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17 Equivalent Relations of Facial Expressions in Autism

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I. Introduction

1. Deficits of Facial Expression Functions in Children with Autism

Individuals with autism have deficits in social cognition and behavior. According to DSM-IV (American Psychiatric Association, 2000), a diagnostic criteria, their deficits may include the following characteristics: 1) Qualitative impairment in social interaction: lack of non-verbal communications such as eye contact and gestures, and lack of sharing experiences about enjoyment, interest and achievements with other people, 2) qualitative impairments in communication: delay of and lack in the development of spoken language, and 3) stereotyped patterns of behavior, and restricted interests.

The modified Checklist for Autism in Toddlers (M-CHAT) is the questionnaire, that can detect individuals with autism as young as eighteen months old (Robins, Fein, Barton, & Green, 2001). Questions are consisted of 23 items including two dummy questions, and seven out of 21 questions relate to the recognition of facial expression. Out of seven questions, four questions refer to the dyadic (i. e., person-person) relations, such as "response to peek-a-boo," "response to face and smile," "look at others' eyes," and "imitation of facial expression." Three questions refer to the triadic (i. e,. person-event-person) relations, such as "initiating joint attention (IJA)," "responding joint attention (RJA)," and "social-referencing."

2. Developmental Mechanism for Facial Expression

2.1. Pictures

Researches using still pictures as stimuli showed no differences for the comprehension of facial expressions between adults with and without autism (Adolphs, Sears, & Piven, 2001), and children with and without autism (Castelli, 2005). Robel et al. (2004) also found no differences in correct responses facial expression comprehension between typically developed children and children with autism, age six to ten years (average VIQ: 88). This suggests that facial recognition ability develops by the age of six in children with autism.

Grossman and Tager-Flusberg (2008), however, reported that when the eyes were masked in the pictures of faces, the correct responses decreased in typically developed children, whereas there was no change in children with autism (CA: 13.8, VIQ: 105.4). This result indicated that children with autism only partially paid attention to the facial expressions.

2.2. Movies

Many researches with movie also have conducted. Tardif, Laine, Rodriguez, and Gepner (2007) reported that there was no significant difference between typically developed children and children with autism (CA: 10.5, VMA: 5.1), except for the case of slow change in facial expression (i.e., neutral to happy). They also reported that spontaneous facial expressions and vocal imitation were accelerated when a vocal response from the experimenter was presented (i.e., "slowly") while changing the facial expression. The results indicated that children with autism showed difficulties in facial recognition due to the fact that others' facial expressions changed very fast, and it was hard for them to process facial expressions sequentially (Nakano, Ota, Kato, & Kitazawa, 2010).

2.3. Intensity

The intensity of facial expression stimuli affects to individuals' recognition of facial expressions. Rump, Giovannelli, Minshew, and Strauss (2009) reported that children with autism (CA: 6.4, VMA: 97.89) showed difficulties

in facial expression comprehension when intensity of facial expression stimuli was low.

2.4. Social Interaction

Research about the social interactions of two persons' facial expressions also have been conducted. Klin, Jones, Schultz, Volkmer, and Cohen (2002) presented the movie clips (30 to 60 seconds duration) of social interactions of two adults to individuals with autism (CA: 15.4, VIQ: 101.3) and typically developed persons. As a result, individuals with autism gazed more at the mouth, body, and objects, rather than gazing at the eyes.

3. Stimulus Characteristics in Facial Expression

Facial expressions in daily life change quickly and its intensity is weak. Moreover, during interpersonal interaction, the stimulus change is faster, and other behaviors also occurr simultaneously. Individuals with autism have difficulty in attending to such rapidly changing and complicated stimuli. That is to say, difficulties in recognizing facial expressions for individuals with autism are due to their high speed changing and weak intensity of their facial expressions.

Considering the results from the previous studies, we developed a possible intervention methodology for improving the facial recognition of individuals with autism. This infervention would involve: 1) using facial stimuli that change a lot from each facial expression, 2) changing facial expressions slowly, and 3) making visual attention move along with the change of the movie stimulus of facial expression. Once the facial recognition was established by using these cues, we gradually faded the stimuli to everyday life presentations.

4. Equivalent Relations in Facial Expressions

The emergence of equivalent relations among stimuli can explain higher-order psychological functions. Sidman (2000) argued that equivalent relations consist of reflexivity, symmetry, and transitivity. Figure 1 illustrats each stimulus relation for "cognition" about facial expressions.

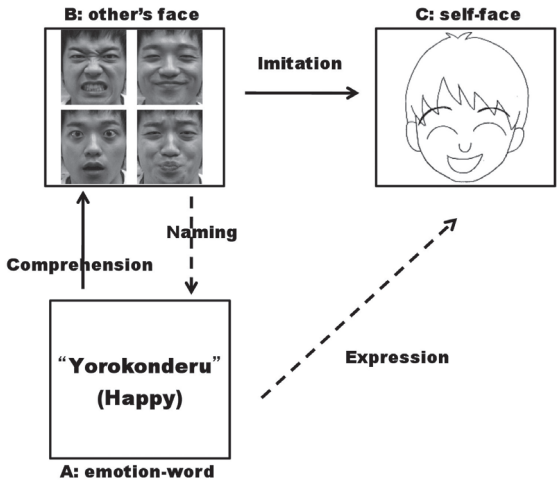

Figure 1. Equivalent relations in facial expression

Three stimulus sets were involved in the equivalent relations: emotion-word (A), other's face (B), and self-face (C). The four stimulus classes were the following four: "happy" (1), " sad" (2), "angry" (3), and "surprised" (4).

4.1. Reflexivity

The following are examples of reflexivity occurred in the following case; "B → B." Matching the facial expression pictures of "happy" (B1) to the same facial expression of "happy" (B1); B1 → B1. Matching the facial expression pictures of "sad" (B2) to the same facial expression of "sad" (B2). B2 → B2. Other stimulus classes were evaluated in the same way, such as "B3 → B3" and "B4 → B4." Reflexivity was expressed as: 'If "B → B", then "B → B."'

4.2. Symmetry

Symmetry occurs in the following example. The child was taught to select the corresponding other's facial expression picture (B), when presented with an emotion word (A) as a sample stimulus. Then, a test was conducted to evaluate whether the child was able to name the facial expression with the emotion-word (A) without training when a facial expression picture (B) was

presented as a sample stimulus. This was expressed as: 'If "A1 → B1," "A2 → B2," "A3 → B3", and "A4 → B4," then "B1 → A1," "B2 → A2," "B3 → A3," and "B4 → A4." In other words, this can be expressed as: If "A → B," then "B → A."

4.3. Transitivity

Transitivity occurs in the following example. The child was taught to select other's facial expression stimulus (B), when presented with an emotion-word (A) as a sample stimulus. Also, the child was taught to express her/his facial expression (C), when presented with a facial expression picture (B) as a sample stimulus. After the acquisition of these two correspondences, the child was tested to evaluate whether s/he could express the facial expression without training when the emotion-word (A) was presented as a sample stimulus. This can be expressed as: If "A → B" and "B → C," then "A → C."

II. Experiment

1. Purpose

Individuals with autism have various kinds of difficulties with the comprehension and production of facial expressions, both with reference to themselves and others. Therefore, we needed to consider a comprehensive analysis for perception, conceptualization, comprehension, verbal-naming, imitation, appreciation of the situation, prosodic inference, and self-other mapping for examining facial expressions.

We developed a comprehensive assessment and learning support program for facial expression called the Face-Expression Expert Program (FEEP), which was based on the framework of the equivalent relations (Sidman, 2000) among the four types of stimuli. The program consisted of four sets of stimuli ("picture of facial expression," "emotion-word," "descriptive sentence," and "prosody of emotion") covering a wide developmental age range.

From the perspective of equivalent relations, Shimamune and Hosohata (2008) uesd the paradigm of stimulus equivalence with two students with

developmental disabilities. In their study, cartoon characters were used as stimuli in order to teach emotion-words for facial expressions.

In the present study, we analyzed the symmetrical relations between facial expression and the corresponding emotion-words and the transitive relations among emotion-words, the other's facial expressions and the self-facial expressions.

2. Methods

Participant

An 11-year 8-month old student with an autism spectrum disorder participated in the present study.

Stimulus

Stimulus Set A: Facial Expression photos. Standardized sets of facial expression photos (ATR facial expression database 99: ATR-Promotions) and phothos of six college students were used as stimuli. The categories of the expressions were "happy," "sad," "angry," and "surprised."
Stimulus Set B: Emotion-words. Four kinds of auditory words were used; "yorokonderu (happy)," "kanashinderu (sad)," "okotteru (angry)," and "odoroiteru (surprised)."

Procedure

The following tasks were evaluated;

1) *Comprehension task (word → selection of picture)*: The student was required to point to one of the facial expressions (choice stimuli) corresponding to the presented emotion-word. For example, the experimenter asked the student, "which one is the happy face?"
2) *Naming task (picture → word naming)*: The experimenter presented the picture of the facial expression on the computer display to the student as a sample stimulus, and then asked, "What is the name of this face?" The experimenter required the student to make vocal response such as "happy."
3) *Imitation task*: The experimenter sat facing the student and made one of the facial expressions by moving his face to be like the sample stimulus. He then asked the student to imitate the presented face,

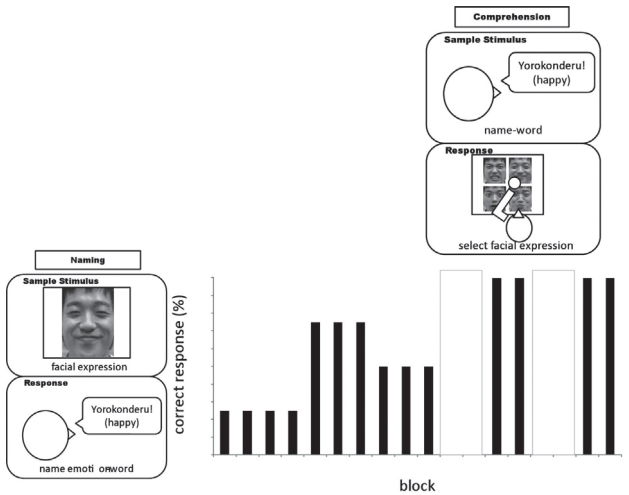

Figure 2. The percentage of correct responses on the Naming task.

saying "Please make your face the same as this face."

4) *Expression task*: The student was asked to make a facial expression corresponding to the spoken emotion-word (i.e., "Please make your face happy").

Each task consisted of a random order of the four sample stimuli as one block.

3. Results and Discussion

The percentags of correct responses on the Naming task are shown in Figure 2. Since the correct responses did not reach 100% at the 10th block, the Comprehension task was implemented. As a result, the percentage of correct responses on the Naming task was 100%. A symmetrical relationship emerged between the Comprehension and Naming tasks. This suggests that comprehension and naming of emotion-words are closely related.

Figure 3 illustrats the percentages of correct responses on the Imitation and Expression tasks. The percentage of correct responses reached 100% in the fifth block of the Imitation task. The percentage of correct responses was maintained at 100 % for four blocks of the Expression task from the first block.

The present experiment showed several equivalent relations: 1) a sym-

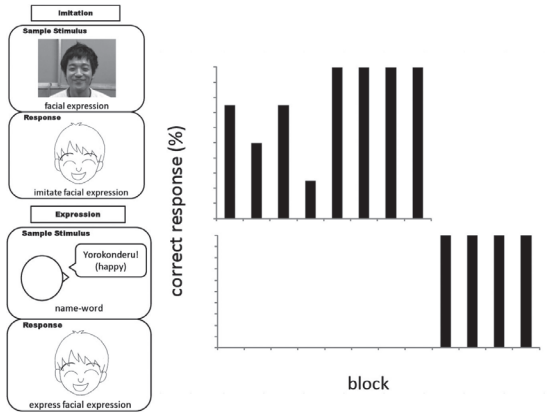

Figure 3. The percentage of correct responses on the Imitation and Expression tasks.

metrical relation emerged between comprehension and naming, 2) a transitive relation emerged among word-name, other's facial expression, and self-facial expression. Research using live action movies, rather than still pictures, should be conducted in the future.

We will develop this experimental program into a computer-based teaching (CBT) program. This could facilitate more comprehensive research, such as a comparative study between children with autism and children with other developmental disorders, such as William's syndrome. Also, we can conduct assessment and intervention studies using this CBT platform.

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