**Original Article**

**Modification of Physiological and Behavioral Responsivity to Auditory Stimuli with the Progress of Dohsa-Method Training in Children with Autism**

Yoshitaka KONNO

This study examined the modification of responsivity to auditory stimuli in children with autism. In Study I, finger plethysmograph and behavioral responses to auditory stimuli (a 1000-Hz 75-dB pure tone, a 1000-Hz 90-dB pure tone, and calling of a participant's name ("Naming")) of 7 children with autism (6.8 to 7.5 years) were compared with those of 6 age-matched children without autism. Study II explored responsivity changes with the progress of Dohsa-method training in children with autism. In Study I, participants without disabilities revealed distinctive responses to the stimuli with decrements in finger plethysmograph amplitude and behavioral indices of attending to the stimuli. In contrast, those responses were not observed in children with autism, and a few subjects revealed anxiety responses to the 1000-Hz 90-dB pure tone stimulus. In Study II, much improvement in responsivity to auditory stimuli was found, especially at Stage 3 of Dohsa-method training. Participants showed distinctive physiological and behavioral responses considered to be indices of an orienting response. They could also alleviate a negative emotional response conceived as a defensive response to a 1000-Hz 90-dB pure tone, and they could reveal a positive emotional response to Naming. Based on these results, we believe Dohsa-method training is beneficial for children with autism with regard to improving defensive attitudes to social and auditory stimuli and establishing joint attentional behaviors.

Key Words: Dohsa-method training, modification of responsivity to auditory stimuli, finger plethysmograph, children with autism

**Purpose**

Autistic disturbance is described as a lack of apparent affect, withdrawal from people, lack of attention to people, noncommunicative use of language, lack of communicative gestures, treating parts of people as detached objects, lack of eye contact, treating people as inanimate objects, lack of behavior appropriate to cultural norms, attention to nonsocial aspects of people, and lack of awareness of the feelings

Faculty of Education, Bunkyo University
of others. Wing and Gould (1979) defined what all autistic children have in common as a distinctive triad of impairment, namely, the impairment of social, communicative, and imaginative activities.

A commonly observed characteristic of autistic children is selective unresponsivity to environmental stimuli. In particular, unresponsivity to auditory stimuli is so prevalent characteristic of autistic children that deafness is often suspected. Because adults are unable to attract autistic children’s attention by calling their names or speaking to them, autistic children have been described as living “in a shell.”

Van Engeland (1984) examined electrodermal orienting responses to auditory stimuli of moderate intensity in a group of autistic children and in control groups (children with mental retardation, children with psychoses, and children with no disabilities). Autistic children, as compared with children from the control groups, were significantly more often nonresponsive to the first trial. Dawson, Meltzoff, Osterling, Rinaldi, and Brown (1998) compared children with autism to developmentally matched children with Down syndrome or with typical development in terms of their ability to orient visually to two social stimuli (name called, hands clapping) and two nonsocial stimuli (rattle, musical jack-in-the-box), and in terms of their ability to share attention (following another’s gaze or pointing). They found that, compared to children with Down syndrome or typical development, children with autism more frequently failed to orient to all stimuli, and that this failure was much more extreme for social stimuli. Children with autism also exhibited impairments in shared attention. Results suggest that social orienting impairments may contribute to the difficulties in shared attention found in autism.

Palkovitz and Wiesenfeld (1980) compared the autonomic response of autistic and other children by using auditory stimuli that varied in social relevance. Consistent differences in heart rate responses and skin conductance level were found between the groups. The results suggest that children with autism exhibited deficits in psychophysiological reactivity to environmental stimuli. Ujimori, Yamanaka, Yajima, and Mae (1986) examined the effects of auditory stimuli on responses in the autonomic nervous system and overt behaviors in children with autism, children without disabilities, and children with mental retardation. They used finger plethysmograph readings, electrocardiogram monitoring, skin potential reflex results, and respiration monitoring to measure autonomic responses. Participants were presented with a 1000-Hz 72-dB pure tone and an experimenter’s voice calling the child’s name through a loudspeaker. Participants with autism showed fewer autonomic responses to the pure tone than did members of the control groups, and participants with autism showed greater autonomic responses to a voice calling the child’s name, even revealing difficulty in habituation to repetitive voice stimuli. Ujimori et al. (1986) suggested that once participants with autism could recognize the meaning of a stimulus, they would be so excited at the cortical level that they would respond defensively to the stimulus. Konno (1980) also examined finger plethysmograph responses to auditory stimuli in autistic children and found similar results in testing with a pure tone, although a defensive response to the naming stimulus could not be
Modification of Responsivity to Auditory Stimuli

found. However, a very interesting finding was obtained in this study. One participants who was falling asleep during the experiment showed a marked decrease in amplitude response for a 1000-Hz 75-dB pure tone. This phenomenon suggested that under low arousal level, autistic children could “attend” to auditory stimuli without defensive attitudes.

What are the primary causes of nonresponsivity in autistic children? Various hypothetical deficits have been proposed. Hermelin and O’Connor (1968), on the basis of an extensive series of laboratory studies, concluded that children with autistic syndrome display an impaired ability to integrate input and output data and to process information from various sources. Rimland (1964) suggested that malfunction of the reticular activating system (RAS) resulted in underarousal to incoming stimuli, with consequent inability to relate new to remembered experience. In contrast, Hutt, Hutt, Lee, and Ounsted (1964) postulated that a chronically high level of RAS activity produces a blocking of sensory pathways.

Ornitz and Ritvo (1968) postulated a model of disturbance of arousal self-regulation, in which autistic children become hyperresponsive to visual and auditory stimuli and are as a result flooded with feelings in certain social situations that are difficult for them to accept or cope with. This is why, according to Bettelheim (1967), autistic children cover their ears or eyes with their hands to exclude auditory or visual stimuli. Kobayashi (1976) and Konno and Ohno (1981) indicated that autistic children develop various stereotyped movements and avoidance behaviors as they are confronted with psychological stress or difficult situations. James and Barry (1980) indicated that autistic children differed from both children with retardation and children with typical development in two aspects: a failure to habituate phasic respiratory responses, and enhanced response magnitude in the vascular systems. Such a hypersensitivity, combined with abnormalities in the habituating mechanism, suggests that autistic children are constantly bombarded by a multitude of environmental stimuli. It is conceivable that the stress of such constant sensory stimulation would lead to selective attention deficits, abnormal perceptual responses, and ultimately, behavioral withdrawal as a defensive mechanism (Konno, 1987).

Konno (1982) found that responses to auditory stimuli became more apparent as avoidance behaviors diminished. These results suggested that the reason autistic children are unable to respond to auditory stimuli is not their hearing problems but their defensive attitudes toward the stimuli. Furthermore, as a defensive strategy grows, the children may develop a state of aloofness in which they disregard, ignore, and shut out most of the stimuli that come from outside (van Engeland, 1984).

These studies suggest that some types of avoiding behaviors and stereotyped movements are learned behaviors, with which autistic children try to adapt to their internal and external environments. Consequently, they suffer from difficulties in establishing the mind-body schemata necessary for relating to both their environments and themselves in an ordinary way. One of the conceivable reasons why autistic children have failed to establish a well-functioning mind-body schemata and have instead developed a functional discrepancy between mind and body is that they
Y. Konno

are too sensitive and vulnerable to internal and external stimuli, including human interaction. Since those stimuli strain their mind and body, they perceive those stimuli as being too stressful to accept, resulting in a distortion in the linkage between mind and body from very early on in life. Thus, autistic children may fail to establish a bodily-identification or body-image, which is an integral construct of self-identification or self-image with which they relate to both themselves and others. They also develop defensive attitudes towards environmental stimuli and withdraw from their environments (Konno, 1992). In addition, since autistic children have difficulties accepting their bodily sensations or bodies from very early on in life, they may perceive their bodies as alien to themselves and unacceptable as their own, and fail to make sense of bodily experience, thus resulting in a deficit of body-experience-based joint attention (Konno, 1993). Therefore, one of the most important educational themes for autistic children is to establish well-functioning self-activity based on a reorganized bodily-identification or body-image (Konno, 1987; Konno, 1992). According to Konno (1984, 1992), Dohsa-method training would be beneficial for reducing a defensive mind-body tension, establishing a harmonious mind-body relation as well as the relation to others and to various environmental stimuli as well.

The purpose of the present study was to replicate and then further explore the findings of previous studies (Konno, 1980; Konno, 1982) in two experiments. In Study I, autistic children's finger plethysmograph responses were compared with those of children without disabilities. Study II explored responsivity changes with the progress of Dohsa-method training in autistic children.

Study I: Comparison of Responses between Autistic and Children without disabilities

1. Method
1-1. Participants

Seven autistic boys and 6 boys without typical development participated in this study. The mean CA was 7.9 years with a range of 6.4-9.8 years for the autistic group, and 7.3 years with a range of 6.8-7.5 years for the other group. Autistic children met the DSM-III diagnostic criteria for autistic syndrome and revealed behavioral characteristics such as hypersensitivity to environmental stimuli, resistance to environmental changes, perseveration in maintaining sameness, covering their ears in a noisy situation, avoiding eye contact with others, and rocking the body or flapping the hands when confronted with difficult situations.

The intelligence level of the children with autism, estimated using the WISC-R, ranged from mildly retarded to moderately retarded. Children with autism were recruited from clients visiting the author's office who were seeking Dohsa-method-based developmental counseling. The other children were recruited from a neighboring elementary school with spoken informed consent from both the children and their parents. Because of the necessity for an adjustment period to the experimental
Modification of Responsivity to Auditory Stimuli

situation, autistic children underwent the experiment two to three months after starting Dohsa-method training. This period corresponds to Stage 1 of Dohsa-method training as described later. The other children participated in the experiment shortly after visiting the author’s office.

1-2. Auditory Stimuli

Auditory stimuli used in this study were a 4-second 1000-Hz, 75-dB pure tone, a 4-second, 1000-Hz, 90-dB pure tone, and the calling of a child's name (“Naming”). Pure tone stimuli were generated by a photo-phono generator (SANEI, type P-S202) and presented through a loudspeaker positioned on the floor one meter from a participant’s head. The Naming stimulus was presented through another speaker placed next to the first one. These stimuli were presented three times in random order with 30- to 40-second inter-stimulus intervals.

1-3. Physiological and Behavioral Measures

As a physiological measure of auditory response, a finger plethysmograph was used to record from the tip of the left index finger using a Biophysiograph (SANEI, type 120) with time constant 1.5 at a paper speed of 5 mm per second. Calibration of the recording was 0.5 cm per 1 mV.

An orienting response is what is elicited by novel stimuli with moderate intensity that draw the attention of an organism. Pavlov (1927) called it “investigating” and a “what-is-it?” reaction. In contrast, stimuli with high intensity evoke a “defensive response.” According to Sokolov (1963), plethysmograph patterns during an orienting response are characterized by a temporal decrease in amplitudes in the hand (vasoconstriction) and also by a temporal increase in the head region (vasodilation) within a few seconds following stimulus onset, followed by a gradual recovery of original amplitudes, whereas a defensive response results in prolonged vasoconstriction both in the hand and in the head region.

An additional characteristic of an orienting response is habituation to the repetition of the same stimuli. In this study, samples of finger plethysmograph measurements were collected over a 15-second period, beginning 5 seconds prior to stimulus onset and continuing for 10 seconds after starting the stimulus. The latter period was divided into four 2.5-second consecutive blocks. The amplitude of finger plethysmograph readings was measured from the chart of the polygraph record, and then the amplitude ratio (% of each consecutive block to the pre-stimulus-onset period) was calculated.

Orienting responses during the experiment were recorded using a video-camera, including head turning to the sound, looking at the sound source, stopping the eye movement and bodily movement, changing of facial expression, answering to one's name, and so on.

1-4. Procedure

All participants were tested individually in a sound-attenuated experimental
Y. Konno

Fig. 1 Comparison of mean amplitude ratios of finger plethysmograph responses between the autistic group and the other group, across four 2.5-second consecutive blocks (Block 1, Block 2, Block 3, and Block 4) for a 1000-Hz 75-dB pure tone.

Fig. 2 Comparison of mean amplitude ratios of finger plethysmograph responses between the autistic group and the other group, across four 2.5-second consecutive blocks (Block 1, Block 2, Block 3, and Block 4) for a 1000-Hz 95-dB pure tone.

chamber. The room was 2.5 meters long by 3 meters wide and equipped with good lighting and a video-camera in a corner of the ceiling. To make the participants feel at ease, two female assistants involved in the participants' training accompanied them. After entering the experimental room, the participant lay on his back, and a finger plethysmograph pickup was attached to the tip of the second finger of his left hand. To prevent artifacts through bodily movements, one of the assistants placed her hands on the participant's legs and the other placed her hand on his left hand. Auditory stimuli followed five to eight minutes of resting, during which time recordings were made as they would be made when stimuli began.
Modification of Responsivity to Auditory Stimuli

![Graph showing mean amplitude ratio (%) for Naming across blocks for Autistic and Other groups.]

**Fig. 3** Comparison of mean amplitude ratios of finger plethysmograph responses between the autistic group and the other group, across four 2.5-second consecutive blocks (Block 1, Block 2, Block 3, and Block 4) for Naming.

2. Results

2-1. **Comparisons of Amplitudes between Autistic and Non-Disabled Groups**

Figure 1 compares the mean finger plethysmograph amplitude ratios for the reaction to a 1000-Hz 75-dB pure tone between members of the autistic group and members of the other group. As shown in this figure, the children without disabilities revealed remarkable decrements in amplitude ratios during Block 2 (76%), Block 3 (68%), and Block 4 (72%), whereas in the autistic group, very few decrements were observed (Block 1: 98%, Block 2: 96%, Block 3: 92%, and Block 4: 95%). As depicted in Fig. 2, similar results were found for a 1000-Hz 90-dB pure tone. The children without disabilities clearly revealed amplitude ratio decrements during Block 2 (76%), Block 3 (68%), and Block 4 (69%). On the contrary, the autistic group revealed very few decrements (i.e., Block 2: 92%, Block 3: 90%, Block 4: 92%). As shown in Fig. 3, the children without disabilities showed more remarkable decrements in amplitude ratios during Block 2 (76%), Block 3 (74%), and Block 4 (81%) for Naming. On the contrary, the autistic group revealed an orienting response in amplitude decrements only at Block 3 (87%).

After converting each amplitude ratio (%) into an angular transformed value ($X' = \sin^{-1}\sqrt{p}$), a two-way analysis of variance (Group × Block) was carried out for each auditory stimulus. Significant main effects were found for Group (1000-Hz 75-dB F (1,44) = 20.821, p < .001; 1000-Hz 90-dB F (1,44) = 18.574, p < .001; Naming F (1,44) = 10.368, p < .001) and Block (1000-Hz 90-dB F (3,44) = 6.597, p < .05; Naming F (3,44) = 10.642, p < .001). Moreover, significant interactions between Group and Block were found for the 1000-Hz 75-dB pure tone (F (3,44) = 7.726, p < .001) and the 1000-Hz 90-dB pure tone (F (3,44) = 23.164, p < .001). These results suggest the decrease of finger plethysmograph amplitudes in children without disabilities as an orienting response to the stimuli, whereas the autistic children’s responses are ambiguous in terms of an orienting response.
<table>
<thead>
<tr>
<th>Participants</th>
<th>Behavioral Characteristics</th>
<th>Response to a 75-dB Pure Tone</th>
<th>Response to a 90-dB Pure Tone</th>
<th>Response to Naming</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participant 1</td>
<td>Fears toilet flushing sound</td>
<td>No particular response</td>
<td>Looks anxiously around the room with a grimace</td>
<td>Turns the head toward the sound source</td>
</tr>
<tr>
<td>(8.10 yrs)</td>
<td>Exhibits bodily tension when called</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Perseveres in sameness (food, drawing)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Participant 2</td>
<td>Has strong startle response to an abrupt sound</td>
<td>No particular response</td>
<td>Moves the eyelids and flexes the neck</td>
<td>No particular response</td>
</tr>
<tr>
<td>(6.4 yrs)</td>
<td>Emotionally unstable</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sometimes makes eye contact when called</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Participant 3</td>
<td>Covers ears and flaps hands in response to noise</td>
<td>No particular response</td>
<td>Covers the ears and grimaces</td>
<td>No particular response</td>
</tr>
<tr>
<td>(9.8 yrs)</td>
<td>Perseveres in sameness (food, route)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Has unstable sleep pattern</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Participant 4</td>
<td>Is awakened from sleep by a small sounds</td>
<td>No particular response</td>
<td>Has startle response, shown by opening the eyes</td>
<td>No particular response</td>
</tr>
<tr>
<td>(7.5 yrs)</td>
<td>Is hypersensitive to tactile stimuli</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Utters a sound when startled</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Participant 5</td>
<td>Behaves as if he cannot hear other’s voice</td>
<td>No particular response</td>
<td>No particular response</td>
<td>No particular response</td>
</tr>
<tr>
<td>(8.4 yrs)</td>
<td>Interested in making musical sound using piano</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Anxious in a group situation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Participant 6</td>
<td>Hypersensitive to sound and over the ears in noisy situations</td>
<td>No particular response</td>
<td>Looks around the room anxiously</td>
<td>Looks around the room without expression</td>
</tr>
<tr>
<td>(7.6 yrs)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sometimes makes eye contact when called</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Participant 7</td>
<td>Exhibits bodily tension in response to a loud sound</td>
<td>Stops eye movement</td>
<td>No particular response</td>
<td>Turns toward the sound and replies with “yes”</td>
</tr>
<tr>
<td>(6.11 yrs)</td>
<td>Anxious in a group situation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Makes eye contact and says “yes” when called</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Modification of Responsivity to Auditory Stimuli

2-2. Comparisons of Behavioral Responses between Members of the Autistic and other Groups

Children without disabilities showed distinctive behavioral changes considered to be orienting responses to the auditory stimuli. They responded to a 1000-Hz 75-dB pure tone stimulus with such behavioral responses as looking at or searching for the direction of the sound source, stopping eye movement, and a facial expression showing interest in hearing the stimulus. Table 1 summarizes the behavioral characteristics and behavioral responses to auditory stimuli of each participant. As shown in this table, less clear behavioral changes were found in all participants with autism except two (Participant 1 and Participant 7) who stopped eye movements or looked around the room when the stimuli were presented.

When a 1000-Hz 90-dB pure tone was used as the stimulus, children without disabilities responded with similar behavioral changes as was observed with the 1000-Hz 75-dB pure tone. On the other hand, Participant 1 responded to the 1000-Hz 90-dB pure tone with an anxiety response, looking anxiously around a room. Participant 2 revealed a frequent eyelid movement and neck flexion. Participant 3 covered his ears with his hands and grimaced, and Participant 4 suddenly opened his eyes and made a face. These behavioral characteristics were considered to be a defensive response rather than an orienting response. However, in spite of these behavioral changes, the participants with autism revealed less decrease in finger plethysmograph amplitudes than that of the other participants.

The children without disabilities responded to Naming stimuli by looking at and smiling at assistants, looking toward the voice source, and verbally answering, such as saying “yes” or “what?” especially to the first presentation of the stimulus. In contrast, of the participants with autism, only two (Participant 1 and Participant 7) looked at the sound source, and they did so without any pleasant emotional expression.

Study II: Changes in Auditory Responsivity with the Progress of Dohsa-Method Training

1. Method
1-1. Participants

Of the children with autism in Study I, five children (Participant 1, Participant 2, Participant 3, Participant 4, and Participant 5) participated in Study II. They all had received Dohsa-method training for more than two years. Besides the experiment carried out in Study I, they underwent the same experiment twice as Dohsa-method training progressed: during the second stage of the training (Stage 2: from 5 to 10 months after starting the training) and during the third stage of the training (Stage 3: from 12 to 19 months after starting the training). As mentioned above, the first stage corresponded to the period of Study I.
Y. Konno

1-2. Characteristics of Each Stage of the Training

Dohsa-method training consists mainly of three kinds of training: relaxation training to relieve bodily tension, volitional control training of bodily movement, and postural control training (Konno, 1990; Konno, 1997). As part of the relaxation training, the author developed “Arm movement control training (Udeage-dohsa control training)” and “Therapeutic touch with sense of melting experience (Tokeau-taiken).” “Arm movement control training” is also utilized for bodily movement control training.

According to Konno (1983, 1984), the progress of Dohsa-method training in autistic children is characterized by the following four stages. During the first stage, autistic children began to be able to accept the training task without crying, pay attention to their bodies, and reduce muscular tension with the trainer’s help. In addition, they are able to reduce emotional excitation and phobic responses to others. During the second stage, they became more vividly aware of bodily tension, began to intentionally pay attention to the process of relaxation, and start to feel better bodily sensations through muscular relaxation. The enhanced awareness of the relaxation of bodily tension enables them to be aware of their emotional states and facilitates the volitional control of emotional behaviors as well. During the third stage, they come to enjoy comfortable bodily sensations through muscular relaxation and cooperative bodily movements with the trainer and to derive pleasure from relating actively to others, indicating the establishment of “bodily experience-based joint attention” between the trainer and the trainee. The subjects are able to control temper tantrum behaviors, engage in fewer repetitive behaviors, perseverative behaviors, or behaviors showing resistance to changes, and decrease their excessive responsivity to auditory and tactile stimuli as well. The fourth stage is characterized by establishing self-control of bodily tension reduction and movements. At this stage, students of this method learn to move the body with an adequate strength and speed and achieve comfortable and stable mind-body states. In this study, all participants reached the third stage.

1-3. Procedures

When each participant had made sufficient progress in the training, he then underwent the experiment twice. The experiment occurred during the second stage of the training (Stage 2) and the third stage of the training (Stage 3). The experiment administered in Study I occurred during the first stage of the training (Stage 1). Apparatus used in this experiment was basically the same as those used in Study I. Auditory stimuli were a 1000-Hz 75-dB pure tone, a 1000-Hz 90-dB pure tone, and Naming. These auditory stimuli were presented three times in random order with 30- to 40-second inter-stimulus intervals. Physiological and behavioral measures were also the same as those used in Study I.
Modification of Responsivity to Auditory Stimuli

**Fig. 4** Comparison of mean amplitude ratios of finger plethysmograph responses among three stages of Dohsa-method training (Stage 1, Stage 2, and Stage 3) across four 2.5-second consecutive blocks (Block 1, Block 2, Block 3, and Block 4) for a 1000-Hz 75-dB pure tone in children with autism.

**Fig. 5** Comparisons of mean amplitude ratios of finger plethysmograph responses among three stages of Dohsa-method training (Stage 1, Stage 2, and Stage 3) across four 2.5-second consecutive blocks (Block 1, Block 2, Block 3, and Block 4) for a 1000-Hz 90-dB pure tone in children with autism.

**2. Results**

2-1. *Comparison of Plethysmograph Amplitudes among Stages*

Figure 4 depicts the changes in mean amplitude ratios for reactions to a 1000-Hz 75-dB pure tone in accordance with progress made during training stages. As described earlier, decrements in amplitude ratios were unclear during Stage 1. However, during Stage 2, there were gradual decrements from Block 1 to Block 4 (i.e., Block 1: 96%, Block 2: 91.2%, Block 3: 88%, and Block 4: 87.2%). During Stage 3, there was a prominent decrement in mean amplitude ratios across the blocks, especially in Block 2 (i.e., Block 1: 88%, Block 2: 62.8%, Block 3: 60.8%, and Block
Y. Konno

Fig. 6 Comparison of mean amplitude ratios of finger plethysmograph responses among three stages of Dohsa-method training (Stage 1, Stage 2, and Stage 3) across four 2.5-second consecutive blocks (Block 1, Block 2, Block 3, and Block 4) for Naming in children with autism.

4: 72.6%), indicating the appearance of orienting responses to the stimuli. After converting each amplitude ratio (%) into an angular transformed value (X' = sin⁻¹ √p), a two-way analysis of variance (Stage × Block) was conducted. A significant main effect was found for Stage (F(2,59) = 32.158, p < .001). Pair comparisons using the Bonferroni method revealed significant differences between Stage 1 and Stage 2 (t = 4.123, df = 48, p < .001), Stage 1 and Stage 3 (t = 8.018, df = 48, p < .001), and Stage 2 and Stage 3 (t = 3.885, df = 48, p < .001).

Figure 5 compares mean amplitude ratios for a 1000-Hz 90-dB pure tone across the stages. There were no clear decrements in amplitude ratios during Stage 1 (i.e., Block 1: 96.4%, Block 2: 96%, Block 3: 97.6%, and Block 4: 98.8%), and subjects showed less prominent orienting responses in the form of amplitude decrements during Stage 2 (i.e., Block 1: 98%, Block 2: 88%, Block 3: 88.4%, and Block 4: 92.4%). There were remarkable decrements in mean amplitude ratios during Stage 3, especially at Block 2 and Block 3 (i.e., Block 1: 88%, Block 2: 62.8%, Block 3: 60.8%, and Block 4: 72.6%). A two-way analysis of variance (Stage × Block) revealed significant main effects for Stage (F(2,48) = 59.114, p < .001) and Block (F(3,48) = 6.112, p < .001). Pair comparisons using the Bonferroni method revealed significant differences between Stage 1 and Stage 2 (t = 3.861, df = 48, p < .001), Stage 1 and Stage 3 (t = 10.733, df = 48, p < .001), and Stage 2 and Stage 3 (t = 6.872, df = 48, p < .001).

Figure 6 compares mean amplitude ratios for Naming. As described above, decrements in amplitude ratios were unclear during Stage 1 (i.e., Block 1: 98.4%, Block 2: 98.4%, Block 3: 98.4%, and Block 4: 96.8%). However, during Stage 2, there were small decrements across the blocks (i.e., Block 1: 88%, Block 2: 86.4%, Block 3: 90%, and Block 4: 89.6%). During Stage 3, more prominent decrements in mean amplitude ratios across the blocks were found (i.e., Block 1: 84.4%, Block 2: 72%, Block 3: 75.2%, and Block 4: 74.4%). A two-way analysis of variance (Stage × Block)
Modification of Responsivity to Auditory Stimuli

revealed a significant main effect for Stage \( F(2,48)=34.659, p<.001 \). Results of pair comparisons using the Bonferroni method indicated significant differences between Stage 1 and Stage 2 \( t=3.064, df=48, p<.001 \), Stage 1 and Stage 3 \( t=8.236, df=48, p<.001 \), and Stage 2 and Stage 3 \( t=5.173, df=48, p<.001 \).

2-2. Comparisons of Behavioral Responses among Stages

As described above, during Stage 1, participants with autism did not show distinctive behavioral changes that could be considered to be orienting responses to a 1000-Hz 75-dB pure tone or to Naming, but rather they revealed a defensive response to a 1000-Hz 90-dB pure tone. However, from Stage 1 to Stage 2, participants gradually demonstrated behavioral changes that could be considered to be orienting responses to those stimuli. As shown in Table 2, especially during Stage 3, they responded to Naming with smiling, verbally answering “yes,” and pleasant vocal expressions. These characteristics were somewhat similar to the behavioral changes shown in the other participants. In response to a 1000-Hz 90-dB pure tone, anxiety responses such as frequent eyelid movements, sudden eye-opening, and making faces disappeared during Stage 3, and participants also demonstrated greater emotional stability and a lowered incidence of avoidance behaviors in noisy situations in everyday life.

Discussion

In Study I, seven participants with autism were compared with regard to physiological and behavioral responses to auditory stimuli (a 1000-Hz 75-dB pure tone, a 1000-Hz 90-dB pure tone, and calling of the child’s name (“Naming”)) with six age-matched children without disabilities. In Study I, participants without disabilities revealed distinctive orienting responses to the stimuli with decrements in finger plethysmograph amplitude and changes in behavioral indices of attending to the stimuli. These physiological and behavioral responses were not observed in participants with autism, some of whom revealed anxiety responses such as looking anxiously around the room (Participant 1 and Participant 7), frequent eyelid movements and neck flexion (Participant 2), covering of the ears (Participant 3), and a startled response to a 1000-Hz 90-dB pure tone (Participant 4). These results were similar to the findings obtained in previous studies (Palkovitz and Wiesenfeld, 1980; Konno, 1980; van Engeland, 1984; Ujimori et al., 1986; Dawson et al., 1998). Palkovitz and Wiesenfeld (1980) suggested that participants with autism exhibited deficits in psychophysiological reactivity to a range of environmental stimuli. Van Engeland (1984) examined electrodermal orienting responses to auditory stimuli of moderate intensity and found that autistic children were significantly more often nonresponsive to the stimuli than were members of control groups. Dawson et al. (1998) found that children with autism, compared to children with Down syndrome or with typical development, frequently failed to orient to all stimuli.

A well-developed body of research supporting Sokolov’s (1963) orienting theory
<table>
<thead>
<tr>
<th>Participants</th>
<th>Behavioral Modification</th>
<th>Response to a 75-dB Pure Tone</th>
<th>Response to a 90-dB Pure Tone</th>
<th>Response to Naming</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participant 1 (8.10 yrs)</td>
<td>Experiences less fear of sound and hears other's call without feeling anxiety or exhibiting bodily tension</td>
<td>Turns the head toward the sound source and smiles</td>
<td>Turns the head toward the sound source and looks around the room</td>
<td>Turns the head toward the sound source and smiles</td>
</tr>
<tr>
<td>Participant 2 (6.4 yrs)</td>
<td>Responds moderately to an abrupt sound Maintains emotionally stable states and makes eye contact when called</td>
<td>Searches for sound source with interest</td>
<td>Stops eye movement, and turns the head toward the sound source</td>
<td>Verbally answers &quot;yes&quot; and smiles</td>
</tr>
<tr>
<td>Participant 3 (9.8 yrs)</td>
<td>Covers the ears and flaps hands in noisy situation perseveres in sameness (food, route) Has a stable sleep pattern</td>
<td>No particular response</td>
<td>Turns the head toward the sound source without bodily tension</td>
<td>Turns the head toward the sound source, and looks around the room</td>
</tr>
<tr>
<td>Participant 4 (7.5 yrs)</td>
<td>Able to alleviate excessive response to sound and tactile stimuli Is better at controlling temper tantrums</td>
<td>Searches for sound source with interested facial expression</td>
<td>Turns the head toward the sound source with an interested facial expression</td>
<td>Smiles and responds to the sound with a pleasant voice</td>
</tr>
<tr>
<td>Participant 5 (8.4 yrs)</td>
<td>Attends to other's voice Shares attention to musical sound with others Enjoys being in a group situation</td>
<td>Stops eye movement with interested facial expression</td>
<td>Turns the head toward the sound source without bodily tension</td>
<td>Verbally answers &quot;what?&quot; and smiles</td>
</tr>
</tbody>
</table>
Modification of Responsivity to Auditory Stimuli

has shown that differential physiological responses are evoked by nonsignal auditory and visual stimuli of varying physical intensities. That is, stimuli of moderate physical intensity evoke a phasic response characterized by a temporal decrease in finger plethysmograph amplitudes. Graham and Clifton (1966) also reported that moderately intense stimuli evoked cardiac deceleration and an increase in skin conductance. These reactions are considered to be an index of an orienting response. In contrast, stimuli of high intensity elicit prolonged or tonic responses with decrements in finger plethysmograph amplitudes or heart rate acceleration with a defensive response. The orienting response pattern has been interpreted as a correlate of attentional receptiveness to environmental input, while the defensive response is considered to reflect a pattern of rejection of environmental stimuli (Lacey, 1967). According to this model, autistic children may have difficulties in making an orienting response to auditory stimuli of moderate physical intensity. Rather, they may be so vulnerable that they would reject those stimuli or respond defensively.

As mentioned earlier, development of "nonresponsiveness" is considered to be a defensive strategy in a child minimizing an overload of stress, resulting in a state of aloofness in which the child disregards, ignores, and shuts out most of the stimuli that come from outside (van Engeland, 1984). Some types of avoidance behavior and stereotyped movements are considered to be learned behavior with which children try to adapt to their internal and external environments, resulting in a distortion in the linkage between mind and body from very early on in life. Consequently, these children suffer from difficulties in establishing the mind-body schemata that are necessary for relating to both their environments and themselves in an ordinary way (Konno, 1990; Konno, 1999).

In terms of establishing a well-functioning body-image, Dohsa-method training may be beneficial for autistic children (Konno, 1990). In Study II, to examine the effects of Dohsa-method training on responsivity to auditory stimuli, five autistic children who participated in Study I underwent the same experiment twice with as they progressed through Dohsa-method training.

In Study II, we observed the progress of Dohsa-method training in autistic children and characterized it as occurring in the following three stages. During the first stage (Stage 1), they began to be receptive to the training task and reduce muscular tension with the trainer's help. In addition, they were able to reduce emotional excitation, hyperactive behavior, and phobic responses to others. During the second stage (Stage 2), they became more vividly aware of bodily tension and began to feel bodily sensation better through muscular relaxation. The enhanced awareness of the relaxation of bodily tension enabled them to be aware of their emotional states and facilitated the control of emotional behaviors as well. During the third stage (Stage 3), they were able to enjoy comfortable bodily sensation through muscular relaxation and cooperative bodily movements with the trainer, and they enjoyed actively relating to others, indicating the establishment of "bodily experience-based joint attention" between the trainer and the trainee. After experiencing this progress, the children were better able to control temper tantrum behavior, resist
Y. Konno

engaging in repetitive behavior, and decrease their resistance to changes.

In this study, Stage 1 corresponded to Study I, and the second stage and the third stage corresponded to Stage 2 and Stage 3 in Study II, respectively. Considerable improvement in responsivity to auditory stimuli was found, especially during Stage 3, when subjects showed distinctive physiological and behavioral responses that are considered to be indices of an orienting response. The subjects could also alleviate a negative emotional response that was part of a defensive response to a 1000-Hz 90-dB pure tone and reveal a positive emotional response such as smiling at assistants or answering to the vocal stimulus of hearing their names called. Dawson et al. (1998) indicated that autistic children's failure to respond to auditory stimuli was much more extreme for social stimuli and that this failure caused impairments in shared attention.

According to many clinical case studies with autistic children, Dohsa-method training may have beneficial effects for reducing hypersensitivity, stereotyped repetitive behavior, and withdrawal behavior and for establishing joint attentional behaviors such as the exchange of eye contact accompanying a joyful facial expression, protodeclarative pointing gestures, and referential looks (Konno, 1999). However, since participants in this study received the Dohsa-method training for more than two years, these behavioral changes could not be attributed solely to the effects of the Dohsa-method training, because other factors such as maturational and learning processes must be considered.

References
Modification of Responsivity to Auditory Stimuli

Report of the Faculty of Education, Bunkyo University, 16, 12-29. (in Japanese)

—Received November 20, 2000; accepted February 19, 2001—