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MASTERY PLEASURE: FACIAL EXPRESSION AS AN INDEX OF GOAL ACHIEVEMENT AMONG TODDLERS

By

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In loving memory of my mother,

Eva J. Bétournay

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Abstract

The changes in facial expression of 36 18-month-old children prior to and following completion of a challenging task were coded using an adaptation of the Brannigan and Humphries system (1972). For each of 10 point samples taken at .5 s intervals from videotape still frames — 3 prior to (baseline), 1 at, and 6 following completion of the task — 8 facial components were independently coded. Facial expression over the first 4 samples showed no change in facial expression. The six samples following task completion showed increased variability and a sequence of subtle changes toward a pleasant expression and return to baseline expression within 2.5 s. Procedural and coding modifications are discussed.

CHAPTER I

Literature Review

The concept of what motivates an individual to act has long been considered central to the understanding of behaviour. Harter (1981) suggests that "motivational constructs have perennially been at the heart of our theorizing about human behaviour". Motivational theories have ranged from instinct and drive theories to intrinsically motivated behaviour theories. White's (1959) critique of the drive and instinct theories and challenge to consider feelings of self efficacy as the motivational factor in the development of competent behaviour had a significant impact on altering the direction of research in the study of motivation. He held that a child has an intrinsic need to deal with, and to master the environment, and when this need is met, the child is satisfied by a feeling of efficacy (Harter & Zigler, 1974). To distinguish this intrinsic need from other psychological needs White used the term effectance motivation. He states that, "the achievement of competency is accompanied by a feeling of satisfaction which in turn contributes to the development of self-esteem and self-worth."

Though White's concept of effectance or mastery motivation initiated a new direction in research, it has also evoked criticism from the same investigators (Zigler & Harter, 1974; Harter, 1978a, 1981; Yarrow, Morgan, Jennings, Harmon, & Gaiter, 1982; Morgan & Harmon, 1984). A major difficulty encountered by researchers is the operational definition and empirical verification of the concept (Fung, 1984). However, despite its shortcomings, effectance motivation has been adopted as the fundamental concept by a significant number of researchers in the area of child development. Theories that have led to the development of White's concept of motivation and research that has stemmed from his motivational concept are now reviewed.

History of the Theories of Motivation

The main influences in the evolution of motivational psychology can be traced to the 1800's and Darwin's theory of evolution. Early in the 20th century, psychologists such as Freud and McDougall regarded instincts as the primary motives of behaviour in both man and animals (Madsen, 1968).

Freud (1915) distinguished between instincts and stimuli and asserted that the former were the principal motivators of behaviour. He postulated that man is propelled to action by instinctive drives emanating from within the organism and penetrating to the mind (Weiner, 1972). For Freud, all behaviour was determined by two basic instincts: Eros (Life) and Thanatos (Death) which are expressed by sexual and hostile behaviours.

McDougall (1908) postulated that instincts or propensities propel the organism toward certain end states and that these end states can be modified by experience (Weiner, 1972). McDougall also maintained that each instinct has a cognitive, affective, and conative component (Weiner, 1972). The instinct doctrine reached its peak during the early 1900's. The debate on the value of the concept of instinct as the explanation of motivational phenomena had barely started, when Woodworth (1918) introduced the concept of drive as an alternative to that of instinct (Bindra, 1971).

Woodworth suggested that physiological deficits or needs propel the organism to engage in behaviours which result in the offset of these needs. This is a homeostatic conception in which behaviour is directed toward the offset of physiological disequilibrium and the re-establishment of the original state of equilibrium of the organism (Deci, 1975).

Hull's drive-reduction theory of learning was one of the most significant to emerge from Woodworth's drive concept. He postulated the existence of four biological or primary drives (hunger, thirst, sex and pain) which are the primary sources of action, response reinforcement and the acquisition of new or secondary drives. The existence of some need, such as for food, water or reduced body temperature, is said to produce a drive which motivates the organism to behave. In other words, behaviour does not proceed directly from the initiating need; it comes about as a reaction, typically a learned reaction, to the intermediary motivation (Bolles, 1975).

In an attempt to account for learned behaviour, Hull further postulated that learning occurs as a consequence of reinforcement (Hilgard & Bower, 1966). The organism, when encountering a certain need situation, is activated and will emit a variety of responses that may serve to reduce the drive. The reduction of the drive is experienced as reinforcing and the stimulus-response occurrence that solves the immediate need is learned. Upon the recurrence of the same situation, the organism is then more motivated to perform the same behaviour.

The main contribution of drive theory was as a model that allowed systematic and precise exploration of motivational phenomena from an entirely mechanistic position. However, the drive explanation of behaviour was not accepted by many in the psychological community. Among the main issues raised were whether the theory is sufficient to incorporate the richness and complexity of human behaviour and particularly whether the influence of thought upon action can be ignored in motivational theory (Weiner, 1972). This gave rise to cognitive theories of learning and motivation.

The cognitive approach to motivation is concerned primarily with choice behaviour. It assumes that people make choices about what to do by processing information which they receive from the environment, memory or internal states. By evaluating such information, people choose to engage in behaviours which they believe will lead them to a desired end state or goal (Deci, 1975). Lewin (1936, 1938, 1951) and Tolman (1952, 1959) were among the first to recognize the importance of cognitions as causal factors in behaviour.

Lewin (1936) viewed behaviour as driven by tensions or forces that are directed by positive and negative valences toward goals (Bolles, 1975). When a goal is established a person engages in behaviours which lead to the goal and a discharge of tension. Behaviour is directed toward regions in one's "life space" which have positive valence and away from activities perceived as increasing tension or that have a negative valence (Bolles, 1975).

Similarly for Tolman, a person's evaluation of a goal stimulus as positive or negative in the presence of a need state was considered to motivate behaviour. A behaviour begins with an energy source which Tolman refers to as drive stimulation, by which he meant internal conditions which might be loosely termed needs (Deci, 1975). An energy source initiates the choice of a goal and an expectation of success in achieving the goal. The achievement of a goal decreases the drive stimulation. Thus, the expectation of success is also a motivating force for behaviour.

Thus for both Lewin and Tolman, a person behaves so as to approach goals that are expected to decrease drive stimulation or tension (Deci, 1975). Expectancy theories of motivation, which began with the work of Lewin and Tolman and were then expanded by Atkinson (1964), focus primarily on expectations about the achievement of goals. A person selects a goal by considering his awareness of potential satisfaction and his expectations about achieving that satisfaction (Deci, 1975). Motivation, as an area of study, had now expanded to include both mechanistic theories such as Hull's, and cognitive theories including Tolman's and Lewin's.

Researchers such as McClelland, Atkinson, Clark and Lowell (1953) extended the concepts of Lewin and Tolman to the area of achievement motivation (Deci, 1975). On the premise that affect is the basis of motivation, McClelland et al. (1953) contend that throughout life certain stimulus situations become associated with affective states. A later reappearance of such stimulus situations, arouses affective states that, in turn, elicit instrumental approach or avoidance behaviour. A motive is construed by McClelland (1953, p. 28) as "the redintegration by a cue of a change in an affective situation". The motives not only energize behaviour, they also have directional properties and guide the organism towards particular end states or goals (Weiner, 1972).

In summary, from the early 1900's, the explanation of motivated behaviour changed from innate sources such as instincts to physiologically initiated needs to a later addition of a cognitive component of evaluation and choice of goal. An affective component was recognized by McClelland and an active organism in continual interaction with the environment, by Woodworth (1958) in his behaviour-primacy theory (Deci, 1975). Another theorist who has elaborated on this belief of the human as an active organism and on the existence of intrinsically motivated behaviour is Robert White (1959) in his paper, "Motivation Reconsidered: The Concept of Competence".

The Concept of Effectance Motivation

Robert White (1959), who introduced the concepts of competence and effectance motivation challenged the traditional drive theory models of Hull as well as the psychoanalytic instinct theory of Freud. White's central argument was that "motivation needed to attain competence (which) cannot be wholly derived from sources of energy currently conceptualized as drives or instincts" (Harter, 1978a, p. 162). In voicing his discontent with traditional drive theories of motivation, he presented considerable evidence that such behaviours as exploration, curiosity, mastery, play and one's general attempt to deal competently with one's environment could not be adequately explained by the reduction of deficit motives, by secondary reinforcement, or by anxiety reduction (Harter, 1978a).

White defined competence as "an organism's capacity to interact effectively with its environment" (p. 162) and considered it necessary to treat competence as having a motivational aspect. White's ultimate purpose was to describe more fully the possible nature of the motivational aspect of competence. He, thus, proposed a new motivational construct which he labelled "effectance". He viewed this motive as one which impels the organism toward competence and is satisfied by a feeling of efficacy (Harter, 1978a). He considered this need to deal effectively with the environment as intrinsic, and one which when gratified produces inherent pleasure (Harter, 1978a). White (1959) stated, "Effectance motivation similarly aims for the feeling of efficacy, not the vitally important learning that come as its consequence" (p. 175).

According to White, effectance motivation is aroused by stimulus conditions which offer "difference-in-sameness". Interest wanes when action begins to have less effect and effectance motivation subsides when a situation has been explored to the point that it no longer presents new possibilities (White, 1959). White views effectance motivation as undifferentiated in the young child but later in life it becomes profitable to distinguish various specific motives such as cognizance, construction, mastery and achievement (White, 1959).

In developing his concept of motivation, White refers to Woodworth's (1958) behaviour-primacy theory and quotes from Woodworth that "a great deal of human behaviour appears to be directed toward producing effects upon the environment without immediate service to any aroused organic need" (White, 1959, p. 169). It is, thus, reasonable that White's concept of competence is similar to Woodworth's behaviour-primacy theory.

White's view of motivation has also been influenced by Jean Piaget (1952). Piaget's observations on young children and research animals pointed to the existence of a motive to explore, to be active, and to solve manipulative problems (Yarrow & Messer, 1983). Interestingly, although Piaget does not elaborate on the concept of motivation, the acknowledgement of the existence of such a behaviour determinant is implicit throughout his theory of cognitive development (Deci, 1975). The concept of adaptation central in Piagetian theory emphasizes the dynamic interaction between the infant and the environment (Yarrow & Messer, 1983). In commenting on Piaget's view, Yarrow and Messer (1983) point out that "the motivation to find out, explore and solve problems is inseparable from the cognitive process of achieving a better adaptation to reality. The disparity between the child's schemata and perceptions of reality is regarded as the source of motivation. The implication is that cognitive development is facilitated by an environment that provides an optimal level of disparity between the child's own schemata and the problems and events that the children encounter" (p. 453).

Although White presents a general concept of effectance motivation, he did not provide a theory, model or operational definition of effectance motivation. Among the researchers who have attempted to formulate a model of effectance motivation, Hunt (1963, 1965) outlines the processes that provide a bridge between White's views of competence in the human organism and the beginnings of mastery motivation in infancy. Hunt's views of intrinsic motivation are based mainly on Piaget's thinking and are also basically in accord with White's formulations. He emphasizes the existence of an intrinsic motivation to attend to people and objects, to learn about them through exploration, and to have an impact on them (Yarrow & Messer, 1983). He observed that when an infant has fully explored and mastered the stimuli available to him, interest wanes and he seeks situations of greater complexity (Yarrow & Messer, 1983).

Thus, White, Piaget and Hunt emphasize the infant's innate motivation to take an active role in his own environment. This interaction with the environment provides infants with knowledge about their world and their effect on it.

The broad conceptualizations of White's competence and effectance motivation have provided others with the opportunity to elaborate and further define this motivational construct (Matthews, 1986). Three others whose concepts are similar to White's include Wenar, Heckhausen, and Harter.

Wenar's (1976) concept of <u>executive competence</u> stems from White's definition of competence. Executive competence is seen in "toddlers ability to initiate and sustain locomotor, manipulative, and visually regarding activities at a given level of complexity and intensity, and with a given degree of self-sufficiency." (Wenar, 1976, p. 191).

Heckhausen (1981) has elaborated on a concept of achievement motivation that shares many similarities with effectance motivation. Heckhausen's achievement motive presupposes: 1) that individuals intend by their own activities, to produce an outcome that is evaluated according to some standard of excellence; 2) that there is a gradual differentiation of the internal attribution of competence into the concepts of ability and effort; and 3) that an action cannot be motivated by desires to achieve unless the outcome of the action is perceived to be influenced by internal factors (Matthews, 1986). While Wenar and Heckhausen have drawn from White's work in developing motivational theories similar to effectance motivation, it is Susan Harter who expanded on and attempted to operationalize White's concept of effectance motivation into a workable model.

Harter (1981) conceptualized White's basic model as follows: "effectance motivation impels the child to engage in mastery attempts. If these attempts are successful, that is, if they result in competent performance, the child experiences feelings of efficacy or inherent pleasure. This, in turn, should maintain, if not increase, the child's effectance motivation" (p. 216). Using this conceptualization, Harter proposed a general framework to examine the structure of effectance motivation and the content of the components across different developmental levels (Matthews, 1986).

Within this framework she considered various factors including 1) components of the motive system within a developmental framework, 2) the effects of failure and success on the components of effectance motivation, 3) refinement of the concept of intrinsic pleasure derived from success to include "optimal degree of challenge", (p. 217), 4) the rate of the socializing agents and various functions of rewards, 5) effects of reinforcement over time on the child's ability to internalize a self-reward system and set of mastery goals, 6) the relative strength of intrinsic versus extrinsic motivational orientation, and 7) the correlation of motivational constructs such as perceived competence or self-esteem with perception of control. A complete description of this model can be found in an earlier paper (Harter, 1978a).

More importantly, Harter also addressed the "feeling of efficacy or inherent pleasure" proposed by White (1959). In her model, Harter examines the change of affective states as an indicator of self-efficacy or inherent pleasure. Her model developed from her empirical work in the area in which she addressed the issue of pleasure derived from challenge.

Mastery Pleasure

Four dimensions of mastery motivation have been identified through past research. These include latency to task involvement, persistence, task completion and positive affect (Yarrow, 1981). The major concern of this study is positive affect. For further discussion of the first three of these dimensions, the reader is directed to various review papers (Yarrow & Messer, 1983; Morgan & Harmon, 1984; and Morgan, Harmon, Culp, & Jennings, 1984).

Positive affect, or as referred to more specifically in respect to mastery motivation, causality pleasure or mastery pleasure is experienced while engaged in or immediately following the successful completion of a task. Harter (1974, 1977, 1978, 1981), Yarrow and Messer (1983), and Luetkenhaus, Grossman and Grossman (1983) have identified smiling as a behavioural indicator of mastery achievement.

Harter conducted a series of studies of school-age children, focusing on positive affect associated with task performance and mastery motivation. In her earliest study (Harter, Thomas & Blum, 1971) she examined the relationship between the magnitude of smiling behaviour of children four and eight years of age and the correctness of their response on the Peabody Picture vocabulary test. Smiling responses were rated on a four-point scale used in previous humour research by Zigler, Levine and Gould, (1966), including (0) no response; (1) slight smile; (2) full smile; (3) laugh. A significant relationship between smiling behaviour and correct responses was found. Because children were not told whether they were correct or incorrect on any item, their tendency to smile to correct items could not be attributed to feedback received from the experimenter, but rather to their awareness of having answered correctly. Such smiling was interpreted by Harter as an indicator of a sense of mastery accompanied by a feeling of satisfaction and pleasure.

However, it should be noted that while there was a general tendency for smiling to accompany correct responses, there were obvious individual differences among the children. While some subjects smiled to virtually every correct item, others rarely smiled at all. Harter proposes that "one possible source of these differences is the children's orientation toward mastery. Children who have a greater need to be correct for the sake of being correct and who have a greater investment in successful performance, may be more likely to manifest the pleasure derived from such mastery by smiling" (p. 404).

In 1974, Harter examined the relationship between task difficulty and the pleasure derived from cognitive mastery among eleven-year-olds. An anagram task was chosen because the child must expend some effort in order to figure out the solution, and also since the difficulty dimension can be made relatively obvious. Difficulty level was defined in two ways: 1) the number of letters in the anagram and 2) the meaningfulness of the anagram, that is, whether it was a nonsensical arrangement of letters or actual words.

An additional purpose of the study was to assess the extent to which pleasure is primarily associated with the active discovery of the solution, as opposed to successful repetitions of the correct response after the problem is solved. Thus subjects were asked to repeat several of the anagrams they had solved correctly. The major index of pleasure was the smiling response employed in the previous study (Harter et al., 1971).

The findings of more frequent smiling on correct than on incorrect anagrams replicated those of the previous study (Harter et al., 1971) and provided further support for the general view that children derive pleasure from cognitive mastery of problem-solving tasks. However, the major finding was the positive relationship between smiling and the difficulty level among correctly solved anagrams, indicating that the greatest satisfaction is derived from the solution of the most challenging problems.

Clear support for the predicted decline in smiling with repetitions of correctly solved anagrams was also obtained. That this decline was not merely a fatigue or satiation effect was demonstrated by the reappearance of smiling when new and challenging anagrams were presented. These findings confirmed the hypothesis that mastery-related satisfaction is derived from actively solving an optimally challenging problem and not simply from the repetition or performance of correct responses.

However, post hoc inspection of the children's responses on the two previous studies, indicated that children who solved some of the most difficult items did not smile. Based on these observations Harter suggested that the previously hypothesized linear relationship between pleasure and challenge should be replaced by a curvilinear model. That is, mastery pleasure is most likely to be experienced upon the solution of a task that is optimally challenging. She investigated this hypothesis in two subsequent studies.

In 1977, Harter examined the degree of challenge and the differential characteristics of the mastery smile and social smile following a cognitively challenging task. The study included both normal first-grade children and MA-matched noninstitutionalized familial retarded children. The study included two reinforcement conditions, a social reinforcement condition in which the children were praised for competent performance and an experimenter-absent condition in which the experimenter was behind a one-way screen. Similar to the anagram study the degree of challenge was investigated by allowing children to choose one puzzle from four representing levels of difficulty ranging from extremely easy to very difficult. The findings indicated that normal children displayed more spontaneous smiling following their successes than did the retarded children, particularly in the experimenter-absent condition. Whereas, the retarded children tended to smile slightly more to the easier items. Furthermore, the magnitude of smiling was greater among both normal and mentally retarded children in the social reinforcement condition. Harter suggested that the mastery smile in the experimenter-absent condition was a purer form not confounded by adult reaction. She recommended that further research be directed toward distinguishing between the social and mastery components of the smiling response. Harter (1975) further postulated that there is considerable evidence that the efficacy of social reinforcement declines with age as children gradually internalize self-reward systems whereby they reinforce themselves and derive intrinsic pleasure from competent performance. However, though the mastery smile may decrease with age, the intrinsic pleasure does not decline; rather its means of expression changes.

In her second study of the hypothesis regarding optimally challenging tasks, Harter (1976) presented sixth graders with anagram problems at four difficulty levels. In the first phase the children were given anagrams at each of the four difficulty levels. In the second phase, they were permitted to choose anagrams from whichever difficulty level they preferred. A second variable included in this study was the type of reinforcement with some children working on the task for a school grade (extrinsic motivation) and others simply playing the game with no reinforcement (intrinsic motivation). She found that smiling peaked for those correctly solved anagrams rated as hard but dropped off sharply for those labeled as very hard. The findings also revealed, that preference for optimally challenging tasks is attenuated under conditions where children are working for extrinsic rewards in the form of grades. Children in the grades condition chose significantly easier anagrams than those in the game condition and manifested less pleasure as reflected in smiling to correctly solved anagrams.

Thus, Harter (1981) suggests that "with a sufficiently broad range of difficulty, a curvilinear model may best describe the relationship between the pleasure derived from success and difficulty level, thereby suggesting that the optimal challenge model holds promise for our understanding of the affective correlates of competent performance" (p. 243).

While Harter has examined affective states in school aged children, ranging from four to eight years of age, few studies have involved infants and toddlers. Motivation of infants and young children to master their environment has received much more theoretical than empirical attention.

Studies by Yarrow and his colleagues (e.g. Morgan, Harmon, Culp & Jennings, 1984; Messer, McCarthy, McQuiston, MacTurk, Yarrow & Vietze, 1986; Yarrow, Morgan, Jennings, Harmon & Gaiter, 1982; Yarrow & Messer, 1983) were the first systematic attempts to operationalize White's concept with infants. This group of researchers, who shared the view that there is an intrinsic motive to control the environment to master skills and to be effective, adapted the term <u>mastery motivation</u>. They operationally define mastery motivation as the amount of time engaged in task-directed behaviour during the presentation of a set of toys that pose optimally challenging problems to be solved or completed (Morgan & Harmon, 1984; Yarrow, McQuiston, MacTurk, McCarthy, Klein & Vietze, 1983).

Yarrow and Messer (1983) observed younger children's responses to successful completion of a task and further, observed the child's affective responses during task involvement. During task involvement, the child's responses were predominantly neutral except for a small portion (25%) who expressed some negative affect. Following task completion they found no significant positive affect, which varies from Harter's research with older children. They concluded "that although pleasure derived from a sense of mastery may be associated with smiling after successfully completing a task, the expression of pleasure is probably not an especially sensitive measure of a motive for mastery. Many factors influence smiling, thus obscuring the relationship between mastery and the expression of pleasure. Moreover, this method can assess only the presence or absence of smiling, not the degree of pleasure experienced" (Yarrow & Messer, 1983, p. 459).

Other early studies of mastery motivation in which the smiling response was used as an index of mastery motivation are reviewed by Morgan, Harmon, Culp and Jennings (1984). In the first study, which included 44 infants, 12 to 13 1/2 months of age, the general affective state of the child while working at a task was rated on a 5-point scale. Contrary to Harter's findings, they observed few instances of positive or negative affect during or after completion of the mastery tasks. On 8 of the 11 tasks, the predominant expression was neutral. Morgan and Harmon (1984) concluded that it would have been desirable to record specific instances of positive affect during and immediately following the solution of a task rather than rate general affect during the whole task.

Subsequently, in a longitudinal study, Morgan, Bush, and Culp (Morgan, Harmon, Culp & Jennings, 1984) tested 21 children 9, 12 and 25 months of age. Causality pleasure was scored when positive affect was expressed immediately after the task solution. They found that children who at 12 months showed continuity or persistance at tasks during free play and who were high on causality pleasure had been positively responsive to their mother's interactions at 9 months. Mothers of these high causality pleasure infants played with them often at 9 months and at both 9 and 12 months said they did a variety of cognitively enriching play with them. Though the relationship between variety of maternal play and mastery motivation is important, the objective of the present study is to examine the characteristics of facial expression associated with mastery motivation. Mother-child interactions in relation to mastery motivation and causality or mastery pleasure are addressed by Fung (1984).

Similar to Harter's observation of the need to distinguish between the social and the mastery pleasure smile, Leutkenhaus, Grossman and Grossman (1983) reported that among three-year-old children, a further variable involved in affective responses is eye contact with an adult. Such eye contact conveys emotional and communicative meaning. Facial expressions involving eye contact communicate meaning which in turn may initiate social interaction. Among three-year-olds who succeeded or failed on a task Leutkenhaus et al. (1983)

observed reliable differences in facial expression with and without eye contact. Without eye contact the children's facial expression seemed to reflect their emotional reaction to the action outcome: a positive feeling after success indicated by smiling and a negative feeling immediately after failure expressed by a sad face. With eye contact, the children's smiling seemed to have a communicative function and to regulate the interaction. The eye contact from the adult may also affect the children's response and encourage them to mask their emotional state. Molnar and Weisz (1981) suggest that children who are more likely to smile if an adult is present may be revealing a need for approval.

In the past decade a number of developmental psychologists have supported the idea that the emotions and their expressive or social signals play a key role in the growth of the infant and in the organization of the infant's behavioural systems (Emde, Gaenbauer & Harmon, 1976; Izard, 1978; Spitz, 1965; Sroufe, 1979; Izard & Dougherty, 1982). The communicative, social interaction function of facial expression has been examined by many investigators (Leutkenhaus et al., 1983; Campos, 1983; Emde, Kligman, Reich & Wade, 1978; Fuenzalida, Emde, Pannabecker, & Stenberg, 1981; Sorce & Emde, 1982). Although these communicative and social aspects of cues provided by facial expression merit attention, social signalling and the social smile are not of concern in the present study. Rather, the intent is to focus specifically on the child's facial expression while involved in and completing a task. Despite the fact that smiling has not been reported as a reliable indicator of the hypothesized feeling of efficacy associated with the completion of optimally challenging tasks, mastery pleasure continues to be considered an important measure of mastery motivation. Thus, systematic observation and a detailed description of facial expression during and following involvement in mastery motivation tasks is warranted.

Measures of Facial Expression

Facial expression has for many years been recognized as a major component in individuals' signalling systems and non-verbal communication especially during early childhood. Nearly a century ago Charles Darwin laid the foundation for theory and research on the facial patterns of humans (Izard, 1971). Through his observations of children, adults, the insane, animals and people of different cultures, Darwin influenced much of the present day research on facial expression. Since his time, several investigators, including N. Blurton Jones, Paul Ekman and Carroll Izard, have conducted studies and confirmed the original concepts set forth by Darwin.

In his classic work, The Expressions of Emotions in Man and Animals, Darwin (1872), placed almost exclusive emphasis on the expressive aspect of emotions. He saw emotional expressions as "the first means of communication between the mother and her infant" (p. 365) and noted that "the language of the emotions, as it has sometimes been called, is certainly important for the welfare of manhood" (p. 367)(Izard, 1982).

The majority of Darwin's observations of facial expression were of infants, in particular his own children (Sherer & Ekman, 1982). An exhaustive catalogue of each of Darwin's infant observations has been published in the Mind paper (Darwin, 1877). In this seminal work, he also introduced the first systematic analysis of facial expression and identified major problems that arise when attempting to judge emotions from expressive behaviour. He described at least seven common emotional states which are accompanied by distinctive facial expressions. He also noted, as is evident with anger, that the situation that elicits the emotion affects the specific expression of it.

Since Darwin, most methods used in research on emotions have relied heavily on the subjective impressions of observers to describe and quantify facial expressions. However, as pointed out by Rinn (1984), there are several problems with this approach. Among them is the fact that constructs such as "happiness" and "intensity" of emotion refer to internal states that are not directly observable. Consequently, subjective inferences about the internal states of others can easily become influenced by the idiosyncracies of the raters and their relation to the other person. To reduce such rater bias, researchers define coding categories but often it is still not clear that all raters involved in a study were using the same criteria for arriving at their judgments. Rinn believes that, although the findings of studies using such methods were by no means invalid, such methods added substantially to error variance and made statistically significant findings more difficult to obtain.

The lack of systematic and standardized ways of describing and measuring facial expression and the lack of uniform rules of inference which would link expressions to emotional or cognitive states (Ekman, 1973) has, until recently, made it virtually impossible to generalize across studies. Though research concerning discrete categories of facial expression of emotion had its origin in Darwin's classic paper (1872/1904) it was not revived until Tomkin's (1962, 1963) theoretical and empirical work on affect. His broadly based theory provided impetus for the approach taken by Ekman (1975) and Izard (1972). All three recognized the importance of the face in the communication of affect and emphasized the need to obtain good records of facial expressions. They did not assume that facial expressions were the only indicator of affective states, but among young children they believed that facial expressions represented the primary and most precise indicator of affective states (Demos, 1982).

The development of objective measures of facial expression has come about mainly through a de-emphasis on inferring the "meaning" of the expression and an increased emphasis on direct description. Rinn (1984) notes that one can objectively describe facial expressions by simply listing the position and movements of various facial landmarks without regard to the semantic or emotional meaning expressed.

The measurement system described by Blurton Jones (1971) illustrates this approach. Among ethologists, Blurton Jones was most explicit in considering the anatomical basis for facial actions. Working with 500 photos of almost 50 different children ranging from 2 to 5 years of age, Blurton Jones arrived at 52 components of facial expressions from which the morphology of expressions could be described (Ekman, 1973). In this system the facial expression is divided into nine anatomical components (e.g., brow position, mouth shape, lip position, eye openness, tongue position, eye direction, lip separation, teeth showing and other miscellaneous). For each component, a choice of descriptors is provided for the rater. For eye openness, for example, the choices are (a) wide, (b) bit wide, (c) normal, (d) bit narrow, (e) very narrow, and (f) upper lid down.

Brannigan and Humphries (1972) developed a coding system for facial expression which included codes similar to those of Blurton Jones but organized into groupings that relate to facial and body regions. The facial regions included are mouth, eyebrow, eye and eyelids, and gaze direction.

In their critical reviews of previous work on the accuracy of judgments of adult facial expression of emotion Izard (1971) and Ekman, Friesen and Ellsworth (1972) noted striking consistencies in the experimental literature that previously had been unappreciated (Emde, Kligman, Reich, & Wade, 1978). Ekman found that in rating emotional states from posed facial expressions most judges used the total configuration. In contrast, the approach of Izard (1971, 1972) and Ekman and Friesen (1975) was to spell out specific facial movements involved in each pattern of emotion. This led to each developing a separate system to specify and score facial expressions.

On the assumption that the expression of emotion includes organized patterns of facial muscle activity, both Izard and Ekman attempted to objectively describe facial expression in terms of the particular facial muscles that produced it. Each, however, developed a different technique to record muscular movements. Ekman used an anatomically comprehensive system in which all muscle movements are coded individually, whereas Izard uses a template-based system in which users identify an emotion by examining the full-faced patterns of muscle movements. The differences in these techniques are due to their purposes and procedures for obtaining reliability. Ekman and Friesen (1975) attempted to determine all the actions the anatomy allows by systematically exploring the activity of each single muscle in an effort to include all the possible appearance changes that the muscles can produce. Izard, on the other hand, selected only movements that he judged relevant to emotion (Ekman, 1982).

The technique developed by Ekman and Friesen (1978), which is known as the Facial Action Coding System (FACS), is designed to record twenty-four discrete actions, twenty complex actions and fourteen different head-eye positions. The FACS is a catalog of all perceptible "action units" (AUs) that the face is capable of producing and the muscular basis of these AUs. Action units are discrete movements of some part of the face, e.g., action unit 5 (AU5) = upper eyelids raised; AU4 = brows lowered and drawn together. Au's are defined strictly in terms of observable movements of the facial skin (see Ekman & Friesen, 1976, for the development of FACS).

Oster (1978) has adapted the FACS in research involving videotaped play sessions between infants and their parents. Although she observed many different expressions, she analyzed her data only in regard to smile and brow knitting. Her results indicated that the adult-based FACS could successfully detect these expressive behaviours in infants (Izard & Dougherty, 1982). Although the FACS provides detailed specification of facial expression, the one disadvantage of the procedure is that it is very time-consuming.

The other muscularly based facial coding system is Izard's (1979) Maximally Discriminative Facial Movement Coding System (MAX). Unlike the FACS, the MAX is not a comprehensive catalog of all possible facial movements. Malatesta and Haviland (1986) explain that "MAX is a theoretically based, anatomically linked, facial movement coding system designed to identify fundamental emotions and blends, based on coding movements in three regions of the face" (p. 53). MAX allows users to identify twenty-seven distinct components or patterns that may be organized to specify particular emotions. Six codes refer to muscle configurations in the brow region, eight codes to changes in the eyes-nose-cheek region and thirteen codes to changes in the mouth-lips region. Three additional codes are reserved for nonscorable, obscured, and resting position categories. To maintain objectivity, the three regions of the face are coded separately. The MAX manual describes nine fundamental emotional expressions in terms of appearance changes detectable by the MAX. These include interest, joy, surprise, sadness, anger, disgust, contempt, fear and the motive state of physical distress or pain (Malatesta & Haviland, 1986). For example, the co-occurrence of "cheeks raised" (Code 38) and "corners of mouth pulled back and slightly up"

(Code 52) together constitute an expression of joy or enjoyment (Lamb, 1987).

Although somewhat less detailed than the FACS, the MAX is easier to use and may be preferred when one is interested particularly in examining emotion-based facial movements. Lamb (1987) contends that the "advantage of the MAX system is that it allows the investigator to specify unambiguously when a particular emotion is being expressed" (p. 311) and that it is designed specifically for use with infants. Rinn (1984) acknowledges that for the study of nonemotional facial movements, or when a highly detailed description of facial behaviour is desired, a more comprehensive system such as the FACS is required.

Thus, a number of techniques have been developed that permit the recording and evaluation of facial expressions in young children.

Statement of Problem

Among the studies of mastery motivation, a number have included a measure of mastery pleasure which is inferred from the smile. In addition to children's smiling upon completion of a task, it is also reported that a curvilinear relationship has been observed between the degree of difficulty of the task and smiling; that mentally retarded children smile less frequently; and that preference for optimally challenging tasks is attenuated, and less pleasure is manifested, under conditions where children are working for extrinsic rewards in the form of grades. However, all authors caution that there is considerable variability among children in their smiling during or after completion of a task. Moreover, conclusive evidence supporting the concept of mastery pleasure as an index of mastery motivation has not yet been documented.

Several factors may account for these inconclusive findings. One such factor is the lack of distinction between social smile which is accompanied by eye contact with another person and the facial expression of pleasure associated with completing a task. A second factor is the breadth of the categories for rating facial expression. The complexity and subtleness of changes in facial expression cannot be captured by broadly defined categories such as those frequently used in past research. A third factor is the failure to distinguish between facial expression while working at a task and following the completion of the task.

In the present study the focus is on the facial expression of toddlers associated with the completion of a task. A component approach to the measurement of facial expression based on Izard (1972), Blurton Jones (1972), and Brannigan and Humphries (1972) was developed. The objective is to systematically examine the facial expression of toddlers as they work at and accomplish the goal on mastery motivation tasks.

The null hypotheses of this study are:

1) The facial expression of a toddler does not change following the achievement of a goal.

2) There is no difference in facial expression following the achievement of an easy or difficult task.

As well, the following questions will be asked:

a) Is there a relationship between the latency to onset of change in facial expression and the level of competence?

b) Is there a relationship between the type of facial expression shown by a child completing a task and the child's level of competence?

CHAPTER II

Method

Subjects

The children in this study were 36 normal toddlers, 18 boys and 18 girls, who were tested within two weeks of their 18 month birthday ($\underline{M}$ = 18 months, $\underline{SD}$ = 9.4 days). The children were obtained through a referral system. Parents of children attending the Child Development Laboratories and Nursery School of the Department of Family Studies, University of Manitoba and individuals associated with the faculty and students were asked whether they or friends of theirs had toddlers of the required age who might be interested in participating in this project. Seven subjects were obtained through the Province of Manitoba Day Care Services, Family Day Care Providers Branch. Telephone contact was made with those interested and a covering letter and consent form were mailed to the parents (Appendix A).

Children included in this study were generally from middle to upper middle income families of the metropolitan area. Two of the 36 children were from single-parent families and three of the children had English as their second language. These children were tested by two of the three examiners who were bilingual in the respective children's first language.

Testing Materials

Mastery Motivation Apparatus

The basic apparatus used for all three tasks was a box (34.5 x 34.5 x 11.5 cm) with an automatic feedback mechanism designed to release in a manner similar to a jack-in-the-box (Brockman, 1977)(Appendix B). Templates corresponding to tasks and increasing in complexity within tasks could be inserted into the apparatus. Upon completion of a template, a toy was automatically released from the covered latch located at the centre top of the task box relative to the child's position. This enabled the child to recognize when the end of the trial had been achieved.

Mastery Motivation Tasks

The three mastery motivation tasks were each designed to measure a single ability at increasing levels of difficulty, namely problem solving (mazes), fine motor ability (pegs) and form discrimination (forms).

Mazes. The maze task was a downward adaption of Brockman's slotted mazes (1977) and consisted of six interchangeable templates and a non-removable stylus (Appendix B, Figure 1 for maze patterns). The results of the Brockman study indicated that the additional templates with less complex mazes were needed for 18-month-olds. Additional templates were designed to include a half-Y-turn, Y-turn, and T-turn, as well as the original straight alley (training template) and mazes with 2- and 5-choice points (Appendix B). When the child had guided the stylus through the maze to the marked goal, a toy was released from the covered hatch.

Pegs. The templates for the peg task were designed relative to the developmental sequences commonly included in infant developmental tests and consisted of five interchangeable templates representing increasing difficulty. The template sequence was one large round hole (2.5 cm, training template), three round holes (2.5 cm), six round holes (1 cm), six square holes (1 cm) and six rectangular holes (1 x 3 cm)(Appendix B, Figure 2). When all the pegs for a template had been placed into the holes, the hatch was automatically released for the toy to appear.

Forms. The templates for the form discrimination task were also designed based on the developmental sequences included in infant developmental tests and consisted of a sequence of five templates with an increasing number and difficulty of forms. Corresponding three-dimensional forms could be dropped into the appropriate holes in the templates (Appendix B, Figure 3). The first template (training) consisted of one round hole into which a 2.5 cm cylinder could be dropped. For each successive template, an additional form of equal surface area as the cylinder was included in the following order: square, triangle, ellipse and rectangle. The template of the highest level of difficulty included all five forms. When all the forms for a template had been placed into the holes, the hatch was automatically released for the toy to appear.

Procedure

Upon receiving the signed consent forms, parents were contacted by telephone to arrange appointments for a home and lab visit.

Home Visit

An examiner and assistant visited the child's home not less than one day and not more than four days before the lab visit to familiarize the child with the examiner and to administer a Development Test and two questionnaires, needed for the larger study[1] (Fung, 1984; Matthews, 1986).

Lab Visit

The mother and child were greeted at the entrance of the testing room in the Department of Family Studies at the University of Manitoba. Upon entering the testing room, the child was given a warm-up toy and seated at a child-sized table. The examiner sat in front and to the left-hand side of the child, and the mother sat behind and to the right side of the child. The general procedure was then described to the mother. The mother was asked to redirect the child back to the task if the child turned to her during the session. The entire lab session was videotaped.

The order of presentation of the three mastery tasks was counter-balanced across subjects within the experimental and control groups (Appendix C). Subjects were randomly assigned to the order of presentation of the tasks and the examiners were also randomly assigned to test the children. If a child refused a task, the next task was presented and the refused task was re-

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[1] The Bayley Scales of Infant Development (BSID), the Mother's Observation of Mastery Motivation (MOMM), and Toy Referent Questionnaire.

presented as the last task. This occurred once, when a child refused the maze task.

The template sequences in all three tasks were from least to most complex. At the beginning of each task, the examiner gave at least one demonstration of the training template and then asked the child to try. The child was then given a minimum of two training trials. Following the training template a child was given two trials per template until the child went off-task for a minimum of three seconds. Only one prompt was given each time a child went off-task. A camera person, seated behind a curtain and out of sight of the child was monitoring the off-task times and signalling them to the examiner. If a child simply glanced at the examiner, the examiner responded with a neutral expression or reciprocated the child's smile. If the child turned to the mother, she responded with a verbal cue as she had been instructed at the beginning of the session, i.e., "You can do some more" or "Find the cow". If the child went off-task for a minimum of three seconds or maintained eye contact with the examiner for three seconds, a verbal prompt was given "Where's the cow?". When the child went off-task a second time for at least three seconds, the task was considered terminated for this study (Fung, 1984; Matthews, 1986).

Upon completion of the tasks, the mother and child were invited to view the videotape. The examiner and camera assistant thanked the mother and child for their participation and offered to send a copy of the summary of results upon completion of the study.

Observational Instrument

The observational instrument includes the specification of the episode from which facial expression would be transcribed and the codes for rating facial components.

Episode Sampling

On each trial an episode was identified on videotape by the opening of the hatch at the point that the child completed the trial. Specifically, the still frame in which the lid of the hatch was open to a 45 degree angle was considered the pivotal frame containing the event. From this pivotal frame, three still frames located at 0.5 s intervals before the event were defined as baseline. Subsequent to the event, ratings at every 0.5 s still frame were obtained until five frames beyond the onset of change in facial expression (Figure 1). Onset of change was defined as the point at which changes occurred in two of the three facial regions (See Codes for Facial Components).

```
                               Episode

Baseline           Event   Onset
0.5   0.5   0.5      |       |       0.5   0.5   0.5    0.5    0.5
 |     |     |       |       |        |     |     |      |      |
 |     |     |       |       |        |     |     |      |      |
3 frames at          |       |       5 frames subsequent to the
0.5 second           |       |       onset
intervals            |       |
prior to the         |       |
event               lid    change in two of the
                  opening  three facial regions
                   at 45
                   angle
```

Figure 1. Time line for an episode.

Codes for Facial Components

Definitions for facial components and the codes for the rating scales within components were derived and adapted from the systems developed by Blurton Jones (1972), Izard (1972), and Brannigan and Humphries (1972). The resulting set included eight facial components from three regions: the brow (position and form), the eye (openness and direction of gaze), and the mouth (line of lips, corners of mouth, openness of mouth, amount of teeth visible). Six of these components were rated on a five-point scale and two on a three-point scale. Definitions of the respective scale-point ratings are included in Figure 2.

To provide greater accuracy and consistency in the interpretation of the verbal definition, each definition was illustrated. These illustrations were based on the rating definitions and a set of full-faced photographs of toddlers.[2] (Figure 2).

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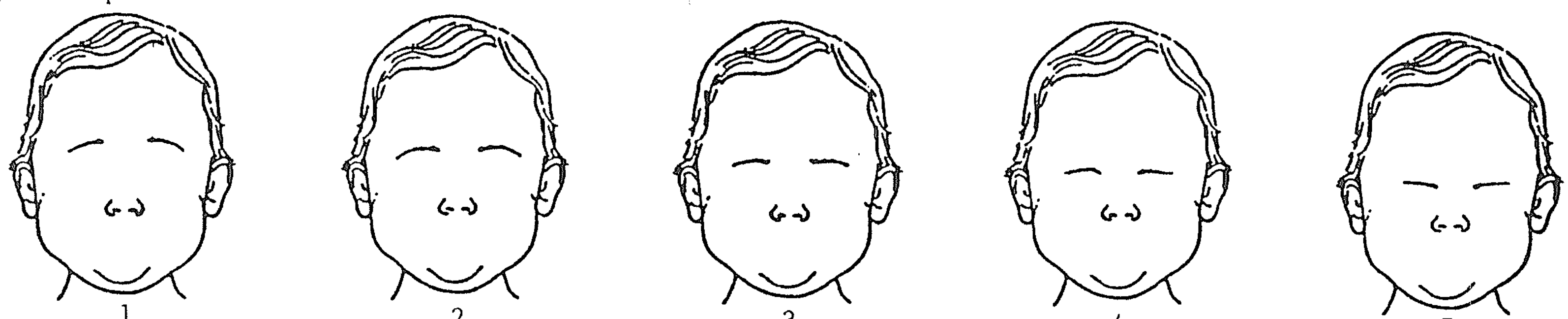
[2] The author extends appreciation to Doug Matthews for the illustrations.

Figure 2a.

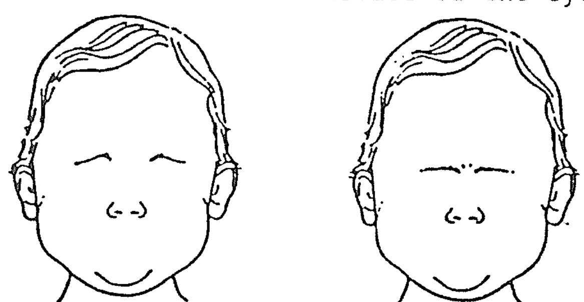
Codes for facial components: (a) eyebrow position, (b) qualitative characteristics of the eyebrow, (c) eye openness, (d) direction of gaze, (e) line of the lip, (f) qualitative characteristics of the lip, (g) mouth openness, (h) qualitative characteristic of the mouth.

(a) Eyebrow position



Code:	1	2	3	4	5
	raised very high	raised slightly higher than the neutral position	neutral or resting position	slightly lowered	drawn low against upper eyelids

(b) Qualitative characteristics of the eyebrow

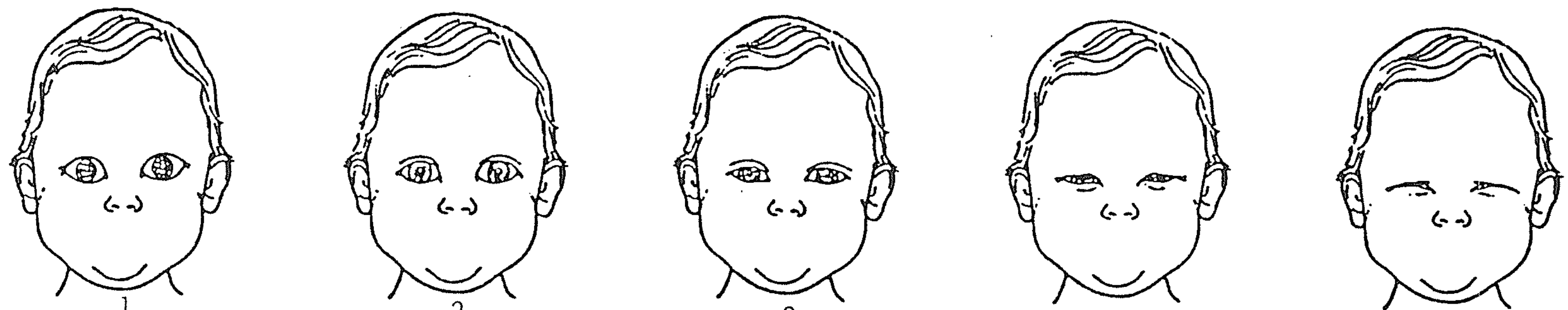


Code:	1	2	3
	inner ends are kinked and slightly lifted, outer ends are lowered	drawn to mid-line	does not occur

...Continued

Figure 2b.

(c) Eye openness



Code:	1	2	3	4	5
	wide open exposing large area of eyeball	open slightly more than the neutral position	neutral position	slightly narrowed	drawn partly together narrowing the area of the eyeball invisible. Eye area appears tense.

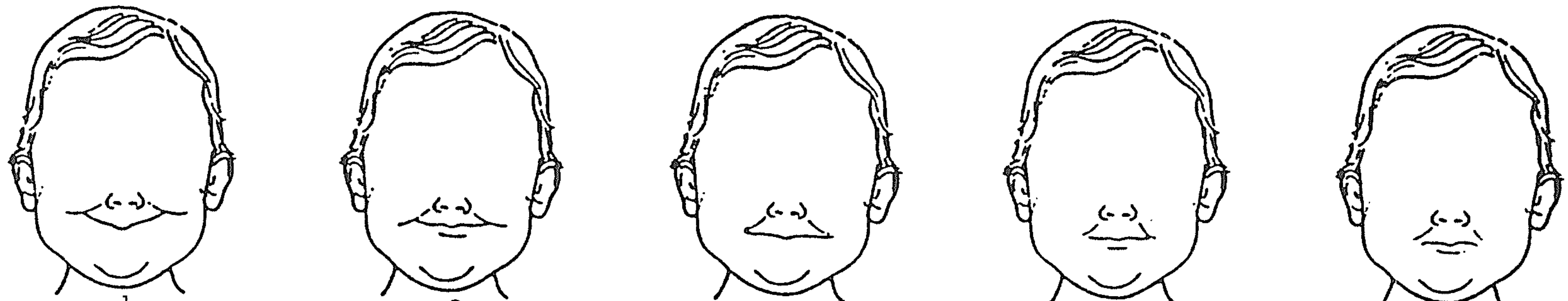
(d) Direction of gaze

Code:	1	2	3	4	5
	to mother	to examiner	to task	to goal	other (e.g. lights, curtains, fan).

...Continued

Figure 2c.

(e) Line of the lip



Code:

1 corners are drawn & lifted or pointed upward

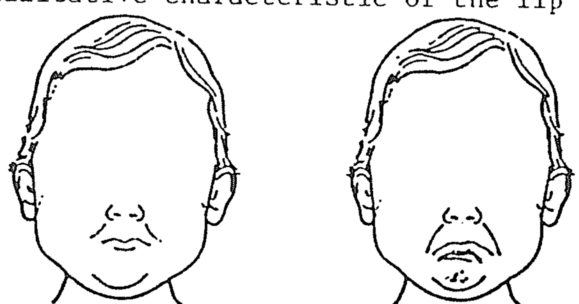
2 corners are drawn upward slightly

3 corners are drawn back but not lifted

4 corners remain in a neutral position

5 corners are drawn down

(f) Qualitative characteristic of the lip



Code:

1 corners moved in toward center but without noticeable compression or protrusion of lips

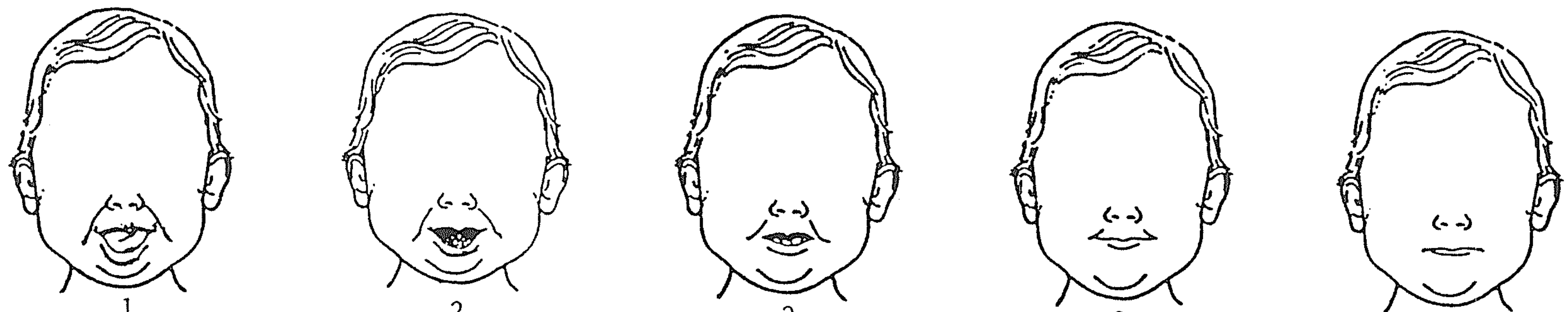
2 corners are drawn and lower lip is out (the chin sometimes acquiring a crumpled appearance).

3 does not occur

...Continued

Figure 2d.

(g) Mouth openness



Code:

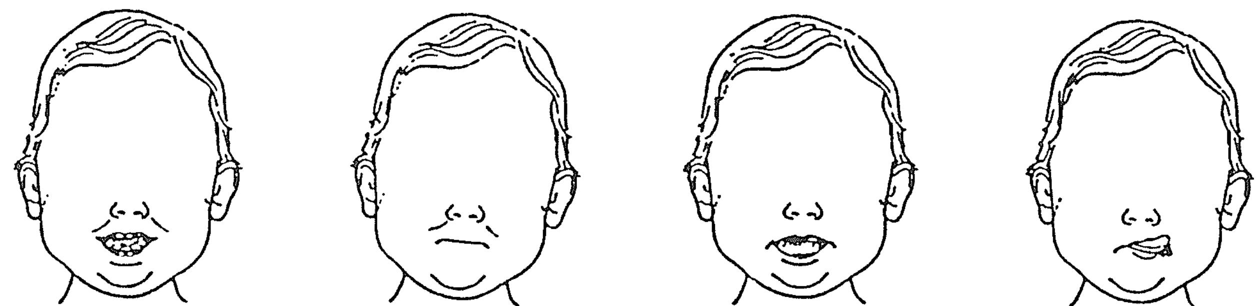
1 open widely

2 open slightly more than neutral position

3. / 3 Mouth closed or slightly open in a relaxed position

4 lips tightly compressed

(h) Qualitative characteristic of the mouth



Code:

1 lips parted to reveal upper &/or lower teeth

2 lips compressed & drawn making them barely visible

3 mouth open revealing tongue

4 tongue sticking out

5 does not occur

Data Transcription

Prior to coding the components, a segment of videotape was viewed in order to determine the child's neutral or natural facial component positions, e.g., neutral eye openness position. The judgments were then made relative to this neutral position. Two enlarged poster-size coding cards with definitions and illustrations of components as shown in Figure 2 were displayed beside the video screen to assist in the coding. The latency to onset of change in facial expression was also coded, i.e. the number of units or half second time frames until a change in two of the three facial regions occurred (Onset)(See Appendix D for code sheet).

CHAPTER III

Results

The objective of this study was to investigate whether there are distinctive changes in the facial response of infants when they achieved a goal after working at a challenging task. If there are such changes, a further interest was whether there are differences in the facial response following an easy or a difficult task. To test these hypotheses, ratings of individual components of facial expression were obtained, and tested separately for changes from working on the task (baseline) to following task completion. Though this type of analytic approach had been used to describe emotions in adults, it has not been used with toddlers in a task situation. Therefore, before presenting the results for the hypotheses, the procedure for data reduction is described.

Data Reduction

Reliability of Coding

Interobserver reliability of ratings for each of the components was taken from the videotapes of nine subjects, on each of 4 randomly chosen trials (Appendix E). The interobserver reliability ranges from 93% (line of lip) to 98% (direction of gaze). The intraobserver reliability compared the coder's original ratings on 9 subjects with a second rating taken at the end of the data transcription. The Intraobserver reliability ranges from 72% (openness of eye) to 92% (direction of gaze).

Number of Trials Completed on Tasks

The purpose of this study is to capture the expression of a child presented with a challenging task which increases in difficulty. Though three tasks (Maze, Peg, Form) were presented, only 39 percent of children completed the second template or four trials on the form task (Table 1). Because facial expression in response to completion of the second template was needed to examine the effect of difficulty, the form task was not included in the analysis.

TABLE 1.
PERCENTAGE OF SUBJECTS WHO COMPLETED EACH TRIAL ON EACH TEMPLATE FOR MAZE, PEG AND FORM TASKS

Template	I		II		III		IV		V		VI	
Trial	1	2	1	2	1	2	1	2	1	2	1	2
Maze	100	100	92	89	75	56	39	31	11	6	3	3
Peg	100	100	92	86	81	64	36	19	3	0	NG	
Form	100	97	58	39	17	11	.06	.03	0	0	NG	

NOTE: NG = Template not given

Uncodeable and Nonoccurring Responses

Whenever it was not possible to accurately code a facial component because of the lighting or the position of the head, the component was rated uncodeable. Examination of the data indicated a high frequency of uncodeables in the eyebrow region (Appendix F) and, therefore, the two eyebrow components (Position of Eyebrow and Qualitative Characteristics of Eyebrow) were excluded from the data analysis.

Furthermore, the modal rating for some components was "did not occur" (Appendix G). These ratings were obtained from the qualitative aspects for each of the eyebrow, lip and mouth with average percentages of 99, 98 and 81 respectively. Therefore, these components were also excluded from the analysis.

Latency to Onset

The mean latency to onset of change in facial expression summed across all four trials is .59 seconds with S.D. = .72 (Figure 3, Appendix H). The latency to onset of change on the maze task diminishes in the first three trials but increases with the final trial. On the peg task this latency increases slightly on the second trial of each template. This mean latency to onset was

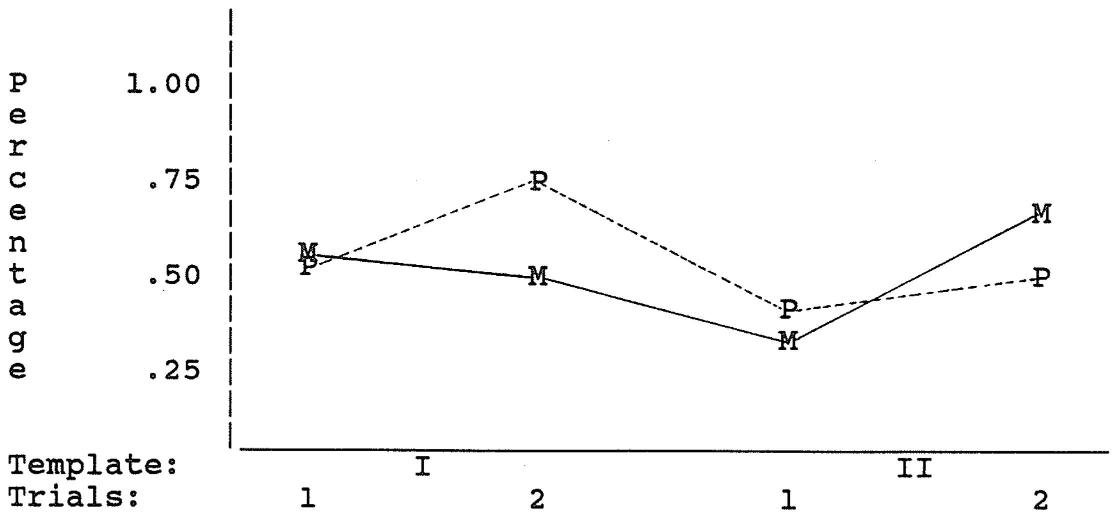


Figure 3. **Latency to onset of changes in facial expression for each of maze (M) and peg (P) tasks.**

based on the number of subjects who did show an onset point. If an onset was not shown on a trial, i.e., if there was not a change in two of the three facial regions, that trial was not included in the analysis (Table 2). The percentage of trials on which an onset point was not shown ranged from 6.9 to 18.1 percent.

TABLE 2.
PERCENTAGE OF TIMES AN ONSET WAS NOT SHOWN SUMMED ACROSS TASKS (72 TRIALS)

Templates	I 12.5		II 14.6	
Trials	1	2	1	2
Percentage	18.1	6.9	15.3	13.9

Direction of Gaze

A further reduction of the data set resulted from a change in the child's direction of gaze, from being focussed on the task to something else in the room, before the last time sample of the episode. The time frame(s) in which the direction of gaze was not focussed at the task were coded as "change of focus", and were also not included in the data analysis because the expression was not directly related to working at the task (Appendix I).

The Data Set

Given that the trials of some subjects were excluded because of lack of onset, change of focus or uncodeable components as described above, it was decided that the analysis would be done on the templates in which at least 86% of subjects had successfully completed the trials on a template. It is also for this reason that the episodes examined were limited to Trials 1 and 2 of Templates I and II (Table 1).

Therefore, the facial components which are examined are openness of eye, line of lip, openness of mouth and the direction of gaze for each of Templates I and II, trials 1 and 2 for both the maze and peg tasks.

The maze and peg mastery motivation tasks both increased in difficulty from Template I to Template II. The data from the maze and peg tasks were, therefore, collapsed across templates and trials.

Changes in Facial Expression

Given the data set described, changes in the facial expression of children over the defined episode were examined. Differences between baseline and each of event (E), Onset (O) and the five subsequent .5 s intervals (AO1, AO2, AO3, AO4, AO5) were tested using the Pearson Chi square test of homogeneity of proportions (Appendix J).

The modal ratings for eye openness, line of lip and mouth openness are shown in the line graph of Figures 4, 5 and 6 respectively. Also shown in the bar graph of these figures is the percentage of children who continued to show the rating observed at baseline through to the end of Onset Five (AO5). (The corresponding frequencies are included in Appendix J.) The Chi square statistics between baseline and each of event, onset and the five time samplings following onset for each facial component are presented in Table 3.

Openness of Eye

On trial 1 of Template I changes occur in the openness of eye 1.5 s following Onset (AO3). The eye then narrows slightly, X^2 (1,1) = 16.28, p = < .01, and remains narrowed for the remaining one second. In the following three trials (Trial 2 of Template I and both trials of Template II) the eye is already narrowed at onset (O), X^2 (1,1) = 34.82, p = < .01 (Template I, trial 2), X^2 (1,1) = 41.17, p = .01 (Template II, trial 1), X^2 (1,1) = 46.33, p = < .01 (Template II, trial 3), and remains in this position for the remaining 2.5 seconds of each episode. Therefore, the change in eye openness from baseline was a slight narrowing which occurred one second delayed on the first trial.

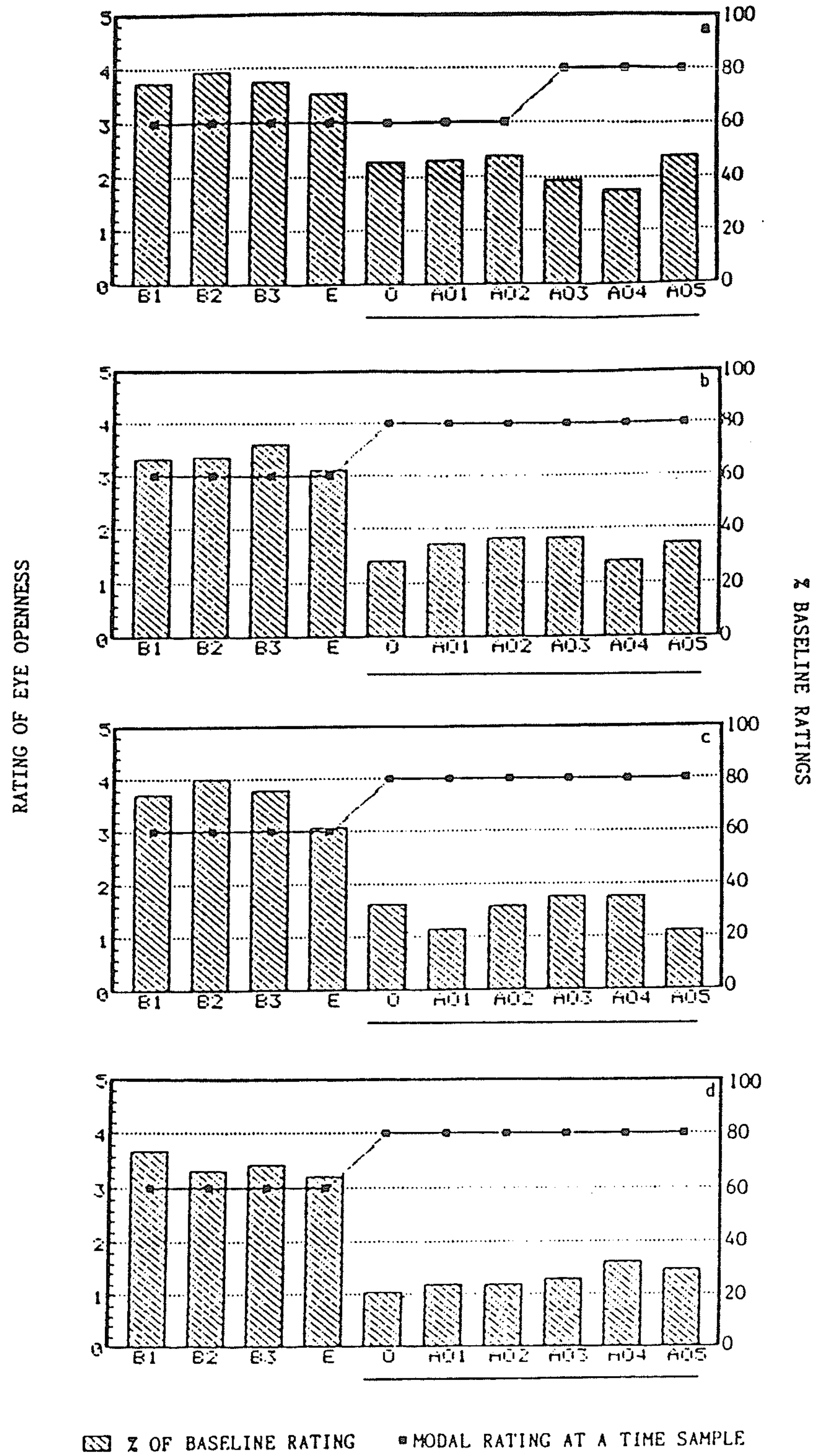


Figure 4 . Modal rating of eye openness during baseline (B1, B2, & B3) following achievement of the goal (E), at onset (O), and at each subsequent .5 second interval (A01, A02, A03, A04, & A05) for (a) template 1, trial 1, (b) template 1, trial 2, (c) template 2, trial 1, and (d) template 2, trial 2. Percentage of children whose eye openness rating changed from baseline (B1, B2, & B3) is indicated a solid line (——) for *p* < .01.

TABLE 3.

Chi square statistic between baseline and each of Event (E), Onset (O), and at each subsequent .5 s interval (AO1, AO2, AO3, AO4, AO5) for each trial on each template for Openness of Eye, Line of Lip and Openness of Mouth.

OPENNESS OF EYE (Component 3)

Template	Trial		E	Onset	AO1	AO2	AO3	AO4	AO5
I	1	$\underline{N}$	72	59	58	52	44	34	29
		X^2	.89	20.63**	19.41**	16.28**	24.18**	24.00**	10.27**
	2	$\underline{N}$	72	67	66	62	52	39	29
		X^2	1.05	34.82**	24.66**	20.59**	18.81**	23.45**	13.36**
II	1	$\underline{N}$	71	61	60	57	51	40	31
		X^2	5.91	41.17**	58.32**	41.39**	32.75**	27.93**	37.58**
	2	$\underline{N}$	65	62	62	58	50	43	34
		X^2	.63	46.33**	40.66**	38.88**	32.26**	21.14**	20.59**

* $\underline{p} < .05$
** $\underline{p} < .01$

Table 3 (Continued)

LINE OF LIP (Component 5)

Template	Trial		E	Onset	AO1	AO2	AO3	AO4	AO5
I	1	*N*	68	58	57	51	43	34	28
		X^2	.25	15.30**	20.16**	20.32**	20.73**	20.20**	24.53**
	2	*N*	68	67	66	61	52	39	29
		X^2	.71	36.90**	40.77**	42.64**	39.44**	43.83**	23.75**
II	1	*N*	67	61	60	56	51	40	31
		X^2	.01	20.83**	19.64**	30.58**	31.60**	32.82**	24.13**
	2	*N*	59	62	62	58	50	44	34
		X^2	1.02	20.43**	22.40**	31.85**	25.66**	23.92**	22.71**

* $p < .05$
** $p < .01$

Table 3 (Continued)

OPENNESS OF MOUTH (Component 7)

Template	Trial		E	Onset	AO1	AO2	AO3	AO4	AO5
I	1	*N*	68	58	57	51	43	34	28
		X^2	2.26	18.20**	28.82**	23.77**	20.20**	14.18**	10.74**
	2	*N*	68	67	66	61	52	39	29
		X^2	2.71	13.18**	29.98**	20.67**	12.40**	10.22**	7.88**
II	1	*N*	67	61	60	56	51	40	31
		X^2	.05	27.00**	32.96**	27.33**	11.94**	13.84**	9.74**
	2	*N*	59	62	62	58	50	44	34
		X^2	.07	17.02**	20.76**	22.73**	12.45**	10.01**	2.65**

* $p < .05$
** $p < .01$

Line of lip

On the first trial of Template I the lips are drawn upward X^2 (1,1) = 20.32, p = < .01, 1.5 s following Onset (AO3). On the second trial of the same template, the lips are drawn back at Onset, X^2 (1,1) = 36.90, p = < .01. and upward at AO1, X^2 (1,1) = 40.77, p = < .01, and remained in this position for the following two seconds. On the first trial of the second Template II the line of the lip remains neutral throughout the episode. On the last trial the line of the lip is drawn upward, X^2 (1,1) = 31.85, p = < .01, one second following Onset (AO2) and continues for one second and then on AO5 returns to the neutral position, X^2 (1,1) = 22.71, p = < .01. Hence, the line of the lip is drawn upward following onset in both trials for Template I and in the second trial for Template II.

Openness of the mouth

The mouth remains in the neutral position seen at baseline for both trials of Template I and the first trial of Template II. However, on the second trial of Template II, the mouth opens, X^2 (1,1) = 22.73, p = < .01, one second following Onset (AO2) but returns to the neutral position X^2 (1,1) = 12.45, p = < .01, by the

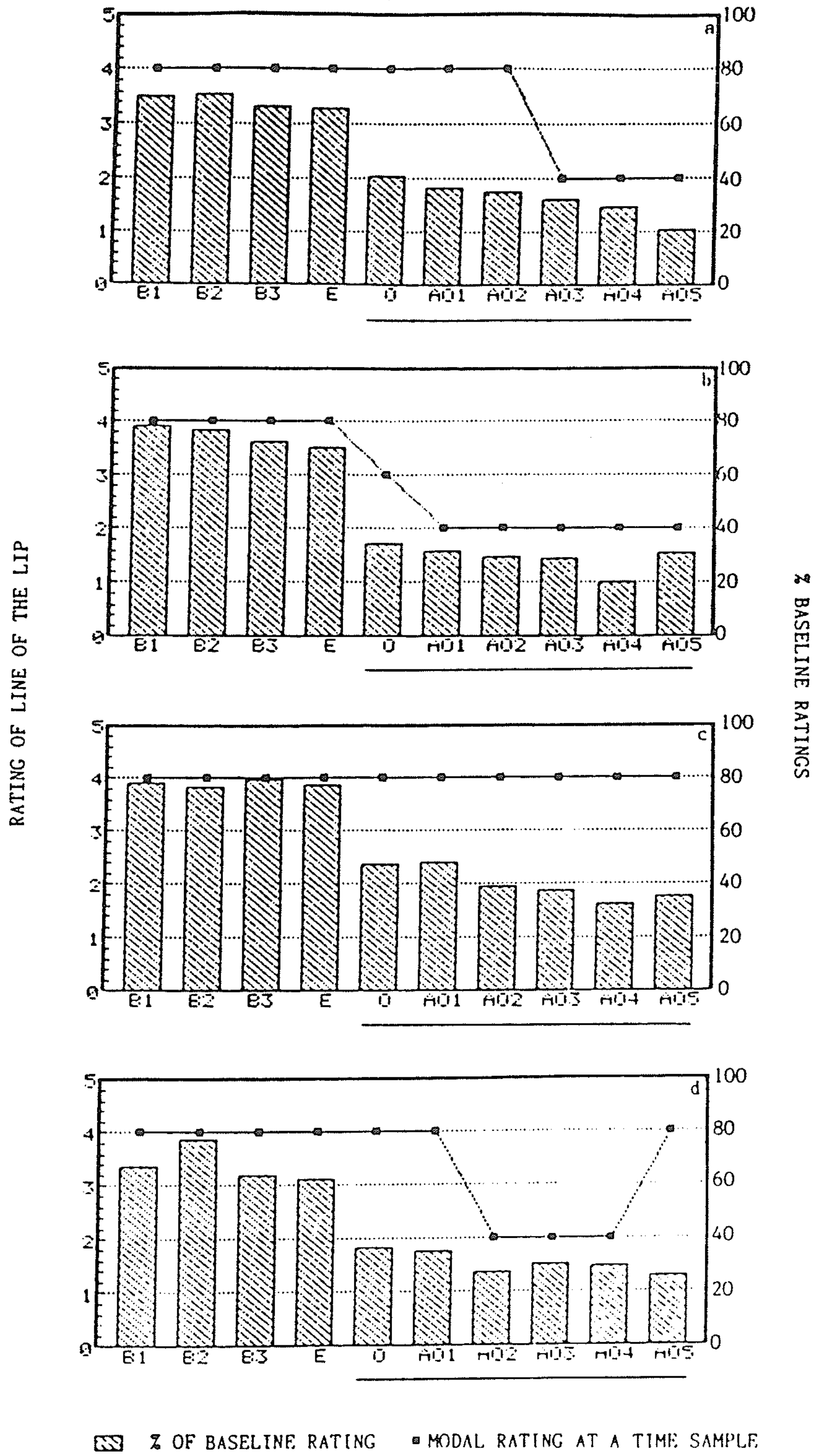


Figure 5. Modal rating of line of the lip during baseline (B1, B2, & B3), following achievement of the goal (E), at onset (O), and at each subsequent .5 second interval (A01, A02, A03, A04, & A05) for (a) template 1, trial 1, (b) template 1, trial 2, (c) template 2, trial 1, and (d) template 2, trial 2. Percentage of children whose line of the lip rating changed from baseline (B1, B2, & B3) is indicated by a solid line (——) for $p < .01$.

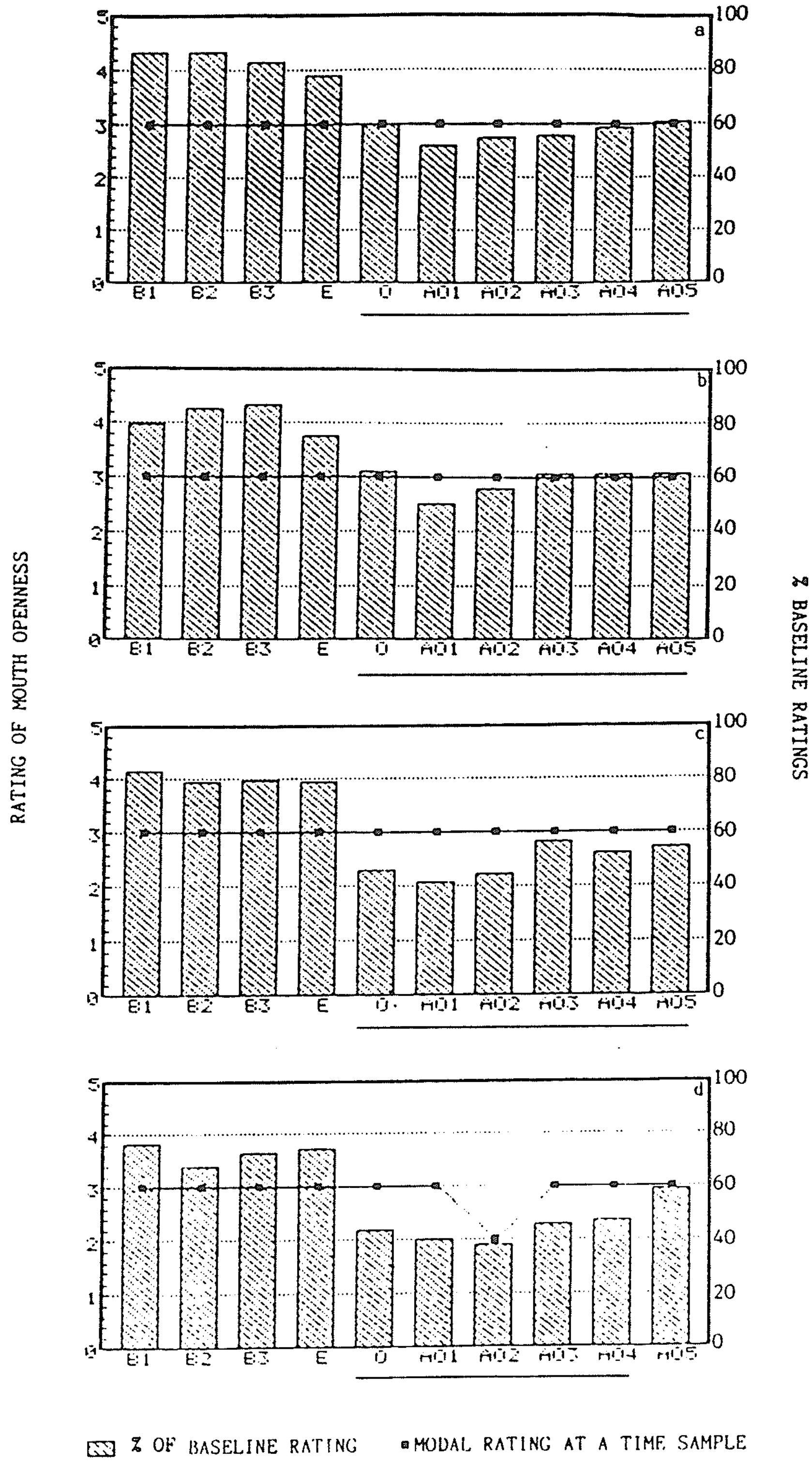


Figure 6. Modal rating of mouth openness during baseline (B1, B2, & B3), following achievement of the goal (E), at onset (O), and at each subsequent .5 second interval (A01, A02, A03, A04, & A05) for (a) template 1, trial 1, (b) template 1, trial 2, (c) template 2, trial 1, and (d) template 2, trial 2. Percentage of children whose mouth openness rating changed from baseline (B1, B2, & B3) is indicated by a solid line (——) for *p* < .01.

next time sampling. Hence, unlike the components of openness of eye and line of lip, there is little change from baseline in the openness of mouth. Only in the final was there a half second sampling of increased openness.

Composite patterns

Based on the changes in the three component ratings presented above, the drawings of the isolated components were assembled to form composite facial expressions for each of the four trials (Figure 7). Throughout the composite facial expressions the eyebrow is represented as neutral or a rating of 3. Also included with each composite is the direction of gaze.

Difficulty of Task and Facial Expression

To examine the facial expression of the children as they worked at and completed tasks of increasing difficulty the modal rating was obtained for each facial component for templates summed across trials (Figures 8, 9, and 10). The Chi square statistic between baseline and each of event, onset and the five time samplings following onset for each facial component are shown in Table 4.

TABLE 4.

Chi square statistic between baseline and each of Event (E), Onset (O), and at each subsequent .5 second interval (AO1, AO2, AO3, AO4, AO5) for Templates I & II summed across trials 1 & 2.

OPENNESS OF EYE (Component 3)

Template		E	Onset	AO1	AO2	AO3	AO4	AO5
I	N	144	126	124	114	96	73	58
	X^2	1.96	55.84**	44.72**	37.85**	43.61**	47.80**	23.52**
II	N	136	123	122	115	101	83	65
	X^2	5.14*	87.37**	98.01**	80.18**	64.79**	48.85**	56.52**

LINE OF LIP (Component 5)

Template		E	Onset	AO1	AO2	AO3	AO4	AO5
I	N	136	125	123	112	95	73	57
	X^2	.82	49.74**	58.85**	60.78**	58.29**	61.53**	47.48**
II	N	126	123	122	114	101	84	65
	X^2	.61	41.46**	42.40**	62.71**	56.93**	56.53**	47.22**

OPENNESS OF MOUTH (Component 7)

Template		E	Onset	AO1	AO2	AO3	AO4	AO5
I	N	136	125	123	112	95	73	57
	X^2	9.33*	31.21**	59.42**	44.63**	31.91**	24.25**	18.55**
II	N	126	123	122	114	101	84	65
	X^2	.00	43.43**	53.00**	50.10**	24.46**	23.93**	11.15**

* $p < .05$
** $p < .01$

Figure 7. Composite drawings of facial expressions at baseline, achievement of goal (Event), onset of change (Onset), and at each subsequent .5 second time sample (AO1, AO2, AO3, AO4, & AO5) for each template and trial. For each time sample, the rating for openness of eye, line of lip and openness of mouth is indicated on the lower right of the facial composite, e.g. 3, 4, 3 and the direction of gaze is indicated as: task (T), goal (G), mother (M), examiner (E), and other (O).

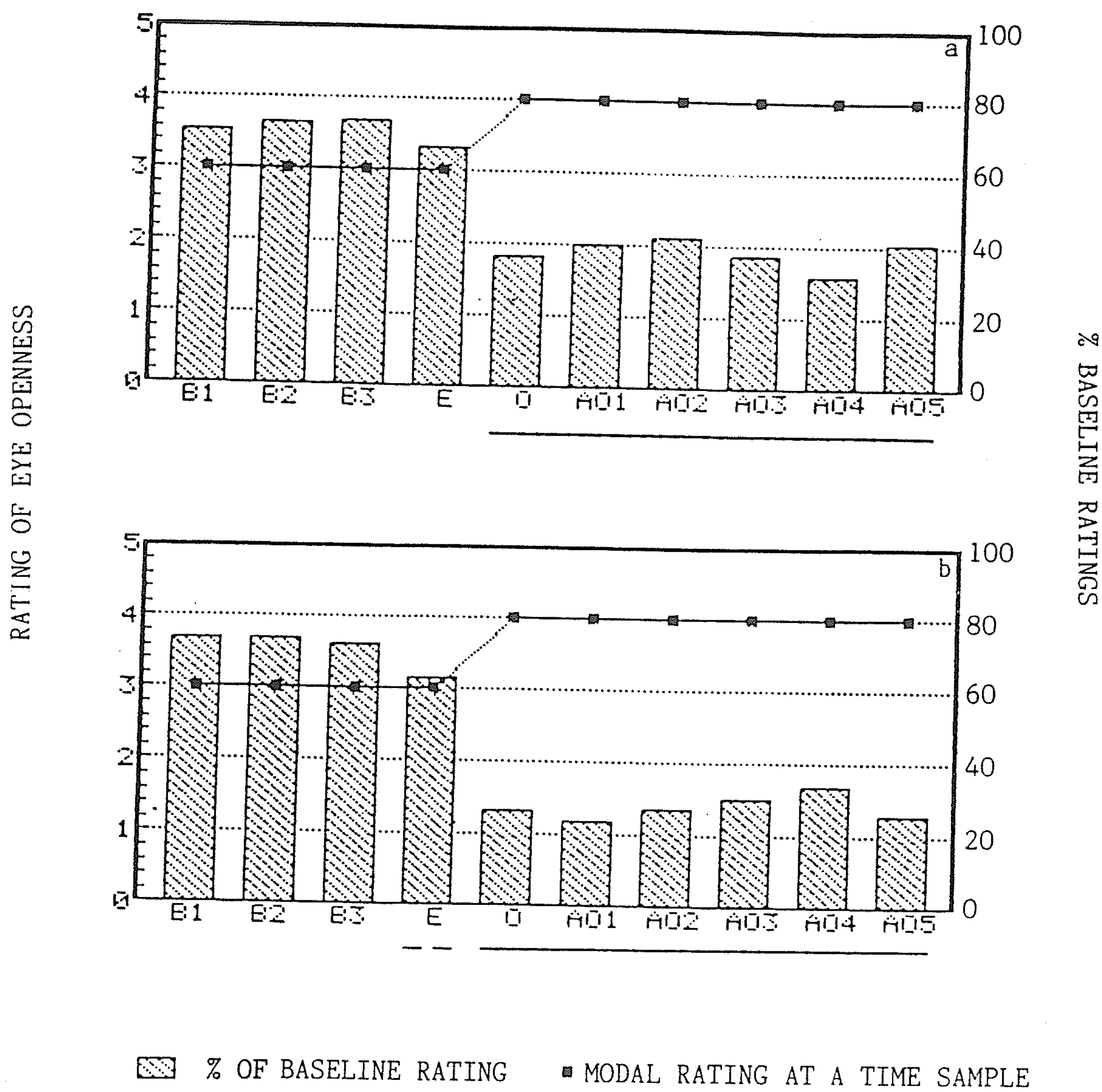


Figure 8. Modal rating of eye openness during baseline (B1, B2, & B3) following achievement of the goal (E), at onset (O), and at each subsequent .5 second interval (A01, A02, A03, A04, & A05) for (a) Template I, (b) Template II, summed across trials 1 and 2. Percentage of children whose eye openness rating changed from baseline (B1, B2, & B3) is indicated by a broken line (— — —) for $p < .05$ and a solid line (——) for $p < .01$.

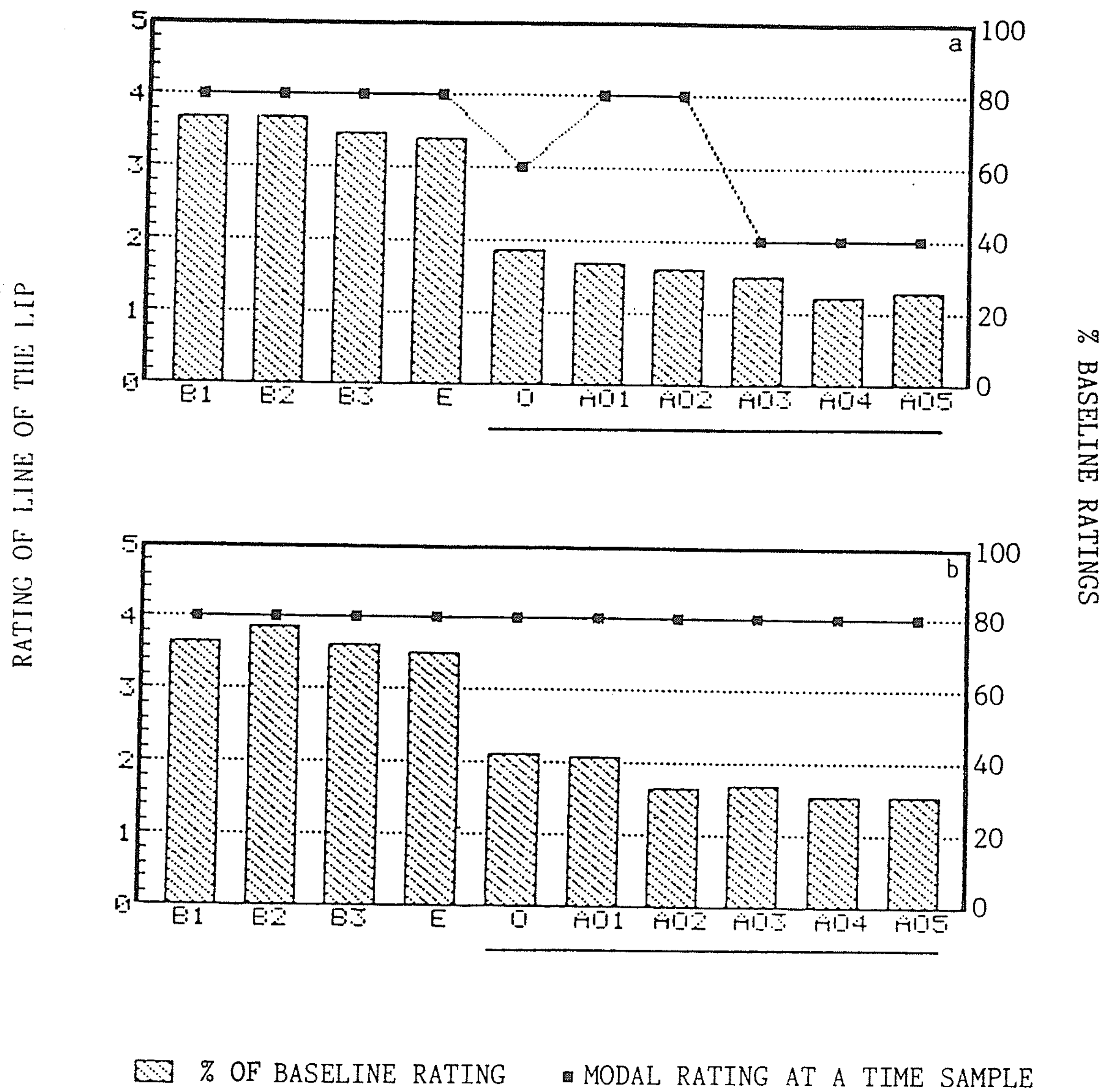


Figure 9. Modal rating of line of the lip during baseline (B1, B2, & B3) following achievement of the goal (E), at onset (O), and at each subsequent .5 second interval (A01, A02, A03, A04, & A05) for (a) Template I, (b) Template II, summed across trials 1 & 2. Percentage of children whose line of the lip rating changed from baseline (B1, B2, & B3) is indicated by a solid line (——) for $p < .01$.

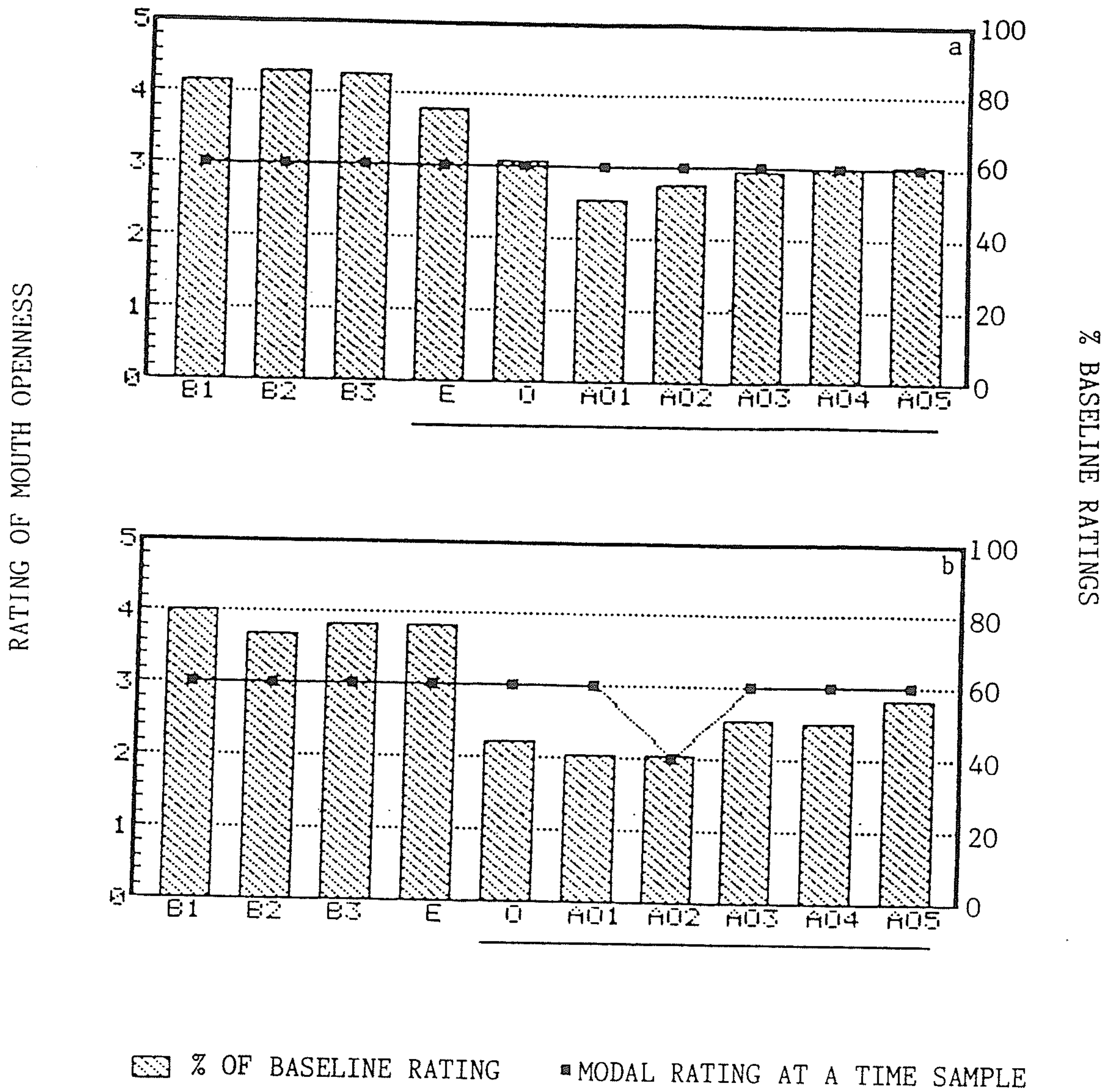


Figure 10. Modal rating of mouth openness during baseline (B1, B2, & B3) following achievement of the goal (E), at onset (O), and at each subsequent .5 second interval (A01, A02, A03, A04, & A05) for (a) Template I, (b) Template II, summed across trials 1 & 2. Percentage of children whose mouth openness rating changed from baseline (B1, B2, & B3) is indicated by the solid line (——) for $p < .01$.

The baseline modal ratings and ratings at event on both templates are consistently neutral for openness of the eye, line of the lip, and openness of the mouth.

Openness of Eye

On both Template I and II the eye narrows slightly at onset, X^2 (1,1) = 55.84, p = < .01, and remains narrowed. Hence, there is no difference in the eye openness following difficult and easy tasks.

Line of Lip

In the first template the lip is drawn back at onset, X^2 (1,1) = 49.74, p = < .01, returns to neutral for 1 second (A01, A02), X^2, 1,1) = 58.85, 50.78, p = < .01 respectively, and is then again, drawn upward X^2 (1,1) = 58.29, p = < .01, for the remainder of the episode. On the second template, the line of the lip remains neutral throughout the episode. Therefore, on the first and simpler template the child's line of lip changes to more nearly approaching that of a smile. However, on the second or more difficult template the child's lip line remains neutral.

Openness of Mouth

On the first template the mouth remains neutral throughout the episode. However, on the second template the mouth opens, X^2 (1,1) = 44.63 = p = < .01 one second after onset (AO2) for one half second. Hence, on the second or more difficult template the mouth opens briefly.

Composite Patterns

Drawings of the isolated components for each template were assembled to form composite facial expressions based on the modal ratings (Figure 11). The composite facial expressions for baseline and event are the same for both templates. However, following the event (E), the changes in facial expression appear to vary with the difficulty of the task (Template I, Template II).

In the first template the eyes narrow, the lips are drawn upward and the mouth remains neutral. The composite facial expression in this first template again approaches more nearly to a smile. With the second, more difficult template the eye narrows slightly at onset, however, the line of the lip remains neutral as does the mouth openness with the exception of one half second time

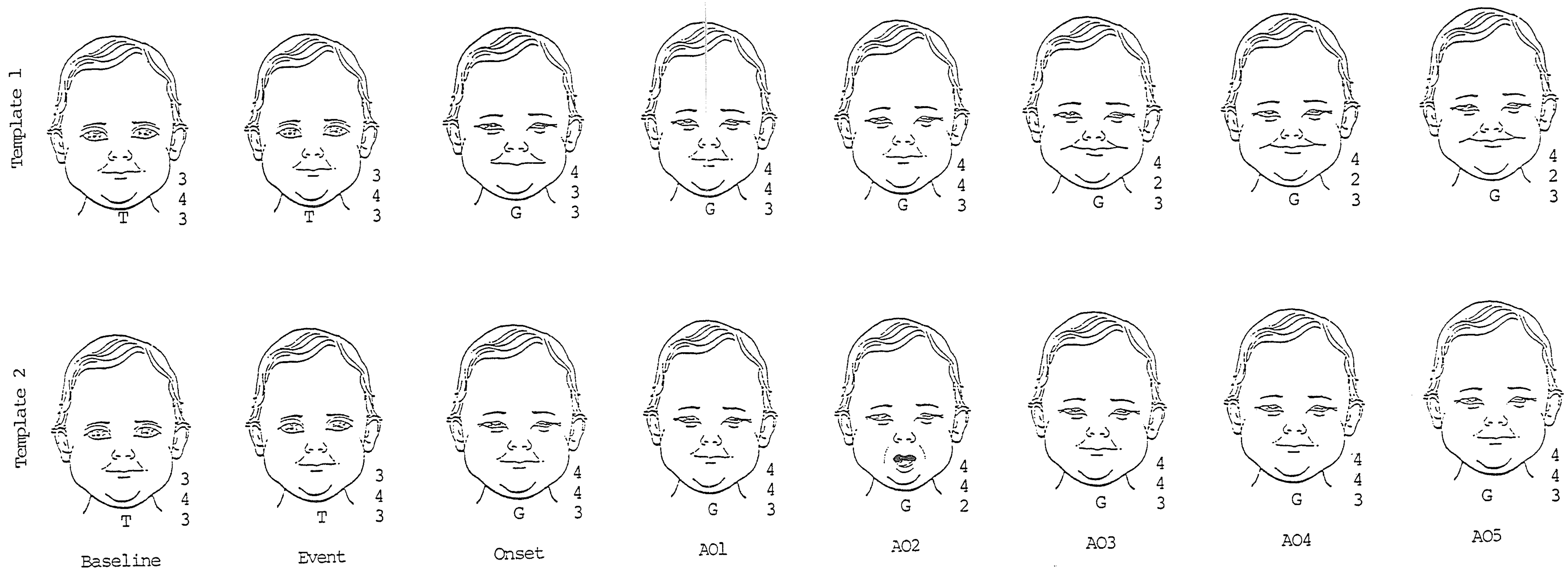


Figure 11 Composite drawings of facial expressions at baseline, achievement of goal (Event), onset of change (Onset), and at each subsequent .5 second time sample (AO1, AO2, AO3, AO4, & AO5) for each template. For each time sample, the rating for openness of eye, line of lip, and openness of mouth is indicated on the lower right of the facial composite e.g. 3, 4, 3 and the direction of gaze is indicated as follows: task (T), goal (G), mother (M), examiner (E), and other (O).

sampling (AO2) where the mouth opens. The composite facial expression in this second template more closely approaches the expression of concentration or attention to the task.

<u>Changes in Direction of Gaze</u>

The modal rating for direction of gaze and the percentage of children who showed the baseline rating from Baseline One (B_1) to after Onset five (AO5) is shown in Figures 12 and 13. The Chi square <u>values</u> between baseline and each of event, onset and the five time samplings following onset are shown in Tables 5 and 6.

The baseline rating, and rating at event for all four trials for direction of gaze, indicates that the child's gaze was directed at the task. At Onset the child's direction of gaze moves from the task to the goal and remains focused on the goal (Template I, trial 1, X^2 (1,1) = 169.33, p = < .01, Template I, trial 2, X^2 (1,1) = 147.02, p = < .01, Template II, trial 1, X^2 (1,1) = 122.74, p = < .01, Template II, trial 2, X^2 (1,1) = 125.14, p = < .01).

The same change in direction of gaze is seen on templates summed across trials. On both templates the direction of gaze changes from task to goal at Onset and

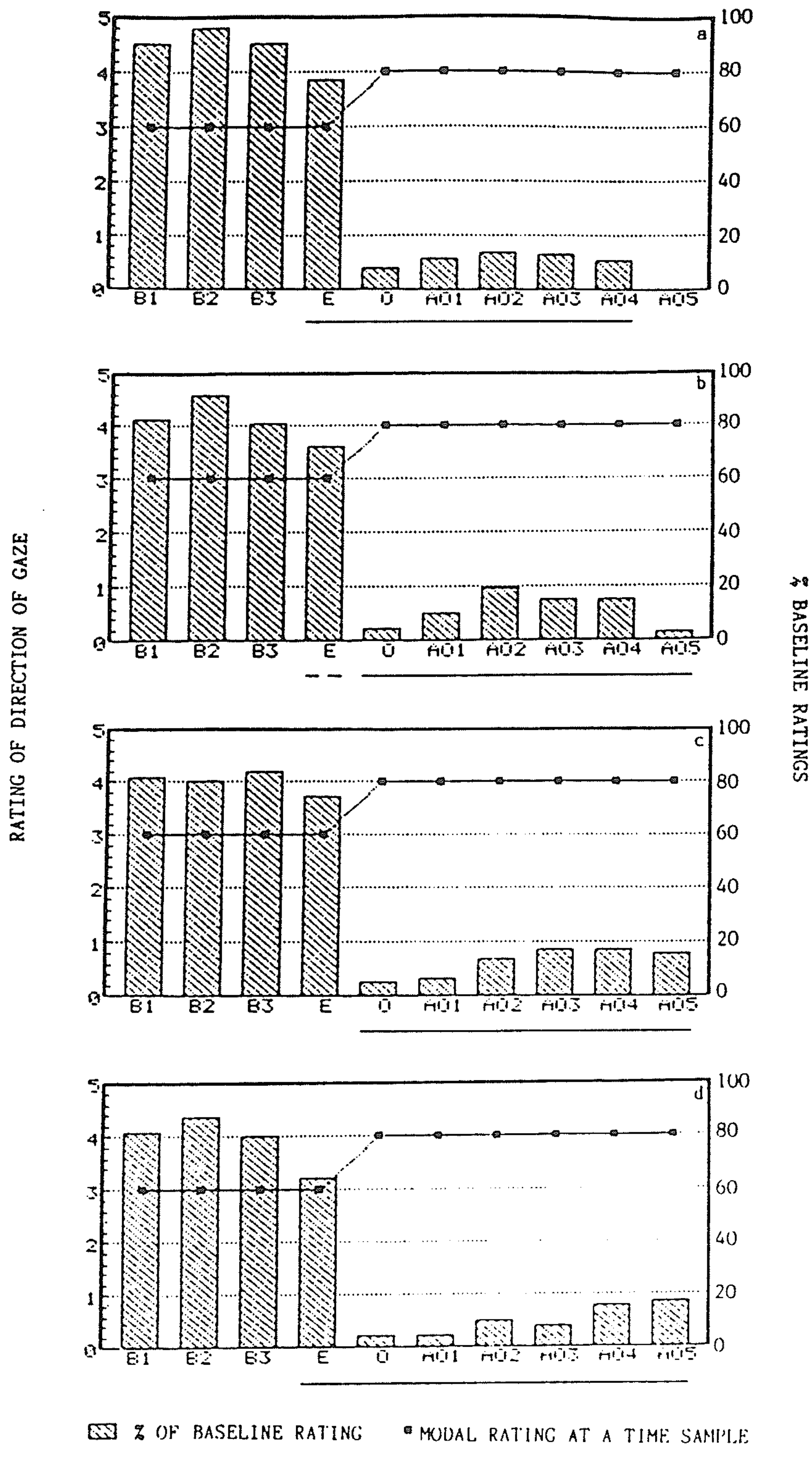


Figure 12. Modal rating of direction of gaze during baseline (B1, B2, & B3), following achievement of the goal (E), at onset (0), and at each subsequent .5 second interval (A01, A02, A03, A04, & A05) for (a) template 1, trial 1, (b) template 1, trial 2, (c) template 2, trial 1, (d) template 2, trial 2. Percentage of children whose direction of gaze rating changed from baseline (B1, B2, & B3) is indicated by a broken line (— — —) for $p < .05$ and a solid line (——) for $p < .01$.

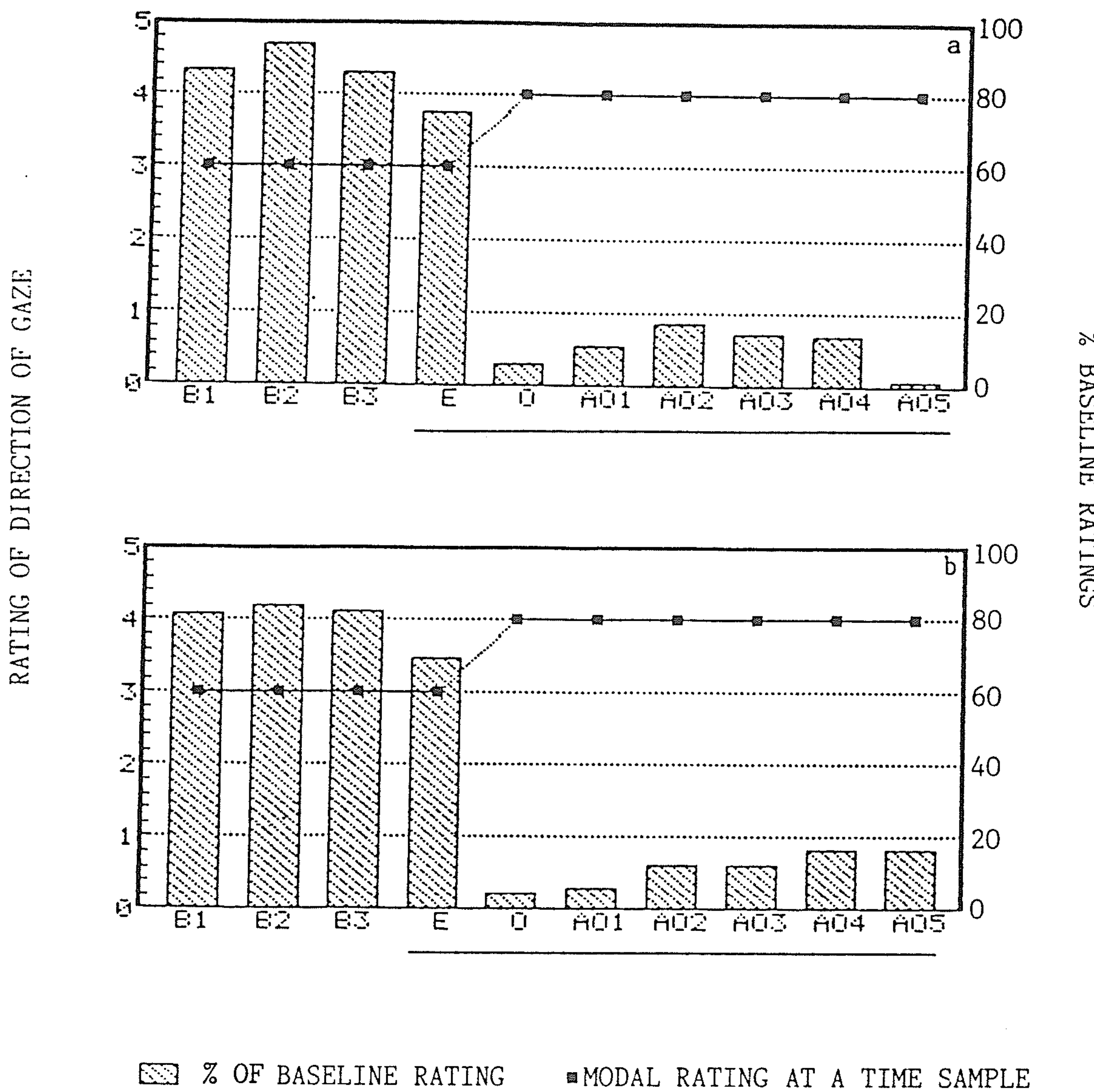


Figure 13. Modal rating of direction of gaze during baseline (B1, B2, & B3) following achievement of the goal (E), at onset (O), and at each subsequent .5 second interval (A01, A02, A03, A04, & A05) for (a) Template I, (b) Template II, summed across trials 1 & 2. Percentage of children whose direction of gaze rating changed from baseline (B1, B2, & B3) is indicated by a solid line (——) for $p < .01$.

TABLE 5.

Chi square statistic for Direction of Gaze (Component 4) between Baseline and each of Event, Onset, and at each subsequent .5 second interval (AO1, AO2, AO3, AO4, AO5) for each trial on each template.

Template	Trial		E	Onset	AO1	AO2	AO3	AO4	AO5
I	1	N	72	59	58	52	45	35	0
		X^2	10.96**	169.33**	157.07**	140.41**	137.21**	126.83**	0
	2	N	72	67	66	62	52	39	29
		X^2	6.13*	147.02**	127.28**	99.36**	99.54**	84.04**	91.68**
II	1	N	71	61	60	57	51	40	31
		X^2	1.86	122.74**	116.69**	94.34**	80.08**	68.94**	60.34**
	2	N	65	62	62	58	50	43	35
		X^2	9.96**	125.14**	125.14**	106.58**	103.24**	76.82**	65.92**

* $p < .05$
** $p < .01$

TABLE 6.

Chi square statistic for Direction of Gaze between Baseline and each of Event, Onset, and at each subsequent .5 second interval (AO1, AO2, AO3, AO4, AO5) for templates I and II summed across trials 1 and 2.

Template		E	Onset	AO1	AO2	AO3	AO4	AO5
I	*N*	144	126	124	114	97	74	59
	X^2	16.15**	313.83**	281.32**	235.16**	232.33**	205.22**	229.86**
II	*N*	136	123	122	115	101	83	66
	X^2	10.15**	248.65**	242.63**	200.84**	182.61**	145.76**	126.23**

* $p < .05$
** $p < .01$

remains focused at the goal (Template I, X^2 (1,1) = 313.83, p = < .01, Template II, X^2 (1,1) = 248.65, p = < .01). Hence, immediately following the achievement of the goal (Event) the child ceases attending to the task and looks toward the goal.

Relationship of Facial Expression to Competence

The possible link between the latency to onset i.e. the amount of time between Event (achievement of the goal) and Onset (Change in 2 of 3 facial regions) and the child's level of competence (number of templates and trials achieved) was explored. The expectation was that the longer the time between event and onset the fewer templates the child would achieve or the lower the level of competence. However, there was no correlation between latency to onset and level of competence.

The possible relationship between composite facial patterns and level of competence was also explored. The three components included for the composite patterns were the openness of the eye, line of the lip and openness of the mouth. When the components were combined to develop the composite drawings, six commonly occurring patterns were found (Figure 14).

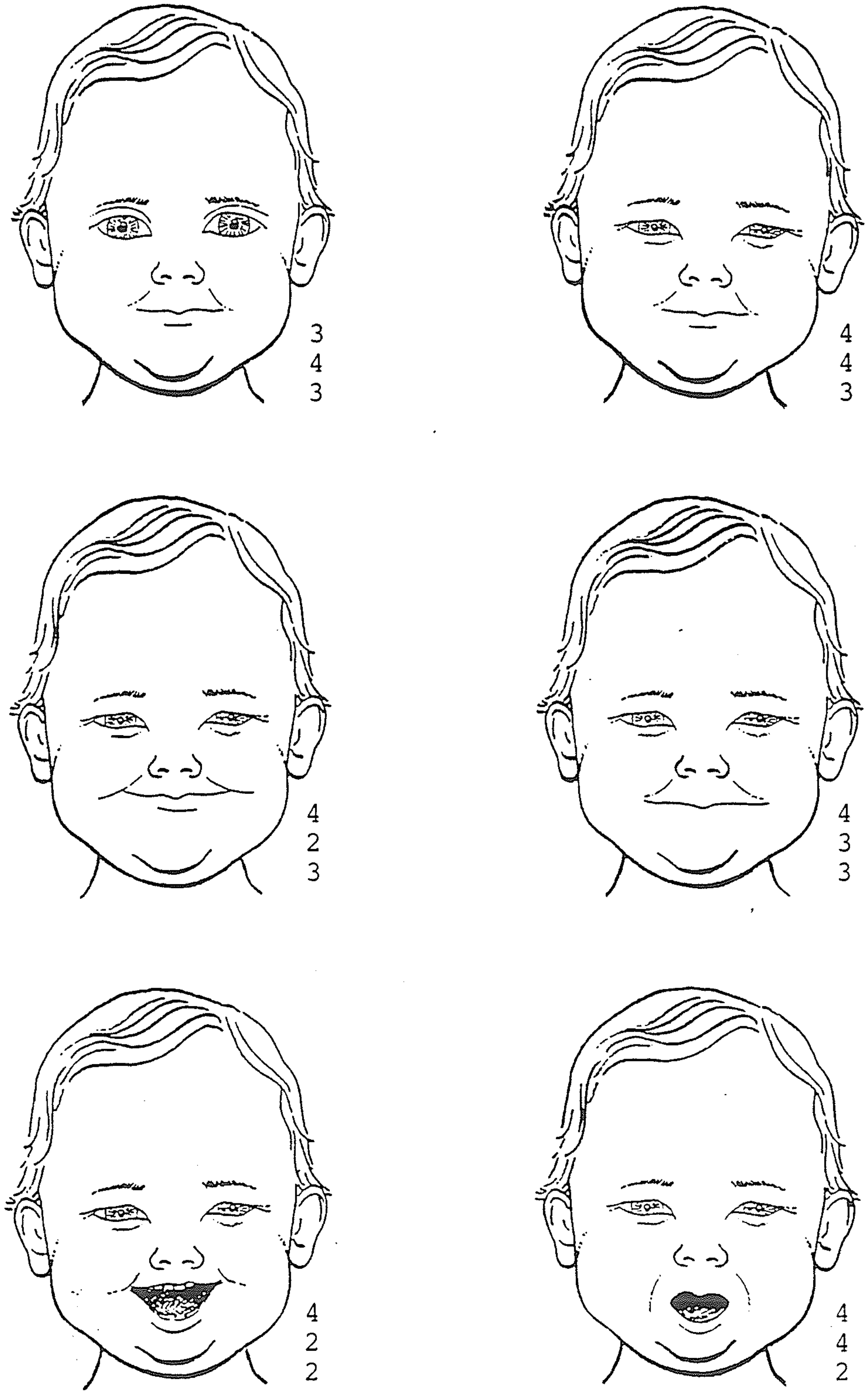


Figure 14. Most frequently occurring facial patterns.

The average number of times across templates and trials that these patterns occurred for each child were then compared to their level of competence. The mean level of competence for the maze task was 6.0, SD = 2.23 and for the peg task the mean was 5.92, SD = 1.71.

In the maze task none of the composite patterns correlate significantly with level of competence (Table 7). On the peg task there is an inverse relationship between the 4,4,3 pattern and level of competence, r = -0.37, p .02 (Table 8).

TABLE 7.
Relationship between frequency of pattern and level of competence for maze task

Composite Patterns		Pattern Scores	Pearson *r* Correlations	Probability
343	M	.76	-0.05	0.75
	SD	.88		
423	M	.23	0.22	0.20
	SD	.36		
433	M	.20	-0.15	0.38
	SD	.30		
443	M	.35	0.03	0.88
	SD	.50		
422	M	.22	-0.09	0.61
	SD	.44		
442	M	.15	0.15	0.37
	SD	.25		
Other	M	39.24	0.56	0.01
	SD	2.87		
Comp.	M	6.0		
	SD	2.23		

TABLE 8.
Relationship between frequency of pattern and level of competence for peg task

Composite Patterns		Pattern Scores	Pearson *r* Correlations	Probability
343	M	.87	-0.07	0.69
	SD	.83		
423	M	.31	0.09	0.58
	SD	.47		
433	M	.34	0.17	0.31
	SD	.38		
443	M	.53	-0.37	0.02
	SD	.61		
422	M	.37	-0.07	0.68
	SD	.61		
442	M	.26	-0.12	0.49
	SD	.42		
Other	M	38.74	0.59	0.01
	SD	2.77		
Comp.	M	5.92		
	SD	1.71		

CHAPTER IV

Discussion

The objective of this study was to investigate whether there are distinctive changes in the facial expression of toddlers upon completion of a challenging task. For this purpose the three video time frames prior to the child's completion of the task (Baseline), at the tripping of the hatch (Event), and six subsequent to Event (Onset to After Onset) were coded on eight facial components. Changes in facial components were identified by comparisons of after onset ratings to baseline. A further interest was whether there are differences in facial expression with increasing difficulty of the task. The relationship between the composite patterns of facial expression and the child's level of competence was also examined. The findings for each will be discussed followed by an evaluation of the procedure and measures.

Baseline Facial Expression

Three samples of facial expression just prior to achievement of the goal were obtained as a measure of the baseline expression. The modal ratings of openness of eye, line of lip and openness of mouth, are relatively constant from trial to trial. This expression is usually maintained beyond the tripping of the hatch to the defined onset of change.

The direction of gaze focusses on the task during baseline and continues until after the hatch is tripped. This suggests the children do not anticipate the tripping of the hatch and further that their attention is focussed solely on the task. This continuity of the baseline facial components and direction of gaze are found across all templates and trials. The fact that facial expression of toddlers does not change while they are working at the task and continues after goal completion suggests that their recognition of goal achievement is not immediate.

Latency to Onset of Change

The time between the event (tripping of the hatch) and the onset of change in facial expression (latency to onset) is, on the average, one second with variability among children ranging from immediate to about two seconds. On the maze task the latency to onset diminishes over the first three trials. This decrease may be related to the nature of the maze task. The termination of each maze is very near to the hatch.

To complete the task the child had to push the stylus up to the goal which was then in a position directly beneath the goal. In contrast, the holes of the peg task are in the middle of the task box, the visual link to the goal is not as apparent as in the maze task. Therefore, the recognition of the accomplishment of the goal may have been slightly faster than on the maze task with a change in facial expression appearing slightly sooner.

Changes in Facial Expression

Following onset, changes were observed in four of eight facial components, namely, eye openness, line of lip, mouth openness and direction of gaze. The isolated components were combined to form composite patterns for each time frame. Six facial composite were found to be the most commonly occurring across tasks, templates and trials. The three most frequent of the six were:

a) the neutral pattern, 3, 4, 3: where all components were neutral. This pattern was representative of baseline and event on all templates and trials. For this reason it is referred to as the baseline expression.

b) the pattern 4, 4, 3: the eyes slightly narrowed, the lips and mouth neutral, closely resembles an attentive or thoughtful expression and, therefore, is referred to as the <u>attention expression</u>. In comparing these component ratings (4,4,3) to component formulas used in the MAX to identify discrete emotions, it was found that they corresponded with the "interest" expression.

c) the pattern 4, 2, 3: the eyes slightly narrowed, lips drawn upward and the mouth neutral, most closely approached a smile and therefore, is referred to as the <u>pleasant expression</u>. When compared to the MAX, these components (4,2,3) corresponded to the "enjoyment-joy" expression.

In trials 1 and 2 of the easier template the child's expression changes from the baseline (3,4,3) to a pleasant expression (4,2,3) and continues to the end of the episode, with this change occurring sooner in the second trial. In the first trial of the more difficult template, the child's expression changes from the baseline to the attention 4,4,3 expression. A definite change is seen from pleasantness in the first 2 trials of template I to the attention expression in the first trial on template II. In the final trial, the child's expression changes from baseline (3,4,3), to the attention expression (4,4,3), to a full smile (4,2,2), to the pleasant expression (4,2,3) and back to the attention expression (4,4,3). Thus, the toddler's facial expression revealed some pleasantness which may be an indicator of a feeling of satisfaction. Thus facial expression of pleasantness may be similar to what Harter (1974) reports as smiling that accompanies correct performance and reflects the pleasure derived from the child's sense of mastery.

The consistent smiling expression found on both trials of Template I, however, does not lend support to Harter's (1974) predicted decline in smiling with repetition of correctly solved tasks. That is not to say that with an increased number of repetitions of the same template that this decline in smiling would not appear.

However, with the second template the child shows an attentive expression on the first trial and on the second, a pleasant expression. This difference between trials can be explained by the child's involvement and attempt at mastering a challenging task in the first trial, and the repetition of the mastered task in the second trial. Thus, pleasure is not expressed until after at least one repetition of a correctly solved template.

Facial Expression and Difficulty of the Task

The facial expression of the children was examined while working at two templates increasing in difficulty to determine whether there was a relationship between task difficulty and facial expression. Unfortunately, due to the low number of subjects completing templates III through to VI the difference in facial expression was examined across two levels of difficulty only (i.e. Templates I and II). On the first template an attention expression is followed by a pleasant expression. However, on the second template the attention expression is present throughout the episode with the exception of one time frame in which the mouth opens, resulting in an expression that suggests surprise. This may reflect the child's response to the increased difficulty of the task.

This study offers some support for Harter's (1971,

1974) findings that smiling (or a facial expression that closely resembles smiling) accompanies the achievement of a task. It also suggests that there is a change in facial expression as tasks increase in difficulty; that broad smiling is not apparent but rather attention and pleasant expressions are present. This descriptive study has succeeded in describing the facial expression present as a child works at mastery motivation tasks. Also identified are a baseline expression and two seemingly overriding expressions present during the accomplishment of mastery motivation tasks, namely, pleasant and attention expressions.

Matsumoto (1983) suggests that expressions considered as neutral may in actuality be a lower-level interaction of affects, rather than a state of non-affect. He states that:

> "theorists who have offered evidence for the primacy of affect in relation to cognition (e.g. Zajonc, 1980), have suggested that purely affective states devoid of cognitive activity can and indeed do occur, whereas there can be no purely cognitive state devoid of affective experience. This implies that what we have been calling the "neutral" state cannot in actuality be a neutral state. In this framework neutral states become less-affective than other emotional states such as happiness, anger, or sadness, but they do not become affect-less. If, in reality, such less-affective states are engaged in

> regularly, both from a perceptual and expressive viewpoint, while at the same time totally affect-less states rarely occur, this would seem to indicate that what we have been calling "neutral" takes on some previously disregarded significance, both as a personal feeling state and as a communicative component." (p. 103)

The thoughts expressed by Matsumoto parallel the views of the investigator relative to the baseline, pleasant and attention expressions identified in the study. Perhaps some subtle cues that have not yet been investigated should be considered as being more indicative of a child's feeling state or feeling of efficacy. A closer examination of the expressions identified in the research merits further consideration in a future study.

Moreover, the findings in this study could possibly account for the inconclusive results reported by previous investigators using mastery pleasure as an index of mastery motivation (e.g., Harter, 1971, 1974, 1977, 1978b; Yarrow & Messer, 1983; Leutkenhaus, Grossman & Grossman, 1983). The systems used in the previous studies were looking solely for the presence of mastery pleasure or positive affect as exhibited with a smile, laugh, etc. The measures used were generally 5-point rating scales with end points of "no response" to "laughing". Thus, in the present study the baseline and attention expressions would have been rated as "no response". This could account for the inconsistency found in earlier studies. Before mastery pleasure can be accepted as an index of mastery motivation, studies should more clearly identify the precise characteristics of facial expressions that accompany task achievement.

This descriptive study of children's facial expression while working at and accomplishing a task has revealed expressions of attentiveness and pleasantness. The next logical step would be to use an anatomically comprehensive system for coding facial expression, such as the FACS, as well as a breakdown of mastery motivation tasks into smaller increments in order to further identify the subtle changes in the child's facial expression that are associated with task achievement. If patterns of facial expression are consistently found for different perceived levels of difficulty, the facial cues provided by each could provide parents and caregivers with valuable information about the feeling state of a child as he works at a task, thus enabling the caregiver to read and respond to the cues appropriately.

Hunt (1965) suggests that the process by which mastery behavior is elicited and maintained occurs when spontaneous acts are responded to, for example, when the adult imitates the infant's vocalizations. The infant soon anticipates that vocalization will lead to a response by the mother or caregiver (Yarrow & Messer, 1983). A responsive environment, one in which the adult is sensitive to the child's signals, may free the infant to attend to objects and explore them. Yarrow (1981) suggests that having an environment in which both parents sensitively respond to the child's needs and provide responsive materials is likely to be most facilitative of mastery.

Harter (1981) further contends that the parent's response to mastery attempts by the child lead to an internalization of external values. She suggests that infants who are praised for attempting difficult problems will come to value these activities. The views expressed by these researchers in the area of mastery motivation indicates the importance of being able to read children's cues and respond appropriately to help them foster this intrinsic motivation to master their environment (Harmon & Culp, 1981).

Composite Patterns and Level of Competence

Researchers in the area of mastery motivation hope to identify indices with predictive capabilities to determine later competence. In this respect, exploratory analysis of possible relationships between each of the six commonly occurring facial composite patterns and the level of competence for each task was pursued.

For the maze task no correlation was evident between any of the six facial composite patterns and the level of competence. Interestingly, for the peg task, an inverse correlation was found between the attention pattern (4,4,3) and level of competence. This would suggest that children displaying an attention expression while working at the first templates in a series, also demonstrate a lower level of competence. In addition, the remaining patterns, which were included in the "other" category, did correlate with level of competence on both maze and peg tasks. It should be noted that the variability in the "other" category was considerably greater than for any of the six individual patterns. However, these correlations also suggest that within this "other" category there may be individual patterns or sequences of patterns that do reflect mastery motivation. The challenge is to identify them.

Evaluation of Procedure and Measures

Important observations were made concerning the procedures and methods used in this study. Most important are procedures that relate to the data transcription and videotaping of the sessions.

Data Transcription

The Onset Point. The criterion for onset of change, i.e., a change in two of the three facial regions (the eyebrow, eye, and mouth regions) was perhaps too stringent in this study. The direction of gaze, which was considered a component of the eye region, was invariably a component which changed at onset, accounting for one of the regional changes needed to establish onset. This change in direction of gaze was from task to goal. Consequently, if there was another change, but again in the eye region, i.e., openness of eye, onset could not be considered. Yet a change from the modal ratings of baseline had taken place which was not accepted or recognized. Possibly, reducing the criteria for onset of change to one facial component, regardless of region, would be more sensitive to individual differences in expression of effectance motivation and would still capture the change in facial expression from that seen at baseline.

Moreover, given that the direction of gaze changes consistently from the task to the goal at onset, perhaps the change in gaze direction as a regional component could be eliminated. This would allow more sensitivity to the individual responses of the children who completed the task and continued to focus on their accomplishment, instead of the hatch. This continued focus on the completed task may have been associated with more mastery pleasure than looking toward the tripped hatch. The criterion of two facial regions for onset may have resulted in responses to such trials being excluded from the data set. Consequently, a child, who may have been demonstrating more intrinsically motivated behaviour through facial expression was not included. The criterion of change in two facial regions eliminated a trial in which change was observed in two components in the same facial region. This could result in changes in three components of two regions as the marker for onset. In such instances, facial expression at onset may have been at its peak. In future research it may be advantageous to consider a change in any region, because it would necessarily differ from the baseline expression particularly in view of the demonstrated stability in facial expression at baseline to after event.

Component System

Due to procedural inadequacies, changes in only four of the eight facial components, namely, eye openness, line of lip, mouth openness and direction of gaze, were analyzed in this study. The eyebrow component was frequently difficult or impossible to code. Changes in the other three components, referred to as qualitative aspects of the eyebrow form, corners of the lip and visibility of teeth or tongue were rarely observed. These latter components were included from Brannigan and Humphries (1972) scales which were developed for use with older children. It may be that the facial features of children at 18-months of age are not yet sufficiently developed to show changes such as kinking of the eyebrow or revealing a full set of teeth when they smile. For future research these latter components may be better omitted in favour of more refined categories for the former three components.

While the component measures in this study did succeed in describing six commonly occurring facial patterns and more specifically, baseline, attention and pleasant expressions, they may not have been sensitive enough to uncover other possible reflections of affective state. A more refined measure of facial expression may yield clearer descriptions; an anatomically comprehensive system, such as the FACS, is suggested.

Mastery Motivation Tasks

In addition to using an anatomically based system in future research, it may also be beneficial to examine facial expression while children work at tasks which clearly increase in difficulty, and where these difficulty levels are distinguishable, i.e., easy to extremely difficult and frustrating. This would elicit a greater variety of facial expressions including those associated with negative affect. Furthermore, mastery pleasure may be expressed through a sequence of facial patterns, rather than through one pattern. The sequences of samples taken at .5 s intervals suggest a rise and recession to baseline over a 2.5 s period.

Uncodeable Responses

Uncodeable responses, i.e., those facial components rated as uncodeable, may have been due to a number of factors, for example, the lighting in the testing room, or the positioning of the child relative to the camera. These resulted in shadows on the monitor which oftentimes made it almost impossible to rate a facial component on a still frame. An effort had been made to eliminate such problems, by altering the position of the lights and increasing the number and type of light (florescent or incandescent).

In addition, the body position of the children relative to the camera was not always optimum. In order to capture the child at work, the task box, the examiner and the mother, the camera was placed at the eye level of the children as they sat at the table. However, as children worked at the tasks, their heads were positioned in a downward slant over the task box making it difficult to view the full face during coding. This position made it difficult to establish a neutral rating, in particular for the eyebrow component, because the eyebrows appeared high when the head was bent downward.

The eyebrow region was also difficult to code because some of the children's eyebrows were light and not yet developed thus seen only as a slight trace. To add to the difficulty, their hairlines were often low and partially covered the eyebrows. Colouring the eyebrows or placing barrettes or hats on the children were considered as solutions, however, were rejected because of the concern that these props rather than the tasks would become the focus of attention for the children. However, facial expression measures such as the FACS and MAX, all include components or units relating to the eyebrow region, which suggests that perhaps some subtle changes are occurring and that the unveiling of these, as well as the reduction in the number of uncodeables, may lie with changes in the procedure.

Two cameras working simultaneously may have been needed to record the necessary data. One camera hidden inside or near the task box pointed upward to capture the full front view of the child's face from which facial components could be coded, combined with appropriate lighting directed on the face should be considered in further research.

Conclusions

In conclusion, among 18-month-old children, the results of this study did identify a baseline expression and a definite change from this expression upon recognition of the achievement of the goal. Following the achievement of a goal, discernable changes in facial expression did occur on less difficult templates and upon repetition of a correctly solved template. However, these changes were subtle and could not be considered a full smile. The first attempt at the more difficult template was followed by an attention expression but no apparent smile. This same expression was found on the second template.

Of the six most commonly occurring facial composite patterns it is interesting to note that the facial expression was either neutral or that the pleasantness evident approached a smile. At this point it may be premature to infer that a pleasant facial expression is indicative of mastery pleasure. It is suggested rather that the child's facial expression while working at and accomplishing a task be observed using a more anatomically comprehensive system for measuring facial expression.

Moreover, future studies could explore the possibility of the existence of a sequence of patterns rather than of one pattern representing the child's affective state. The constancy of facial expression immediately prior to completion of the task in contrast to the clear changes after achievement of the goal suggests the child's awareness of competence may be accompanied by changes in affective state.

While the results of the study are interesting, there are some important observations concerning the procedure that are particularly relevant to further research in the area of mastery pleasure. The observational instrument (episode sampling) in this study was designed to capture the changes in facial expression following the achievement of a goal. The use of the onset point was not entirely successful in this application, however, a slight modification, to a change in only one component, may have merit. With refinement of the sampling and coding procedures, observation of the child's facial expression over the entire task in contrast to goal achievement would not only be of interest in the study of mastery motivation, but could also benefit parents and caregivers in their support of the child's development of competence.

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Appendices

APPENDIX A

LETTER TO PARENTS

THE UNIVERSITY OF MANITOBA

FACULTY OF HUMAN ECOLOGY
Department of Family Studies

Winnipeg, Manitoba
Canada R3T 2N2
(204) 474-9225

January 20, 1984

Dear Parents:

As parents and as professionals working with children, we are mutually interested in supporting optimal development in our children. We want them to develop competencies that will enable them to live productive and fulfilling lives. In recent years researchers in the area of child development have been asking some very basic questions, not simply about child's level of development, but also about how a child indicates that s/he wants to work on developing skills and how our response affects his/her achievement of this goal.

In respect to this latter point, namely, how a very young child indicates s/he is working on and wants to learn skills, we have several tasks which are basically toys the children can play with, that indicate they may be appropriately used for continued research into how we can support a child's optimal development. To test these tasks for appropriateness and feasibility in this area of research, and to refine them for more effective use, we are inviting you with your child to participate in our current research project. For this project we will be focusing upon children who are 18 months of age.

If you choose to participate in our research project, the involvement of you and your child would include a visit by us to your home and a visit by you with your child to the Department of Family Studies at the University of Manitoba. The visit to your home will be approximately one hour. We will bring some toys with us that will assist us in becoming acquainted with your child. During this time we will ask you to respond to two short questionnaires.

Your visit with your child to the Child Development Laboratories of Family Studies will be approximately one-half hour. During this time we will give your child a series of three table games. We ask that you be with your child throughout the half-hour session. For the purpose of precise and accurate data collection, the entire session will be videotaped. In addition to myself, the only persons who will have access to these videotapes are my research assistants. If it is judged that segments of the videotape would be valuable to continued research in this area, I will contact you for permission to edit out and retain the specific segment. Except for specific permission obtained from you for edited retention of segments, all videotaped records will be erased after data has been recorded.

To protect your confidentiality, yours and your child's name will be deleted from all records and will be substituted by a nondescript code.

We have all seen how eager children, as young as infants, are to learn. We also know they need our help. As an educator, I am specifically interested in knowing when and how we can most effectively assist children in learning new skills and to support them in developing their potential. It is for this reason that I invite your cooperation and participation in this research project. We know you, as parents, are similarly interested and, therefore, we will certainly share the findings from this project with you upon its completion.

If you are willing to participate in this research project with your child, kindly indicate by signing the attached consent form and returning it in the enclosed, self-addressed envelope. If you agree to participate, one of my research assistants (Marie Betournay, Annie Fung, or Nancy Lyon) will telephone you several weeks in advance of your child's approaching 18 months of age to arrange times convenient to you for the home and lab visits.

Sincerely yours,

Lois M. Brockman
Professor of Human Development

LMB/dah

Enclosure

P.S. If you know of anyone whose child is turning 18 months between the months of January and April, 1984, and who may be interested in this project, could you please ask them to contact us at 474-9225.

CONSENT TO PARTICIPATE

I agree to participate with my child, ____________________________, in the research project described in Dr. Brockman's cover letter. I understand that information obtained through this project will be respected as confidential. If, at any time following this consent, I wish to withdraw from the research project, I am free to do so.

My child's birthdate is ____.
(month, day, year)

____
(signature of parent)

Date ________________________________

Address ______________________________

____

Phone Number __________________________

APPENDIX B

MASTERY MOTIVATION TASKS

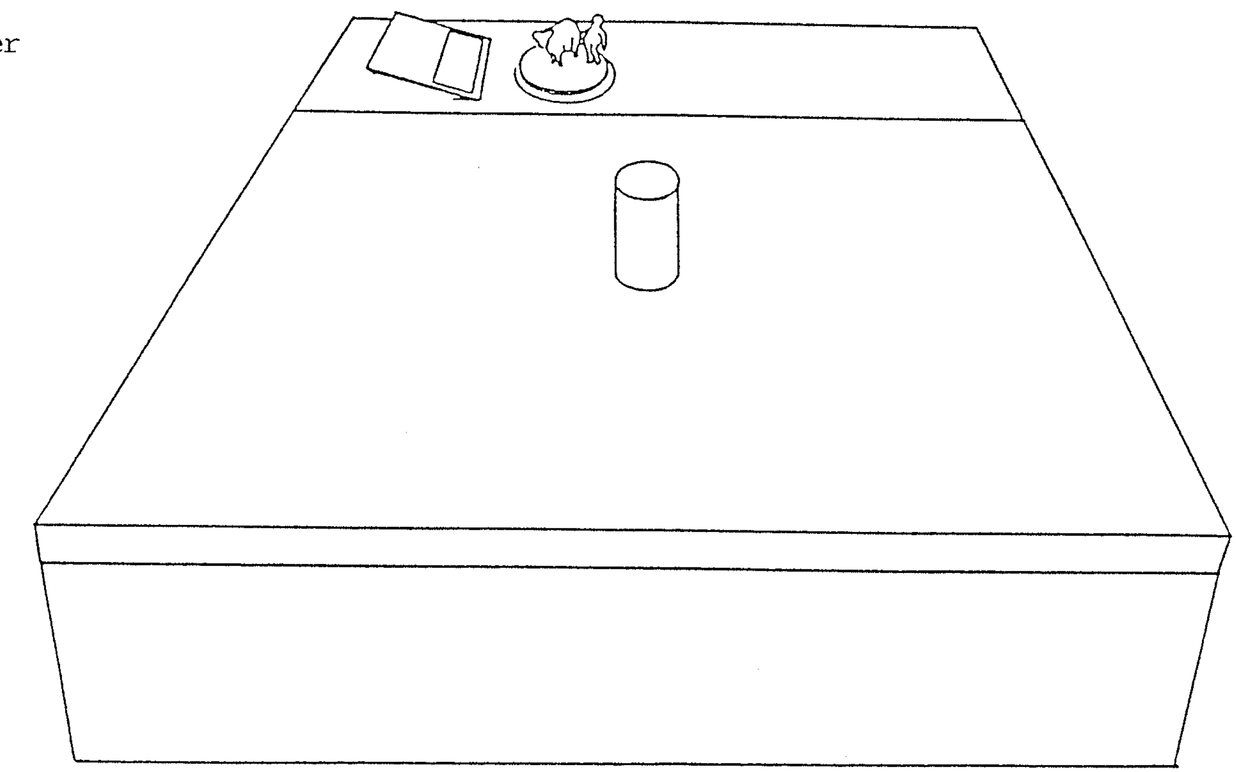


Figure 1. Diagram showing task box and seating arrangements during lab session.

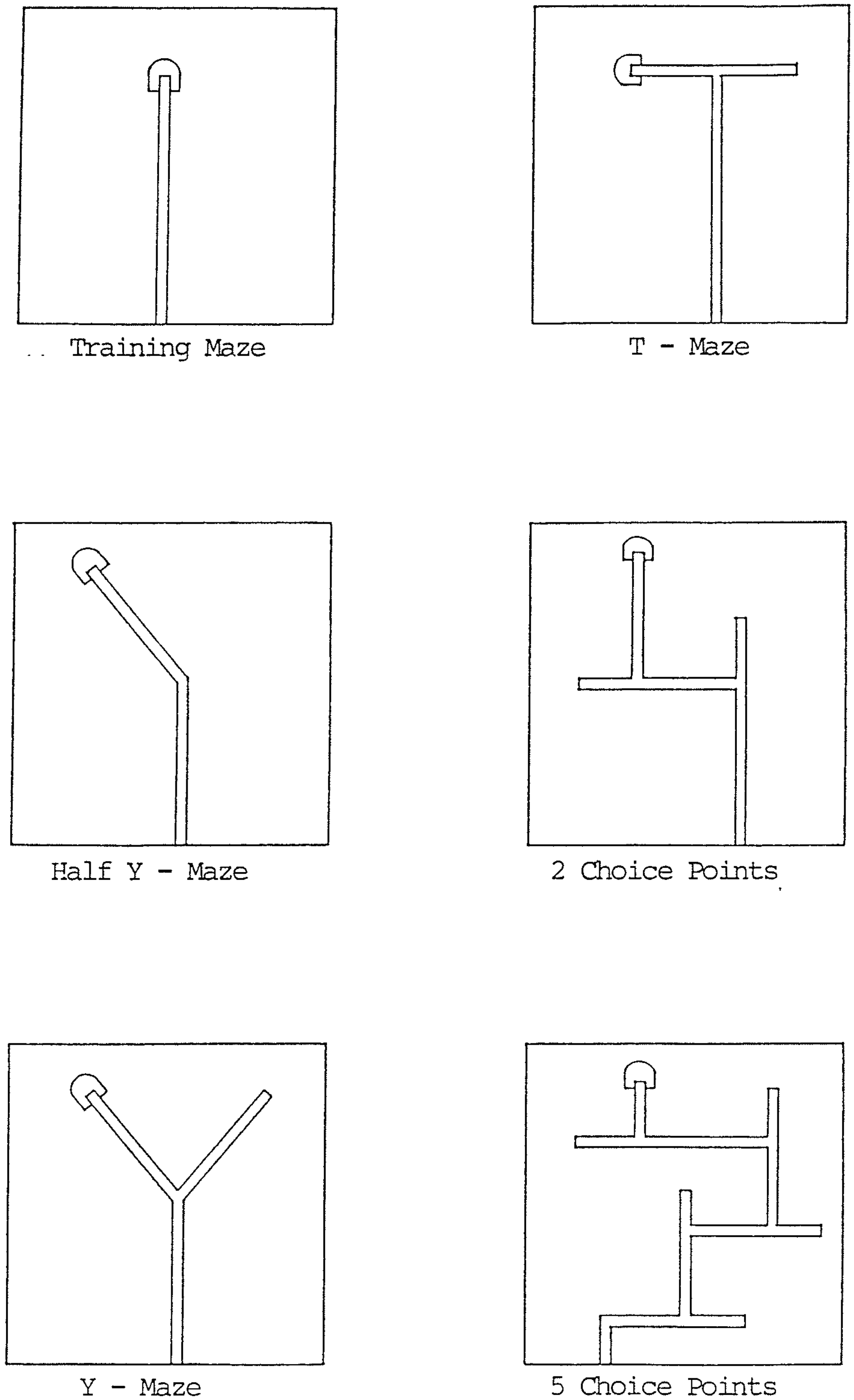
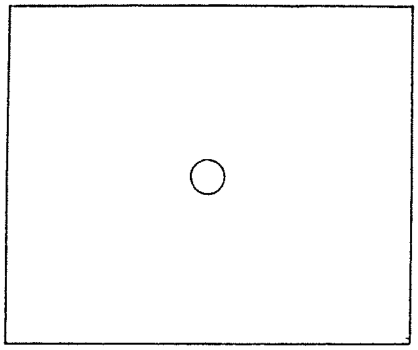
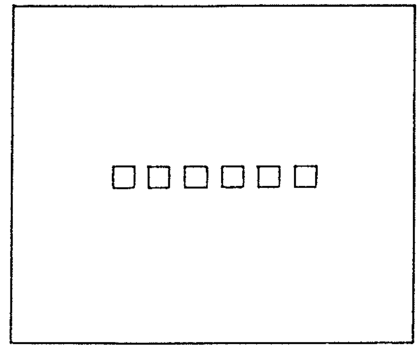


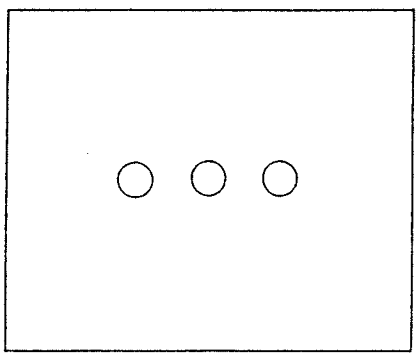
Figure 2. Maze Task



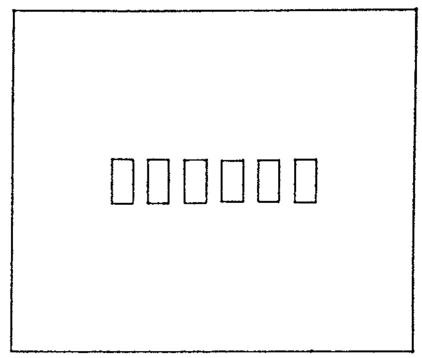
Training Template



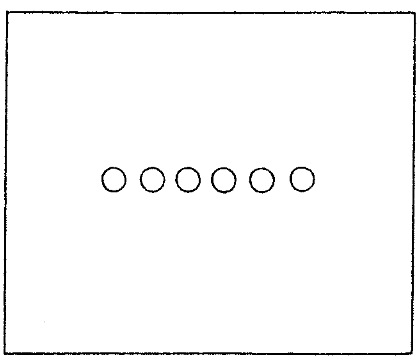
6 Square Holes



3 Round Holes



6 Rectangular Holes



6 Round Holes

Figure 3. Peg Task

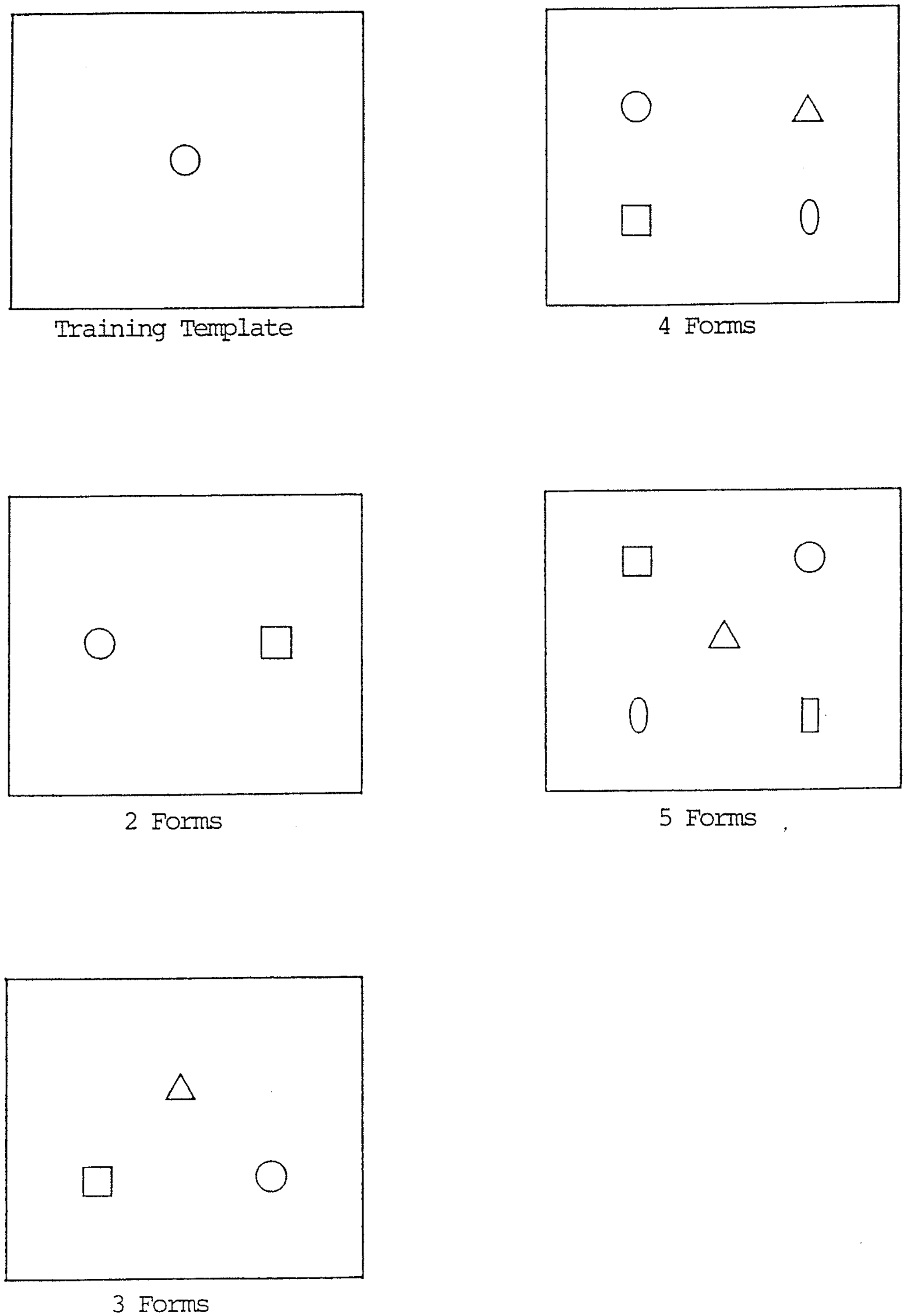


Figure 4. Form Task.

APPENDIX C

PRESENTATION ORDER OF THE MASTERY MOTIVATION TASKS

Figure 1

Distribution of Presentation Orders of the Mastery Tasks

	PRESENTATION ORDER	EXPERIMENTAL		CONTROL	
		MALE	FEMALE	MALE	FEMALE
1	M - P - F				
2	P - F - M				
3	P - F - M				
4	F - P - M				
5	F - M - P				
6	M - P - F				
7	M - F - P				
8	P - M - F				
9	F - M - P				

APPENDIX D

CODE SHEET FOR DATA TRANSCRIPTION OF CHILD'S FACIAL EXPRESSION FROM THE VIDEOTAPE

Child Code # ____________ Task ______ Presentation order ____________

Control ____ Experimental ____

Trippinghatch/ 2nd prompt ____________

Onset ________ Offset ________

Tester ____

	1	2	3	Event 4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Onset 32
Template ____																																
Trial ____																																
F. of S.S. ____																																
Template ____																																
Trial ____																																
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Child Code #________ Control ____ Tester____

Task ______ Presentation order________ Experimental____

	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66

APPENDIX E

INTEROBSERVER AND INTRAOBSERVER RELIABILITY ON CHILD'S FACIAL EXPRESSIONS

Table E1.

Percentage of Interobserver and Intraobserver Reliability on the ratings of facial components based on 36 judgements.

Facial Regions	Inter-reliability	Intra-reliability
Position of eyebrow	80	76
Qualitative characteristic of eyebrow	96	92
Openness of eye	93	72
Direction of gaze	98	92
Line of lip	93	77
Qualitative characteristic of lips	99	97
Openness of mouth	94	87
Qualitative characteristic of mouth	99	98

APPENDIX F

UNCODEABLE COMPONENTS

Table F1.
Percentage of Uncodeable Components Summed Across Tasks and Trials

	Episode Time Sample									
Template I	B1	B2	B3	E	O	AO1	AO2	AO3	AO4	AO5
Position of Eyebrow	39.6	37.5	40.3	37.5	36.5	36.5	32.5	27.8	22.3	15.1
Qualitative Characteristics of Eyebrow	39.6	37.5	40.3	37.5	36.5	36.5	33.4	28.6	23.0	15.9
Openness of Eyes	2.1	.7	1.4	0	0	0	0	.8	1.6	.8
Direction of Gaze	2.1	.7	1.4	0	0	0	0	0	.8	0
Line of Lip	11.8	9.7	11.1	5.6	.7	.8	1.6	1.6	1.6	1.6
Qualitative Characteristics of Lips	11.8	9.7	11.1	5.6	.7	.8	1.6	1.6	1.6	1.6
Openness of Mouth	11.8	9.7	11.1	5.6	.7	.8	1.6	1.6	1.6	1.6
Qualitative Characteristics of Mouth	11.8	9.7	11.1	5.6	.7	.8	1.6	1.6	1.6	1.6
Template II										
Position of Eyebrow	39.6	39.6	43.9	41.7	32.5	35.0	33.4	30.1	22.0	21.1
Qualitative Characteristics of Eyebrow	39.6	39.6	43.9	41.7	32.5	35.0	33.4	30.1	22.0	21.1
Openness of Eyes	5.0	2.2	2.9	2.2	0	0	.8	.8	1.6	.8
Direction of Gaze	5.0	2.2	2.9	2.2	0	0	.8	.8	1.6	0
Line of Lip	17.3	15.1	13.7	9.4	0	0	1.6	.8	.8	.8
Qualitative Characteristics of Lips	17.3	15.1	13.7	9.4	0	0	1.6	.8	.8	.8
Openness of Mouth	17.3	15.1	13.7	9.4	0	0	1.6	.8	.8	.8
Qualitative Characteristics of Mouth	17.3	15.1	13.7	9.4	0	0	1.6	.8	.8	.8

APPENDIX G

QUALITATIVE ASPECTS OF THE EYEBROW, LIP AND MOUTH

Table G1.

Percentage of children with ratings of "did not occur" for each of the qualitative aspects of the eyebrow, lip and mouth summed across tasks and trials.

		B1	B2	B3	E	O	AO1	AO2	AO3	AO4	AO5
Template I											
Eyebrow	a	99	100	98	99	99	100	100	100	100	100
Lip	b	94	95	94	96	94	94	94	94	97	98
Mouth	c	94	95	95	95	86	79	74	73	70	68
Template II											
Eyebrow	a	99	100	97	99	100	99	100	98	100	95
Lip	b	90	95	93	91	92	92	86	92	93	92
Mouth	c	95	96	96	94	80	71	65	60	61	62

Note:
a) form
b) corners of mouth
c) amount of teeth visible

APPENDIX H

LATENCY TO ONSET

Table H1.

Latency to Onset of change in facial expression for each of maze and peg tasks.

	Maze Task		Peg Task	
	Mean	S.D.	Mean	S.D.
Template I				
Trial 1	.64	.88	.61	.68
2	.54	.66	.75	.83
Template II				
Trial 1	.39	.47	.50	.48
2	.73	.82	.55	.92

APPENDIX I

PERCENTAGE OF CHILDREN WITH CHANGE OF FOCUS

Table 11.

Percentage of Children with Change of Focus (Code - 8)

	B1	B2	B3	E	O	AO1	AO2	AO3	AO4	AO5
Template I	0	0	0	0	0	1.6	9.5	23.0	40.5	53.2
Trial 1	0	0	0	0	0	1.7	11.9	23.7	39.0	49.2
2	0	0	0	0	0	1.5	7.5	22.4	41.8	56.7
Template II	0	0	0	0	0	.8	5.7	17.1	30.9	46.3
Trial 1	0	0	0	0	0	1.6	6.6	14.8	32.8	49.2
2	0	0	0	0	0	0	4.8	19.4	29.0	43.5
Total	0	0	0	0	0	1.2	11.6	20.1	35.7	49.8

APPENDIX J

PEARSON CHI SQUARE TEST OF HOMOGENEITY OF PROPORTIONS

Appendix J.

Pearson Chi Square Test of Homogeneity of proportions

Differences between baseline and each of event (E), Onset (O) and the five subsequent .5 second intervals (AO1, AO2, AO3, AO4, AO5) were tested using the Pearson Chi square test of homogenity of proportions. There are 3 underlying assumptions which restrict its usage, however, the sample size used in this study was sufficiently large enough to rule out two of the assumptions:

> "It is assumed that the distribution of the latter can be approximated to the former".
>
> "A second assumption is that the sampling distribution of the observed frequencies about a given # follows the normal curve."
>
> "A third assumption is that the observations be independent of one another. This assumption is isolated when the total of the observed frequencies exceeds the total number of persons in the sample(s). Such an inflation of N occurs when multiple observations are made on each person and each person is counted more than once." (McNemar, 1955).

In this study the facial expressions before and after the event are independent even if the subjects are not. They are considered independent given that it is impossible to predict the child's facial expression upon achievement of the goal (Event), at Onset (O) and in subsequent time frames based on the baseline (B1, B2, B3) facial expression for each trial.

APPENDIX K

MODAL RATINGS FOR BASELINE 1, 2, & 3

Table K1.

Number of children with modal ratings for each of (a) openness of eye, (b) line of lip, (c) openness of mouth on baseline 1, 2, 3 for tasks, templates and trials.

(a)

			OPEN EYE					
			MISS	2	3	4	5	TOT
ALL			4	7	212	58	2	283
TASK	TEMPLATE	TRIAL						
1	1	1			33	2	1	36
		2	1	1	24	10		36
	2	1	2	2	28	4		36
		2		2	26	5		33
2	1	1			26	9	1	36
		2		1	26	9		36
	2	1		1	28	7		36
		2	1		21	12		34

(b)

			LINE LIP					
			MISS	2	3	4	5	TOT
ALL			22	19	37	196	9	283
TASK	TEMPLATE	TRIAL						
1	1	1	1	2	9	23	1	36
		2	1	4	3	28		36
	2	1	2	2	5	25	2	36
		2		7	5	20	1	33
2	1	1		3	6	26	1	36
		2	8	1	5	22		36
	2	1	2		1	30	3	36
		2	8		3	22	1	34

(c)

			OPEN MOUTH					
			MISS	1	2	3	4	TOT
ALL			22	6	31	214	10	283
TASK	TEMPLATE	TRIAL						
1	1	1	1	2	2	30	1	36
		2	1		3	31	1	36
	2	1	2		3	31		36
		2		2	4	25	2	33
2	1	1		1	2	32	1	36
		2	8		2	24	2	36
	2	1	2	1	7	24	2	36
		2	8		8	17	1	34