
Stages of Infant Development, as Illustrated by Responses to the Peek-a-boo Game

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Infants' responses to different peek-a-boo stimuli presented by experimenters illustrate three infant non-mentalist stages of development (Commons et al., 1998). Results showed that for the youngest infants (sensory and motor stage), almost any kind of interactive contact with another human (as long as it included vocalization with smiling and eye-contact) produced responses such as smiling. Between roughly 4 and 8 months (circular sensory motor stage), the specific version of the game that was played became important. Games that included hiding, coming out and saying peek-a-boo in an animated voice obtained maximum responses; games more divergent produced less responding. For older infants (sensory motor stage) games that diverged from the standard in specific ways could sometimes produce even higher rates of responsiveness, although this depended on the particular circumstances.

Parent-infant interactions have been the topic of literally thousands of studies. Studies have examined infants and their parents in very structured situations (e.g., Brazelton, Koslowski & Main, 1974) or more naturalistic situations (LeVine et al., 1994; Stern, 1977; Trevarthen, 1980). Many studies of interactions have focused on attachment or attachment-related processes (e.g., Ainsworth et al., 1978 and others). The current study examines responses to the game of peek-a-boo in infants up to 2 years of age.

Because peek-a-boo has such a definite structure, it provides a framework with which to study the ways in which infants' participation in interactions changes during the first two years of life. It has been related to linguistic interactions; Ratner & Bruner (1978) argued that it could assist in language development because of its highly structured and repetitive structure. It also is a form of game-playing and has often been studied from that perspective. Rome-Flanders et al. (1995) videotaped naturalistically-occurring peek-a-boo interactions between infants 6 to 24 months of age and their mothers. They found significant changes across age in the gestures used and the emotional reactions observed, and evidence that infants increasingly understood the 'rules of the game.' Parrott (1989) found that infants as young as 6 months of age had developed expectations of what would happen at certain times in the game, and when he switched the expected components in some way, they showed less responsiveness. The peek-a-boo game has also been used as a framework within which to study emotion regulation in infants. Stifter & Moyer (1991), for example, found that young infants (5-month olds) use gaze aversion during the peek-a-boo game to

regulate their arousal. Hodapp & Goldfield (1985) found that infant and mother regulation seemed to function in a complementary fashion in pairs studied between 8 and 15 months of age, and that the mother's structuring of the situation was an essential part of the development of self-regulation.

In all of the above studies, developmental changes are referred to in a general way. The changes in behavior are not related to developmental stages. In the current study, 15 variations of the peek-a-boo game were played with the infants. These 15 variations were generated by separating the game into 5 components: hiding, coming out, smiling, saying peek-a-boo, and using an animated voice. The reactions of infants to the different variations of the game will be examined and related to changes in infant developmental stages, as these have been proposed by the Model of Hierarchical Complexity (Commons, Trudeau et al., 1998).

Method

Participants

The participants in this study were 51 infants between 15 and 650 days old (24 female, $M = 212$ (S.D. = 123); 27 males, $M = 183$ (S.D. = 147). All subjects resided in an urban area of Manitoba, a Western Canadian province. Experimenters and observers were persons enrolled in an undergraduate psychology course and mothers and fathers of the infants. Experimenters were the persons playing the actual peek-a-boo game with the infant. Observers were the persons recording infant responses under the prescribed categories. The only information given to either was limited to the experimental protocol necessary to carry out the procedure. The group members recruited participants from among people that they knew in the community.

Procedure

Groups of two to five members worked together in recruiting infants and carrying out the experiment. Group members alternated as experimenters and observers. The experiment was carried out in the infant's home.

The infant was placed directly in front of the experimenter, with the observer off to one side. The experimenter played with the infant as long as he/she could obtain eye-contact with the infant within approximately three seconds of making a noise or calling the infant's name.

Fifteen versions of the peek-a-boo game, each lasting approximately 10 seconds, served as stimuli for infant responses. The versions of the game are shown in Table 1.

Table 1. 15 Games of Peek-A-Boo

Game #	Hiding	Coming Out	Smiling	"Peek-A-Boo" in a Flat Voice	"Peek-A-Boo" in an Animated Voice
1	X	X	X		X
2	X	X	X	X	
3	X	X	X		
4	X	X			X
5	X	X		X	
6	X	X			
7	X				X
8	X			X	
9	X				
10			X		X
11			X	X	
12			X		
13					X
14				X	
15					

The order of games was randomized and presented according to five thirty-game data sheets. In this manner, 150 games could be played without the same sequence being repeated. Each game started with the experimenter obtaining eye contact with the infant. Games continued until one of the criteria for stopping was met. Stopping criteria included:

1. The infant failed to establish eye-contact for three out of five consecutive trials.
2. The infant interrupted the game by crying, falling asleep, etc. for three out of five consecutive trials.
3. A distraction was introduced into the environment.
4. The parents requested the termination of the session.

Each infant engaged in a different number of trials, although generally no more than sixty trials were run on any one day.

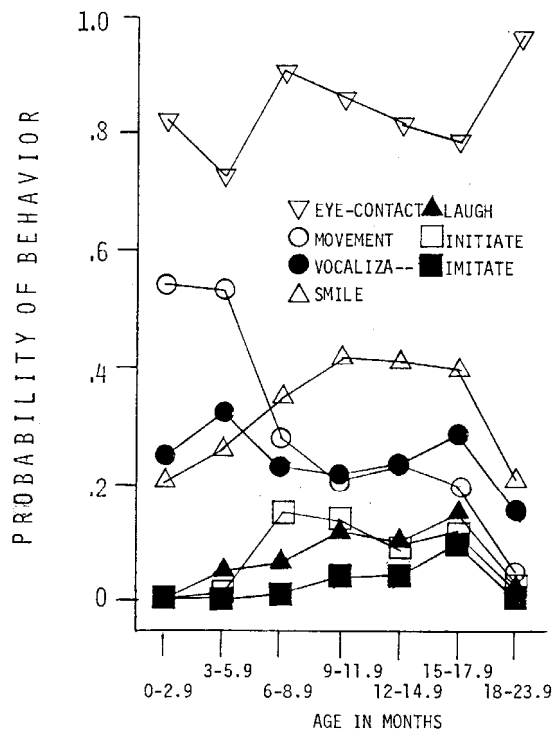
Observers recorded infant responses to each game according to seven response categories: eye contact, smiling, laughing, vocalizing, gross motor movements, imitating and initiating. Infants were given ten seconds to respond. Responses were not interrupted by the start of another game. The total number of trials for all infants was 15,029.

Results

General age differences in responses to the game

To understand the sequence of the development of behavior and what events control behavior, we examine changes in specific behaviors over time. Figure 1 shows that the earliest response, eye contact, was clearly the most frequent response recorded.

Figure 1. Infants' responses (eye contact, physical movement, vocalizing, smiling, laughing, imitating and initiating) in response to peek-a-boo across the first 2 years



Usually 80% or more of the time, an infant would at least look in response to a version of a peek-a-boo game. Vocalizing in response to a peek-a-boo game tended to stay between about 20% and 30% of the time across age, other than at the last age period in which it dropped. Other behaviors tended to show differences across developmental periods. Motor movements were highest during the first two age periods and then dropped. Smiling showed an increase up until the end of the first year, then remained reasonably stable until the last age group. Laughing increased somewhat up until the 15 month age group. Imitation and initiation, while low in frequency began to increase from 6 months onward. All of the responses, except eye contact, dropped off in the last age group.

How do individual responses group together?

In the previous section, we examined individual infant responses: eye contact, gross motor movement, vocalizing, smiling, laughing, imitating and initiating. Because groups of responses appeared to change in a similar fashion across time, a factor analysis was performed for the data as a whole, across age

groups. The seven individual responses could be grouped into three factors. Table 2 shows the results of the factor analysis.

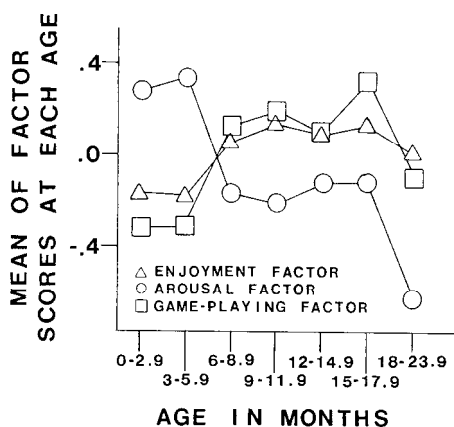
Table 2. Factor analysis results showing group of individual responses¹

	Factor 1 Enjoyment	Factor 2 Arousal	Factor 3 Active Play
Eye Contact	.51921		
Smiling	.69403		
Laughing	.65673		
Vocalizing		.76200	
Movement		.72123	
Imitating			.69009
Initiating			.76293

The first 3 responses – eye-contact, smile, and laugh -- loaded on Factor 1. We have called this the enjoyment factor. The responses vocalize and gross body movement loaded on Factor 2. We have called this the physical arousal factor. Imitate and initiate loaded on Factor 3, which we have called the "active game-playing" factor.

Figure 2 shows the mean of the factors scores, for each of the three factors, across age and across all games. As can be seen, general physical arousal is highest during the first six months of life and decreases thereafter. The Arousal Factor, which consisted of gross motor movements and vocalizing by the infants, may reflect general eliciting properties of the interaction. Young infants, in particular, wriggle, move and vocalize when people talk to them. From 6 months onward, these kinds of responses decrease. These changes over age were significantly different from chance ($F(6,15,023) = 46,996, p < .0001$).

Figure 2. Age differences in factor scores based on three factors: Enjoyment, physical arousal and game-playing



Both enjoyment and game playing increase at 6 months, and remain near the same level until the last age period (18 to 23.9 months), at which time they decreased. Both of these factors showed significant changes across age as well ($F(6,15,023) = 174.261, p < .0001$ and $F(6,15,023) = 60.317, p < .0001$, respectively).

¹ Factor analysis conducted using Principal Components Analysis, with a Varimax rotation

Patterns of responses to different types of games

The above analyses examined infant responses irrespective of the type of peek-a-boo game that was being played. The next step was to look at the response functions for different types of peek-a-boo games? Seven overall types of games were created, as shown in Table 3.

If the function for each component showed exactly the same form of the respective factor as the overall pattern for that factor which was described in Figure 2, but differed in height, we would conclude that adding components changed only the degree of excitation. If different components resulted in different functional forms, we would conclude that the overall pattern of results cannot be explained by a simple summative model, but that individual components may control responding in way different from the overall game.

Table 3. Games that were collapsed to form composite games

Game	Actions
The Full Game	Hide - Come out - Say Peek-a-boo - Animated - Smile
Hide Only	Games 7, 8, 9
Hide and Come out	Games 2, 3, 4, 5, 6
Smile Only	Games 2, 3, 10, 11, 12
Say Peek-a-boo in an Animated Voice Only	Games 4, 7, 10, 13
Say Peek-a-boo in a Flat Voice Only	Games 2, 5, 8, 11, 14
Do Nothing	Game 15

In Figures 3, 4, and 5 the means of the factor scores from a particular factor were calculated for each single component across all age groups. This value of the mean of the factor scores across age, shown by the vertical lines at the right hand side of each of the figures, gives an idea of the relative size of the factor scores obtained in response to each of the single components; larger means suggest higher responsiveness to that component. In order to illustrate the forms of the response functions separately from their heights, the mean calculated for each component across age was subtracted from the mean of the factor scores for a component of each age. These deviations from the mean are represented by the curves seen in the three figures.

Figure 3 shows that for the physical arousal factor, the components produce a much more uniform pattern of responding, with high mean responding from 0 to 6 months, and then a U-shaped pattern with another peak at 18 months, suggesting that individual components did simply sum to produce the function seen for the full game, and that responses to the components are relatively undifferentiated. Overall, the full game shows the highest mean score, followed by smile and animated peek-a-boo.

Figure 4 shows that for the enjoyment factor, different components do result in different patterns of responding. Because 2 major patterns were detected, two separate groups of curves are shown on the graph for ease of reading. A third pattern, for the nothing game, is included in the top set of curves. The top set of curves includes the full game, the hide/comeout game, and the animated peek-a-boo game. Responses to these games all show a steady rise from the first age group (0 to 3 months) to 9 to 12 months and shown a relatively flat function thereafter. The pattern for the nothing game resembles neither of the 2 major patterns.

Figure 3. Deviation from the mean of the enjoyment factor score at each age, in response to seven different versions of the peek-a-boo game

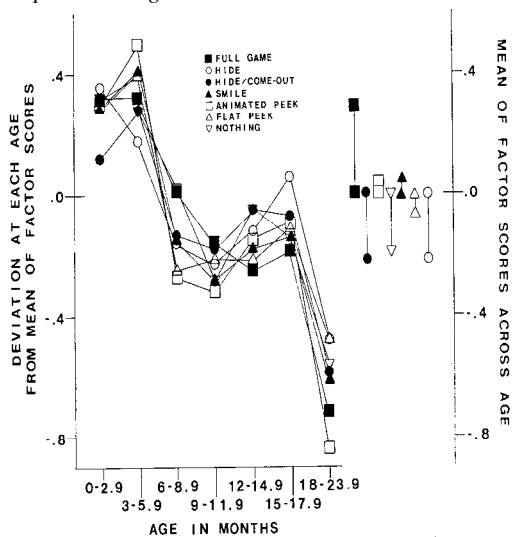
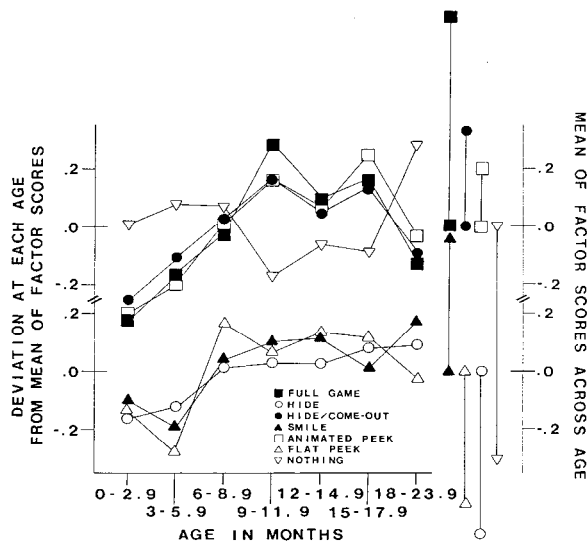


Figure 4. Deviation from the mean of the physical arousal factor score at each age, in response to seven different versions of the peek-a-boo game

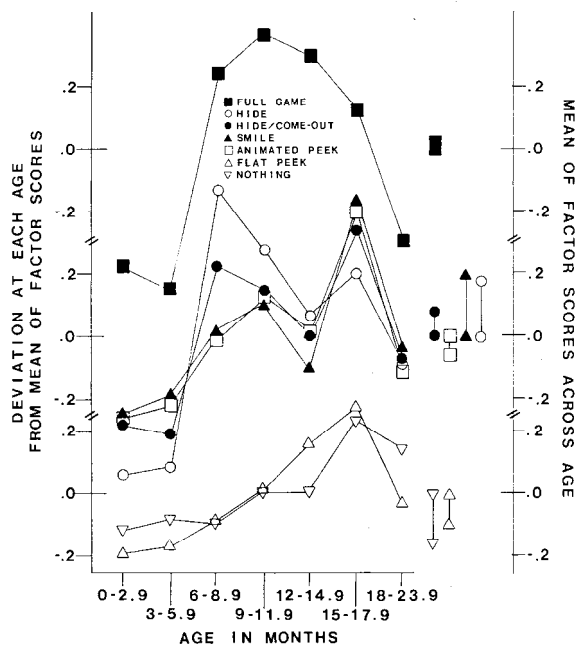


The mean factor scores on the right side of the graph can be ordered from largest to smallest as follows: the full game, then the smile game, then the hide/comeout game, then animated peek-a-boo. The discrepant components, hide-only, flat peek-a-boo, and the nothing game produced negative mean factor scores. From this pattern of results it does not seem as if the functions for the single components, shown at the bottom of the graph, merely sum to produce the function for the full game, shown at the top of the graph. Combinations of as few as two of the components look very similar to the full game, while games with single components do not.

In Figure 5, which summarizes the results for the game-playing factor, we see three separate functional forms. Here, the

flat peek-a-boo game and the nothing game seem to produce equivalent functions - a gradual rise of active game-playing in response to them, which peaks at 15 to 18 months. All the remaining games, except for the full game, produce a two-peak pattern. In this pattern, the first peak appears at 6 to 9 months for the games containing hide, but at 9 to 12 months for the games containing smiling and animated peek-a-boo. All these games show a dip at 12 to 15 months and a second peak at 15 to 18 months. The full game, by contrast, shows the same first rise, at 6 to 9 months, remains high until 12 to 15 months and then decreases at the same time that the single components are showing a peak of responding.

Figure 5: Deviation from the mean of the game playing factor score at each age, in response to seven different versions of the peek-a-boo game



These patterns suggest that different components lead to active game-playing at different ages; hiding games seem to produce such game-playing earlier than games without hide, and the full game produces more such active game-playing. The rise in game playing in response to simple component games at 15 to 18 months, at the same time that such game playing is being reduced for the full game may reflect the fact that by the time, the truncated versions of the game are either more discrepant, or may serve as a cue for infants to begin to fill in the missing components.

Discussion

The responses found in this situation, both at the individual level and when grouped together as factors are consistent with three infant stages, as described in the Model of Hierarchical Complexity. The discussion that follows, and Table 4, discusses a possible stage sequence for peek-a-boo, and compares it with stage sequences of other infant behavior.

Sensory or Motor Actions

In the sensory or motor stage, infants' responses to stimuli tend to be relatively fixed and reflex-based, with only some

generalization. In peek-a-boo, passive responses are seen: looking, motor movements (denoting excitement), and vocalization. Infants show a generalized response to an interactive stimulus, but not necessarily specific comprehension of that stimulus. This is seen in the fact that violations of the standard peek-a-boo game were responded to in the same way as was the standard game.

Circular Sensory-Motor Actions

In the Circular Sensory stage, infants may coordinate their movement with their perceptions. Their vocalizations begin to consist of phonemes that occur in the language they typically hear. They engage in turn-taking in verbal and other games, recognizing the characteristic utterances and gestures of a particular game. They can follow simple, one-act directions. They can communicate using gestures.

More specific "enjoyment" of peek-a-boo is seen starting around 6 months (as shown in Figure 2). The Enjoyment factor (made up of Eye Contact, Smiling and Laughing) is prototypical

emotional behavior associated with game playing, especially because peek-a-boo has been shown to serve as a reinforcer (Watson, 1972). One sees changes at the point that object permanence develops (between 6 and 8 months). The three games that elicited the highest levels of responses were the full game, the hiding and coming out game, and the game in which the experimenter simply says peek-a-boo in an animated voice. The smiling and laughter that occurs in response to peek-a-boo games shows increasing understanding of the meaning of the game. Imitation and initiation also began to increase around the same age period, showing that infants are beginning to take a more active role in interactions, including in the playing of games.

Sensory-Motor

During this third stage, infants have concepts, such as roundness, squareness, more than, plant, people, etc. They have begun to put basic sounds together into meaningful syllables. They can follow simple commands that do not specify individual actions needed (e.g., "Go get your juice.").

Table 4: Infant non-mentalist stages in several domains

Stage Name	Discriminations	Vocalizations Utterances & Words	Verbal Relationships	Receptive Speech	General Examples	Peek-a-boo Examples
Calculatory	Exact: no generalization	Machine Speech	Those Programmed	Speech Recognition	-	-
Sensory & Motor Actions	Rote, generalized	Babbling, Elicited utterances	Repeated sounds	phoneme discrimination	-	Attention to Stimuli; Generalized responses of excitement
Circular Sensory- Motor Actions	Open-ended classes	Phonemes	Turn taking in verbal games	Follows one-act directions	Gestures, Pronounced "[w]," "[ah]"	Smiles, laughs in response to Coming out, Animated peek-a- boo; Imitates single actions
Sensory- Motor	Concepts	Syllables	Combines phonemes into syllables	Follows simple commands	Holding cup out and saying "Wa"	Hides own face and comes out, saying some part of "peek" or "boo"
Nominal	Relations among concepts. Named concepts	Single words, exclamations, verbs, nouns, number names, letter names	Relationship among morphemes producing words	Follows simple chain of commands: "Go to the table and get the cloth"	Says "Water"	Says "peek, or boo." Hides own face. Comes out, saying "peek", "boo" "peek-a-boo" or "play."
Sentential	Imitates and acquires sentences. Follows short sequential acts.	Pronouns. For example, "My book"	Incomplete sentences; then complete sentences, crude dichotomies, ordered numbers and letters	Follows Instructions: "Turn off VCR when tape is over."	States a rule, "Don't touch"	Says "Play peek-a-boo." Hides own face and comes out, saying "peek-a-boo" and then repeats the game.

Note. Lowest stages do not have examples.

In peek-a-boo, simple enjoyment of the standard game begins to wane. Infants can initiate the complete game, not just components of it. We would speculate also that peek-a-boo playing begins to generalize; play with multiple people, in multiple contexts and multiple ways (e.g. peer around a wall at someone).

In conclusion, while a set of behaviors such as peek-a-boo playing surely forms a developmental sequence of its own, it is also the case that by comparing it to established developmental sequences a more complete understanding can be obtained.

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