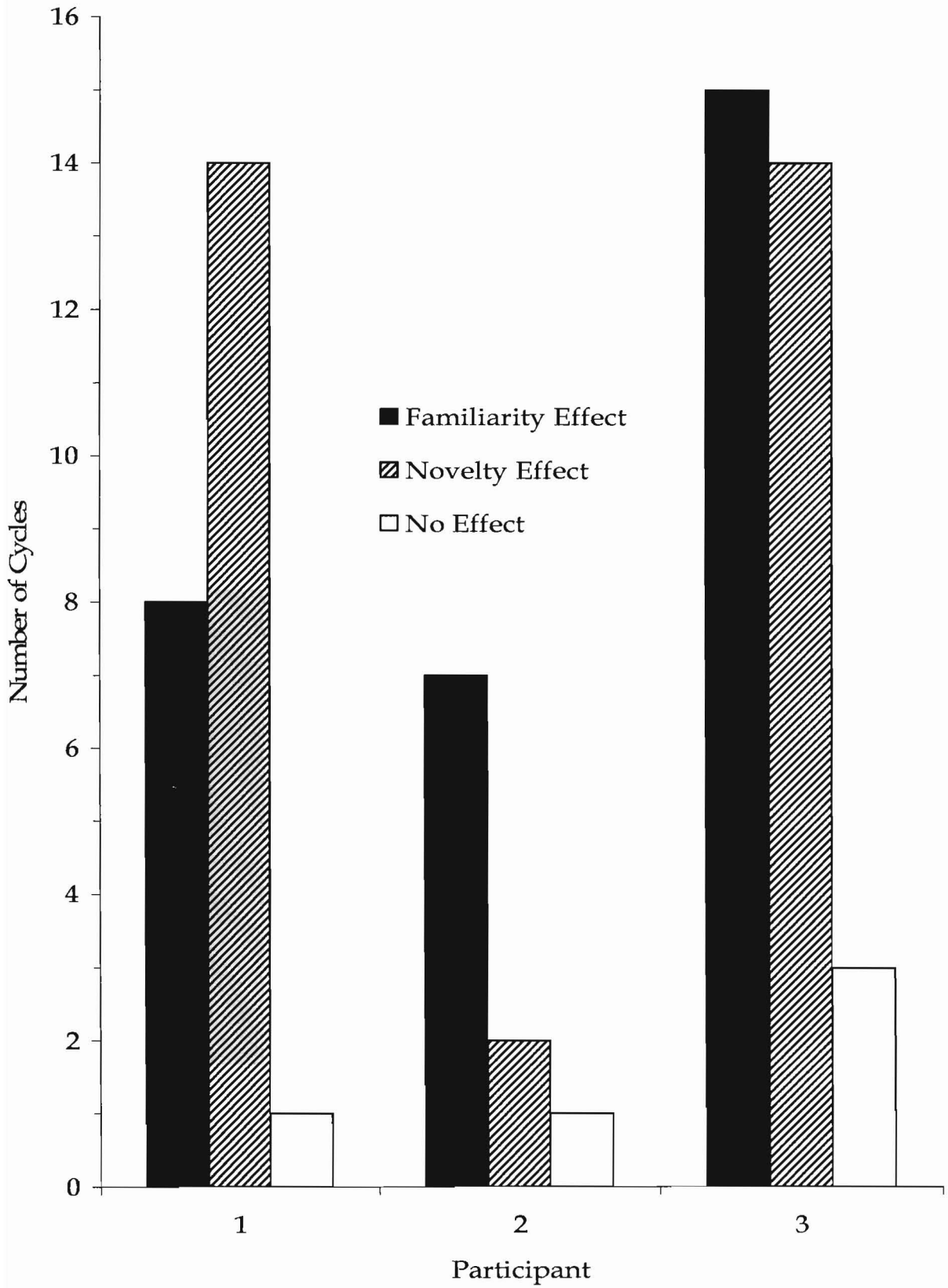

16
14
12
10
8
6
4
2
0
Number of Cycles
Familiarity Effect
Novelty Effect
No Effect
1
2
3
Participant

Figure caption

Figure 5. Infant 1: Number of sucking responses for each face as a function of cycles[1].

[1] A cycle refers to the time from the presentation of the stimuli pair (e.g. beginning of the presentation of father's face followed by presentation of stranger's face ending with the beginning of the presentation of the father's face).

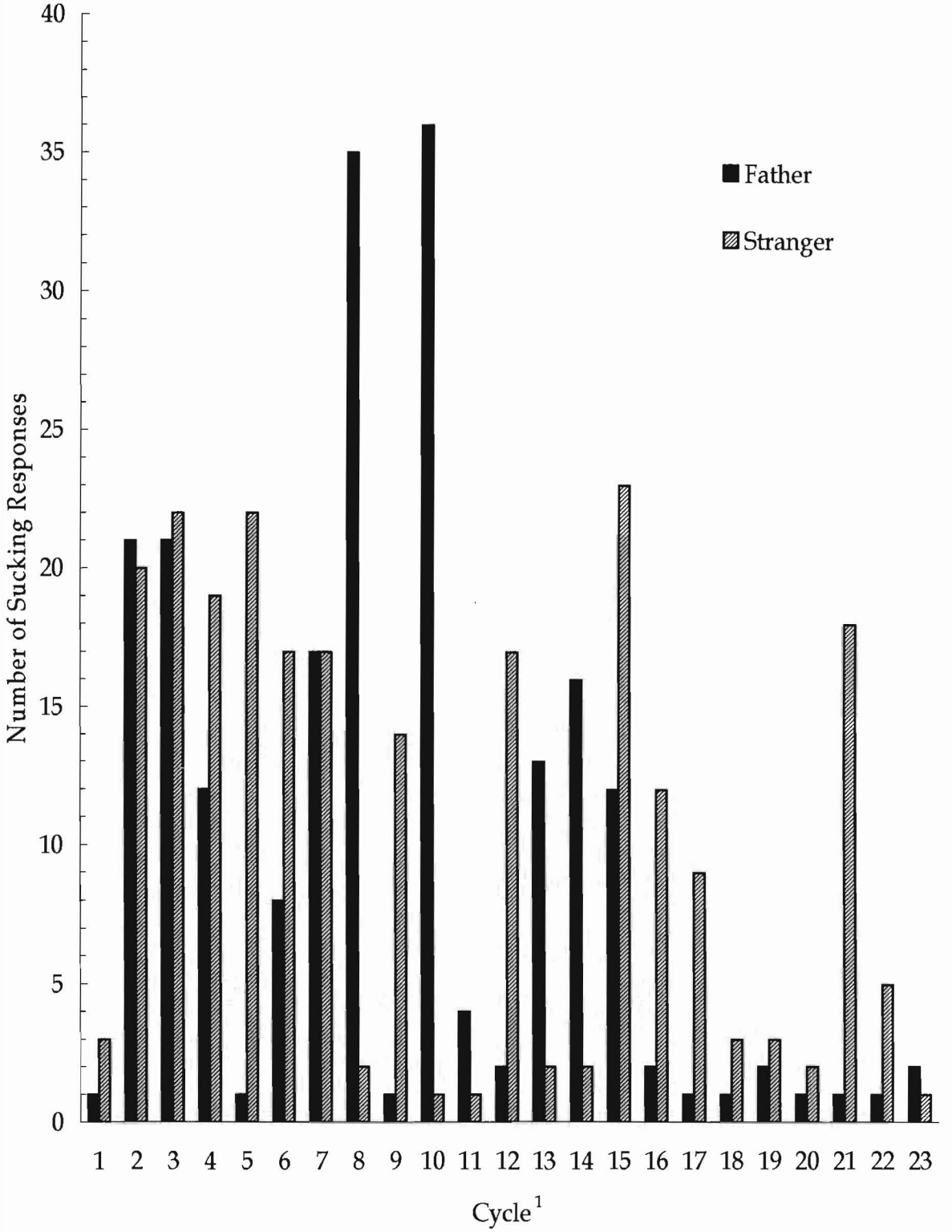

40
35
30
25
20
15
10
5
0
Number of Sucking Responses
Father
Stranger
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Cycle[1]

Figure caption

Figure 6. Infant 2: Number of sucking responses for each face as a function of cycles[1]

[1] A cycle refers to the time from the presentation of the stimuli pair (e.g. beginning of the presentation of father's face followed by presentation of stranger's face ending with the beginning of the presentation of the father's face).

[3] Incomplete cycles are shown, with only the aspects completed reflected.

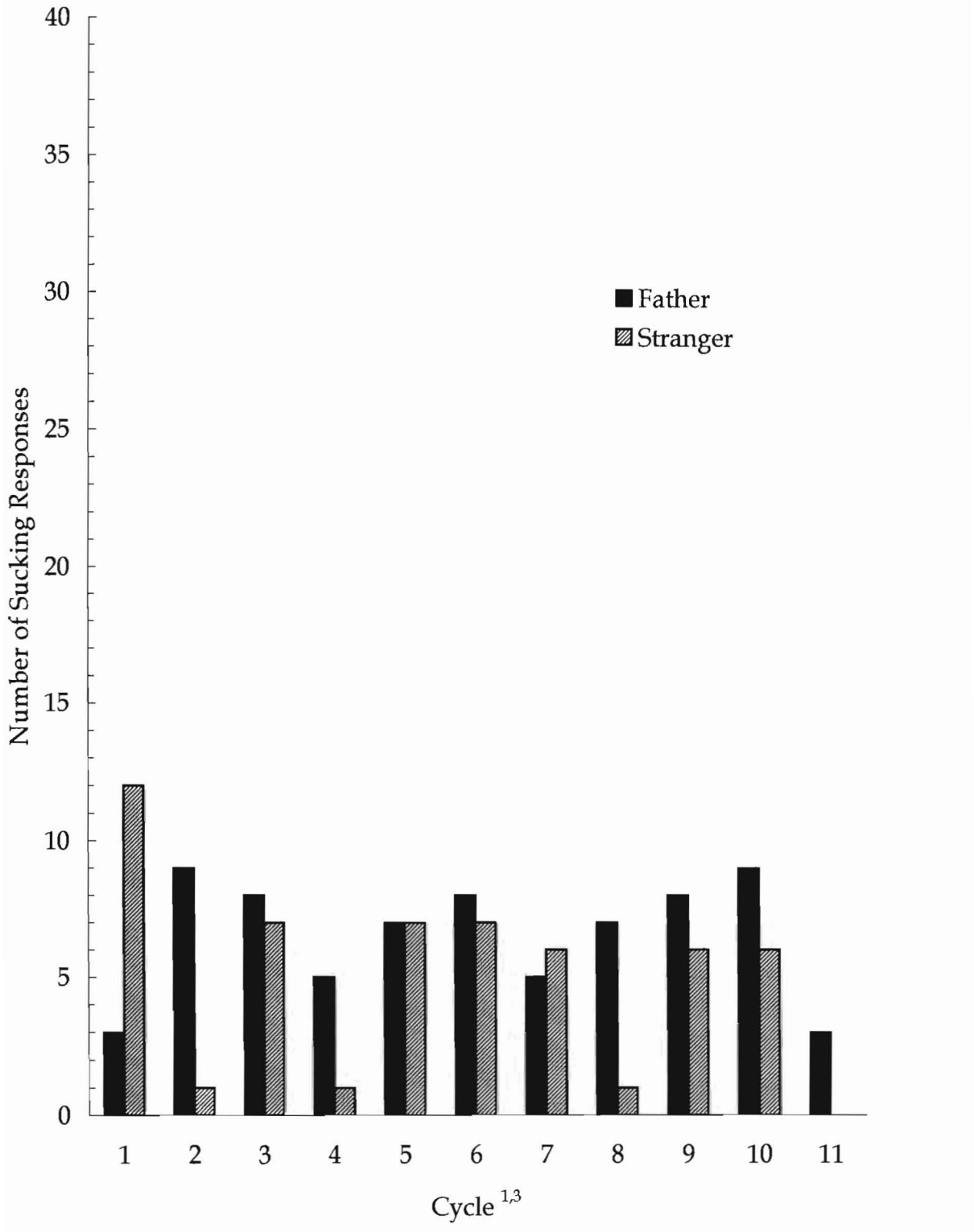
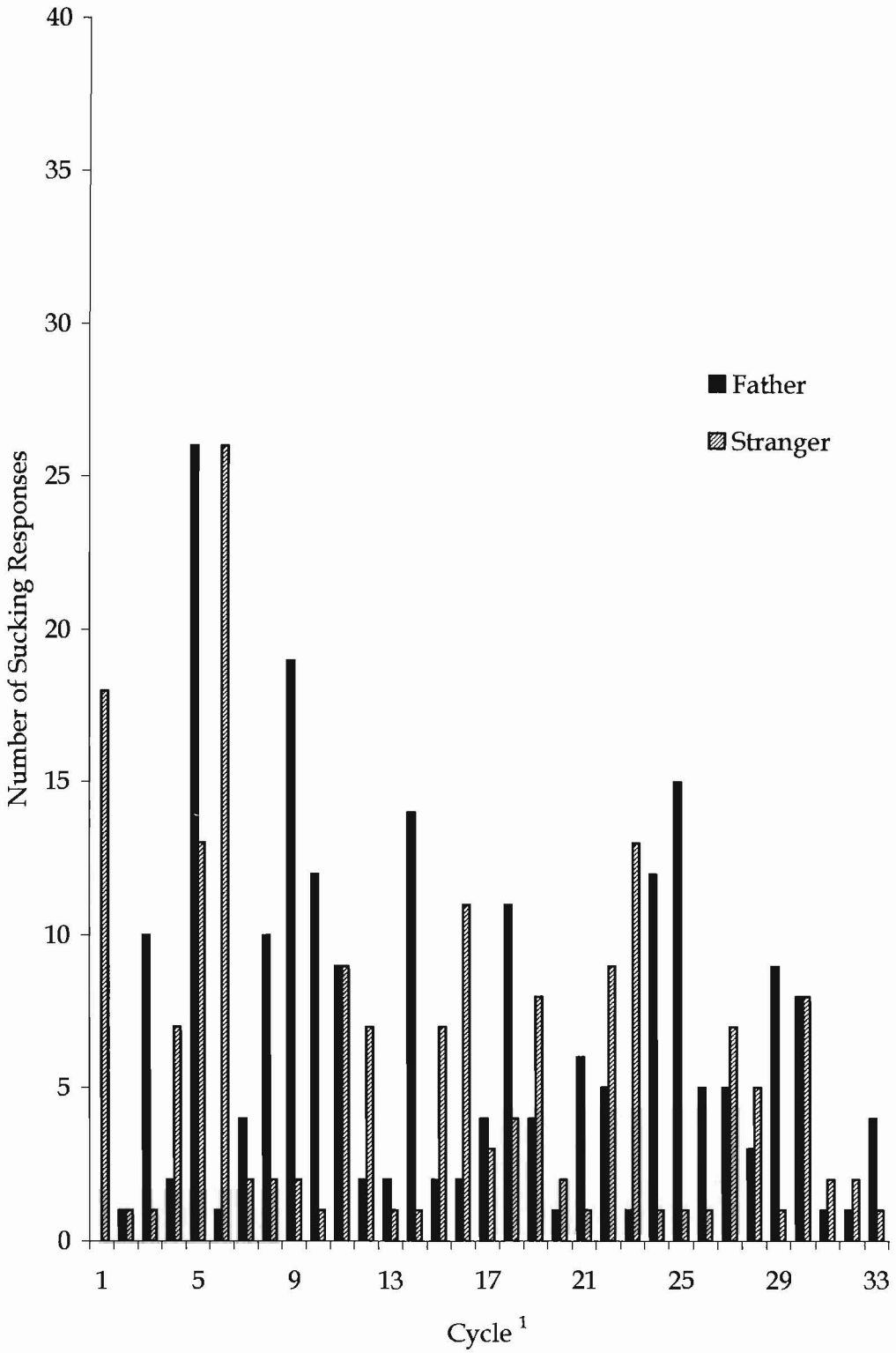

40
35
30
25
20
15
10
5
0
Number of Sucking Responses
Father
Stranger
1
2
3
4
5
6
7
8
9
10
11
Cycle [1,3]

Figure caption

Figure 7. Infant 3: Number of sucking responses for each face as a function of cycles[1]

[1] A cycle refers to the time from the presentation of the stimuli pair (e.g. beginning of the presentation of father's face followed by presentation of stranger's face ending with the beginning of the presentation of the father's face).


40
35
30
25
20
15
10
5
0
Number of Sucking Responses
Father
Stranger
1
5
9
13
17
21
25
29
33
Cycle [1]