THE EFFECTS OF LEAST-TO-MOST PROMPTING PROCEDURE IN TEACHING BASIC TENNIS SKILLS TO CHILDREN WITH AUTISM

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Abstract:

In the present study, the effects of a least-to-most prompting procedure in teaching basic tennis skills (i.e. tennis ball dribble, air dribble and dribble the lines drills) to children with autism were investigated. A single-subject multiple-probe design with probe conditions across behaviors was used. Participants were four male children with autism, aged 7-9 years. Data were collected over the course of 6 weeks, five times a week, an hour per session. Inter-observer reliability data of the study was determined as 93% on probes and 100% on teaching sessions for participant one, 96% on probes and 100% on teaching sessions for participant two, 90% on probes and 100% on teaching sessions for participant three, and 93% on probes and 100% on teaching sessions for participant four. Procedural reliability showed that the trainer implemented the planned steps with 100% accuracy for all participants. Results revealed that least to most prompting was an effective instructional approach and all subjects increased their basic tennis skills considerably during intervention.

Key words: *autism, least-to-most prompt, basic tennis skills*

Introduction

The term *autism* was utilized for the first time by Bluer in 1911. He used the term for schizophrenic patients. Kanner borrowed this term and used it for a group of eleven children, who were social isolates and displayed repetitive behaviors in 1943. In the same period, but unaware of each other, Asperger described (in 1944) the same features that are since then known as *Asperger's syndrome*. Autism is one of the developmental disabilities in the *Pervasive Developmental Disorders* category, also known as PDD. It is a sub-category of the autistic spectrum disorders such as Asperger's syndrome, Rett syndrome, a typical autism, and childhood disintegrative disorder (Koegel & Lazebnik, 2004; Smith, 2004).

Autism is a pervasive developmental disorder (PDD) characterized by difficulties in social interaction and communication, as well as by repetitive, restricted interests and behaviors (American Psychiatric Association, 2000). It is a brain disorder that impairs a person's ability to communicate, establish relationships, socially interact, and respond appropriately within a given environment. These symptoms are usually manifested before the age of three years. The disability can affect individual's behavior in different ways: some individuals are severe cases in which mental retardation and serious language impediments are present, whereas others may be high functioning, very intelligent individuals. The symptoms can vary; however, most individuals share problems associated with social, communication, motor, and sensory issues.

Autism is defined as the fastest growing developmental disability in the United States and schools are having a hard time to find trained teachers to accommodate the needs of students with PDD (Block, Block, & Halliday, 2006). There are 1.5 million Americans with autism. Fifteen more million Americans, such as family members, teachers and health care workers, are affected as a result of developmental disabilities (Crollick, Mancil, & Stopka, 2006).

Although previous research have demonstrated that children with autism have normal motor development patterns, recent studies have found these children have very poor performance of motor skills (Fournier, Hass, Naik, Lodha, & Cauraugh, 2010; Jasmin, Counture, McKinley, Reid, Fombonne, & Gisel, 2009). In addition, researchers found differences of gross and fine motor skills in school--aged children with autism (Berkeley, Zittel, Pitney, & Nichols, 2001; Piek & Dyck, 2004; Provost, Lopez, & Heimerl, 2007; Todd & Reid, 2006). Therefore, it has been recommended that children with autism be encouraged to participate in games and other physical activities, which are essential for cognitive development, social communication, motor and emotional maturation of children. Also, friendship and social interaction have the potential to provide appropriate and positive behaviors (Ayvazoglu, Ratliffe, & Kozub, 2004; Keay-Bright, 2006; Lantz, Nelson, & Loftin, 2004; Yu Pan, 2009).

Physical exercise and educational games are an essential part of a healthy lifestyle for youngsters including children with autism (Todd & Reid, 2006). Benefits of these kinds of activities have been reported as an increase in the appropriate behavior (Kern, Vorndran, Hilt, Ringdaht, Adelman, & Dunlap, 1998), improvement of basic motor and social skills (Lochbaum & Crews, 2003; Lotan, Isakov, & Merrick, 2004; Todd & Reid, 2006), and a reduction of stereotypic behavior (Celiberti, Bobo, Kelly, Harris, & Handleman, 1997; Prupas & Reid, 2001; Yilmaz, Yanardag, Birkan, & Bumin, 2004).

There are several studies that have shown the possibility of teaching individuals with autism or moderate to severe intellectual disabilities to acquire skills such as playing darts (Schleien, Kiernan, & Wehman, 1981), pinball (Hill, Wehman, & Horst, 1982), frisbee (Horst, Wehman, Hill, & Bailey, 1981), playing UNO, croquet (Wall & Gast, 1997), and bowling (Zhang, Bridget, Shihui, & John, 2004). Also, Cameron and Capello (1993) taught specific sport skills for participating in the Special Olympics such as clearing hurdles to individuals with autism or severe intellectual disabilities. Moreover, several studies showed that some skills can be taught via response-prompting procedures such as leisure skills (Tekin, Kırcaali-İftar, Birkan, Uysal, Yıldırım, & Kurt, 2001; Vuran, 2008), bowling (Zhang, Bridget, Shihui, & John, 2004,) aquatic play (Yilmaz, Birkan, Konukman, & Erkan, 2005a; Yilmaz, Birkan, Konukman, 2005b), and ball playing (Yanardag, Yilmaz, Ergun, & Konukman, 2008).

In the process of teaching skills and behaviors to children with special needs by using conventional teaching strategies, the learner is likely to make more errors, which causes more error correction and less reinforcement received compared to errorless learning procedures, where the learner displays fewer errors, does not need error correction, and receives more reinforcement (Duker, Didden, & Sigafos, 2004). Least to most (LTM) prompting is one of the errorless learning procedures, and it is used to teach both a single skill and chained skills to various special populations such as those with autism and mental retardation (Tekin & Kircaali--Iftar, 2004). LTM provides the least intrusive prompt thus allowing the opportunity to respond more to the learner's needs (Alberto & Troutman, 2009). This prompting strategy is practicable if there is no real hurry to complete a task, such as when teaching a learner to participate in a leisure activity (Duker, Didden, & Sigafos, 2004). While using increasing assistance or LTM prompting, the teacher provides a prompt and minimal assistance or increased assistance if the subject does not respond correctly in a specified time (5 to 10 seconds). Increased assistance is provided until the subject completes a correct response (MacDuff, Krantz, & McClannahan, 2001). Especially, the LTM prompting strategy was used to teach different motor skills such as hand-finger movements (Ducker & Moonen, 1986), play skills (Haring, 1985), and mobility skills (Walker & Vogelsber, 1985).

While there have been some studies about the effects of LTM prompting procedure on different disabilities in literature such as the use of visual supports for children with autism (Johnston, Nelson, Evans, & Palazolo, 2003), the acquisition of the commenting function in a special day class program (Buzolic, King, & Broody, 1991), teaching manual signs to an adolescent with severe mental retardation (Bennett, Gast, Wolery, & Schuster, 1986) and disruptive behavior of students with autism (Heckaman, Alber, Hooper, & Heward, 1998), there is limited research on the effects of LTM prompting procedure on leisure and sports skills for children with autism.

Errorless teaching strategies require teaching various skills such as academic, living and leisure skills for children with autism. Moreover, there are many studies covering these strategies for the literary and living skills in literature, but there are not enough studies to reach a conclusion as "efficient" and "productive" for sports and exercise--based drills. Thus, the effects of these strategies for the sports or exercise drills learning as leisure skills in children with autism need to be examined. This study focuses on filling the gap by using special education approaches. Therefore, the purpose of the current investigation was to examine the effects of LTM prompting procedure on basic tennis skills (i.e. tennis ball dribble, air dribble, and dribble the lines drills) for children with autism.

Methods

Participants

Participants were four male children with autism, aged 7-9 years. Four prerequisite conditions were established for the participants before the study: 1) ability to respond to visual and audio stimuli for at least 7-10 minutes, 2) ability to imitate gross motor skills, 3) ability to use the bathroom when necessary, and 4) absence of any mental and physical dysfunction. All participants met these criteria.

Participant 1 was a 9-year-old boy with autism. He had participated in an early special education program when he was 4-5 years old. He had also had an individual special education service four times a week when he was 6 years old. At the time of the study, he was a mainstream student at a public school. He was able to read, write, and do simple math. However, he had difficulty in social interaction, communication and language skills. He did not have any experience or systematic intervention with LTM prompting procedure. Participant 2 was the twin brother of Participant 1, and his individual features and educational background were similar. Participant 3 was a 9-year-old boy with autism. He had participated in an early special education program when he was 3-5 years old. He had also had an individual special education service twice a week when he was 6 years old. At the time of the study, he has been a mainstream student at a public school for two years. Participant 3 had reading, writing, and all simple mathematical skills. However, similar to the other participants, he had problems in social interaction, communication, and language skills. He did not have any systematic intervention with LTM prompting prior to the study. Participant 4 was a 7-year-old boy with autism. He has been a mainstream student in a preschool program for 4 years. He has received a special education service 5 times a week since being 3 years old. He has learned the concepts of color, shapes, and the numbers between 1 and 9 like the other subjects; however, he had problems in social interaction, communication and language skills, and did not get any systematic intervention with LTM prompting.

The intervention sessions were applied by four researchers. All researchers had PhD degrees in special education, physiotherapy, and physical education. They had prior research experience ranging from between 5-10 years in special education and sports. Reliability data were collected by an assistant professor who also had experience in using response prompting procedures during instruction in his class with students with developmental disabilities and studies.

All the probe and teaching sessions were conducted in the university's indoor gym, and all sessions developed in a one-to-one format for 6 weeks, five times a week, an hour per session. There was also a writing board in the gym to write the scores of the subjects so that they could see their own and each other's scores.

Tennis rackets and tennis balls were used, and no other special equipment was used during the study. However, a video recorder, video tapes, data collection forms, a writing board and a pencil were used to collect the data for the probe sessions, training, and reliability data in this study.

Experimental design

The main purpose of this study was to teach basic tennis skills such as ball dribble, air dribble, and dribble the lines drills for children with autism. Therefore, these skills were selected from the USA School Tennis Curriculum (USA Tennis Association, 2000).

The task analyses were independently developed by all authors using response definitions based on the USA School Tennis Curriculum (USA Tennis Association, 2000). Later, three of the authors got together and reviewed the task analyses by performing these skills (tennis ball dribble, air dribble and dribble the lines drills) again. These task analyses are presented in Table 1.

The study was designed as a multiple probe model to implicate target behaviors efficiently. However, target behaviors must be selected according to two important characteristics: a) target behaviors should be functionally similar to each other and b) target behaviors should be independent of each other (Alberto & Troutman, 2009).

At this point, all of these selected behaviors are functionally similar gross motor tasks that can be taught easily via LTM prompting method. Besides, these behaviors are independent of each other, so that learning a selected skill does not have a negative effect on the other target skills. Selected target behaviors are functionally independent of each other in the study.

Data collection

A one-to-one instructional format was used during all the experimental sessions. There were probe and teaching sessions in the study. Teacher and participants were face to face in all sessions.

In order to assess subjects' performance, a single opportunity method was used. Accordingly, the trial was stopped when the first wrong response/no response occurred and the rest of the steps were marked as (-) negative. The baseline and intervention sessions were conducted as follows: (a) the verbal cue was given to draw the subject's attention, (b) the subject was asked to perform the skill, (c) five seconds were given for the subject to perform the first step, (d) if the subject responded

Table 1. Task analyses for performing tennis skills

Steps in the task analyses	Skills
	Tennis ball dribble drill
1. Subject takes a tennis racket from the teacher.	
2. Subject takes a tennis ball from the teacher.	
3. Subject's fingers and thumb curl around the handle grip of the racket.	
4. Subject turns the hand's palm downward while holding the racket.	
5. Subject dribbles the ball on the ground.	
	Air dribble drill
1. Subject takes a tennis racket from the teacher.	
2. Subject takes a tennis ball from the teacher.	
3. Subject's fingers and thumb curl around the handle grip of the racket.	
4. Subject turns up the palm of the hand while holding the racket.	
5. Subject dribbles the ball in the air.	
	Dribble the lines drill
1. Subject takes a tennis racket from the teacher.	
2. Subject takes a tennis ball from the teacher.	
3. Subject's fingers and thumb curl around the handle grip of the racket.	
4. Subject turns palm of the hand downward while holding the racket.	
5. Subject dribbles the ball while walking on the line along five meters.	

correctly, a "+" was recorded, (e) five seconds were given for the next step, (f) if the subject responded incorrectly, a "-" was recorded and the assessment was terminated. For each correct response, the subject was reinforced with verbal praises.

LTM prompting (i.e. increasing assistance) was used to teach the basic tennis skills such as ball dribble, air dribble and dribble the lines. For example, the teacher provides a visual prompt (e.g. dribble the ball in the air), the correct task was recorded on the writing board and accompanied by a reinforcement if the subject completed the task based on the response definition. However, if the subject made a mistake, the teacher showed the correct task performance again and gave an instruction such as *Look at me now and dribble the ball in the air in this way*. If the subject performed the task errorless, a reinforcement was provided and recorded on the board. However, if the subject performed incorrectly again, a physical guidance was provided with a verbal prompt while holding the child's hand (e.g. *Let's dribble ball in the air together*.).

Specifically, the least intrusive prompt, which involved just the name of the appropriate behavior used initially, was the tennis racquet grip (e.g. *Grasp the racquet*; *Get the tennis ball*; *Dribble the ball*). If the subject responded wrongly, the level of prompting was increased gradually to the verbal prompt, and the trainer used a model prompting. If the modeling did not provide the correct response, then a physical prompt for grasping the racquet correctly was delivered to the subject. In literature, it is stated that increased assistance with every trial provides an opportunity for the students to make unprompted responses relevant to their environmental stimulus (Duker, Didden, & Sigafos, 2004; Risley and Cuvo, 1980). When all the sequences of the target skill were completed, the subjects were reinforced by verbal praises (e.g. *Good boy*.). In addition, the subjects were given a tangible reinforcer (e.g. fruit juice, chocolate) after conducting each skill independently.

Each ball dribble was scored as one point (+) in the case of initiating the response within five seconds and the number of target behaviors was counted until the subject needed prompting or was displaying inappropriate behaviors. The criterion for each target skill to be considered well performed was the last step of the task performed correctly and the ball dribbled ten times.

Reliability

Reliability data were collected during at least 35% of all the experimental sessions. Observers were experienced data collectors who did not require training. During the probes, they stood facing one another on the opposite sides of the subjects and the instructor, so that they had unobstructed views of the subject's face and the target motor responses. The percentage of inter-observer agreement was calculated by dividing the number of agreements by the total number of agreements plus disagreements and multiplying by 100 (Kennedy, 2005).

Independent variable (procedural) reliability was calculated by dividing the number of teacher behaviors observed by the number of teacher behaviors planned multiplied by 100 (Tekin &

Kircaali-Iftar, 2004). Teacher behaviors observed were as follows: (1) controlling materials, (2) drawing attention, (3) delivering task direction, (4) delivering controlling prompt (for training sessions only), (5) waiting for the 4-second response interval, (6) giving appropriate responses for the participants' responses (error correction was conducted during training), and (7) waiting for the inter-trial interval.

Results

Probe and instructional data

Results of the study were analyzed using graphic illustrations. Results showed that all the subjects increased their correct basic tennis skills to an important extent during the probe and teaching sessions. Figures 1, 2, 3, and 4, show the percentage

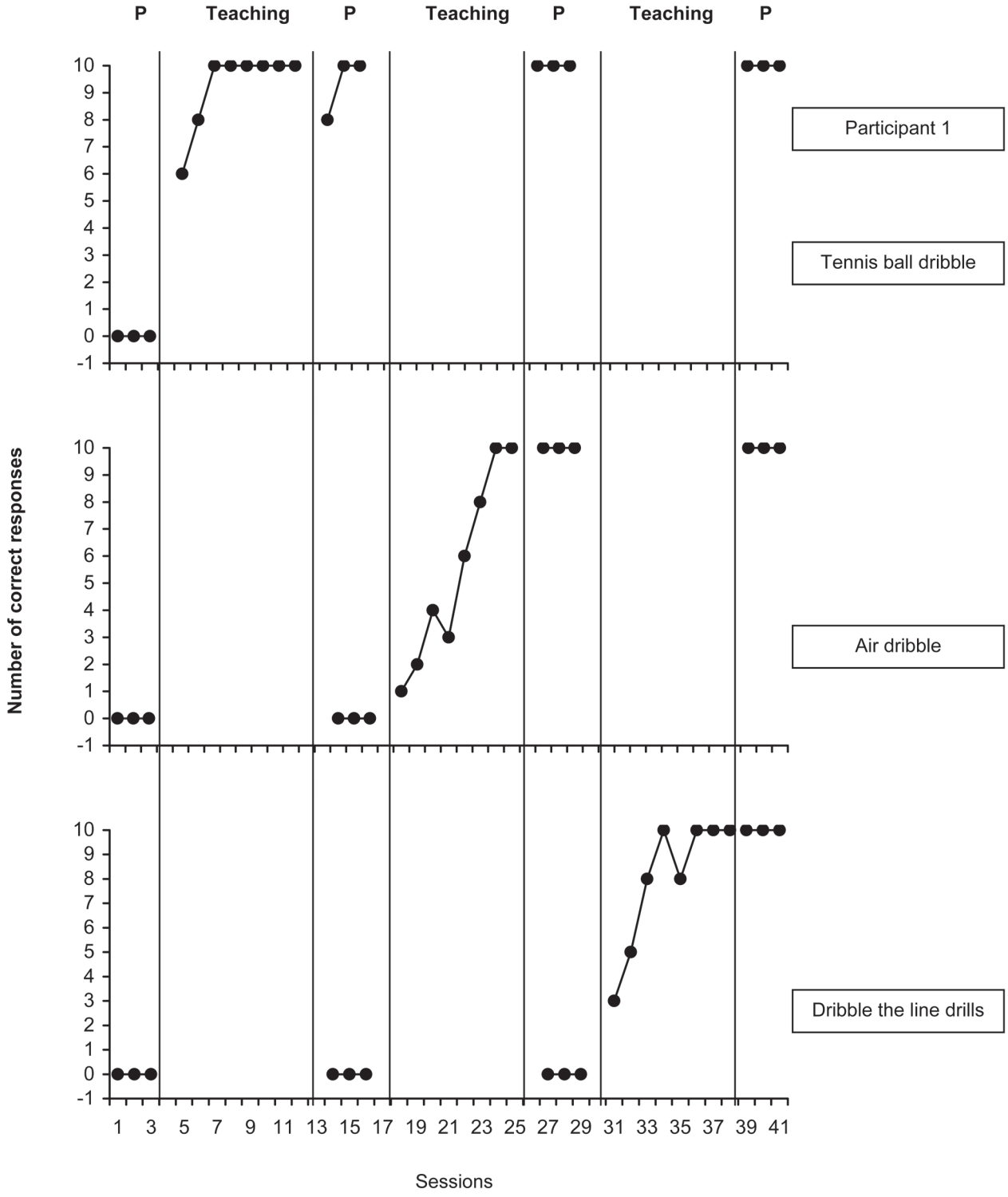

Figure 1. Number of correct responses for Participant 1 during probes (P) and teaching sessions.

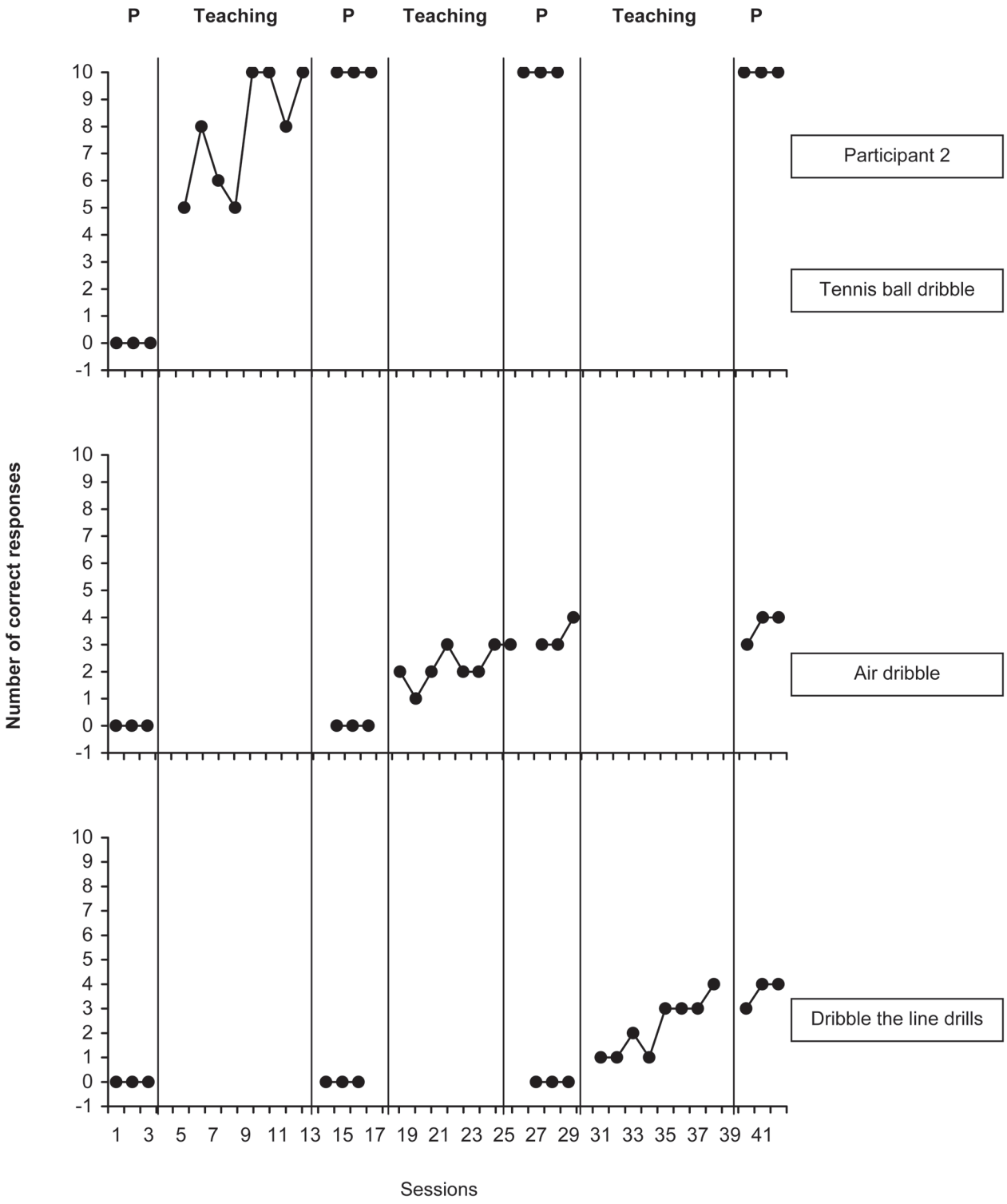

Figure 2. Number of correct responses for Participant 2 during probes (P) and teaching sessions.

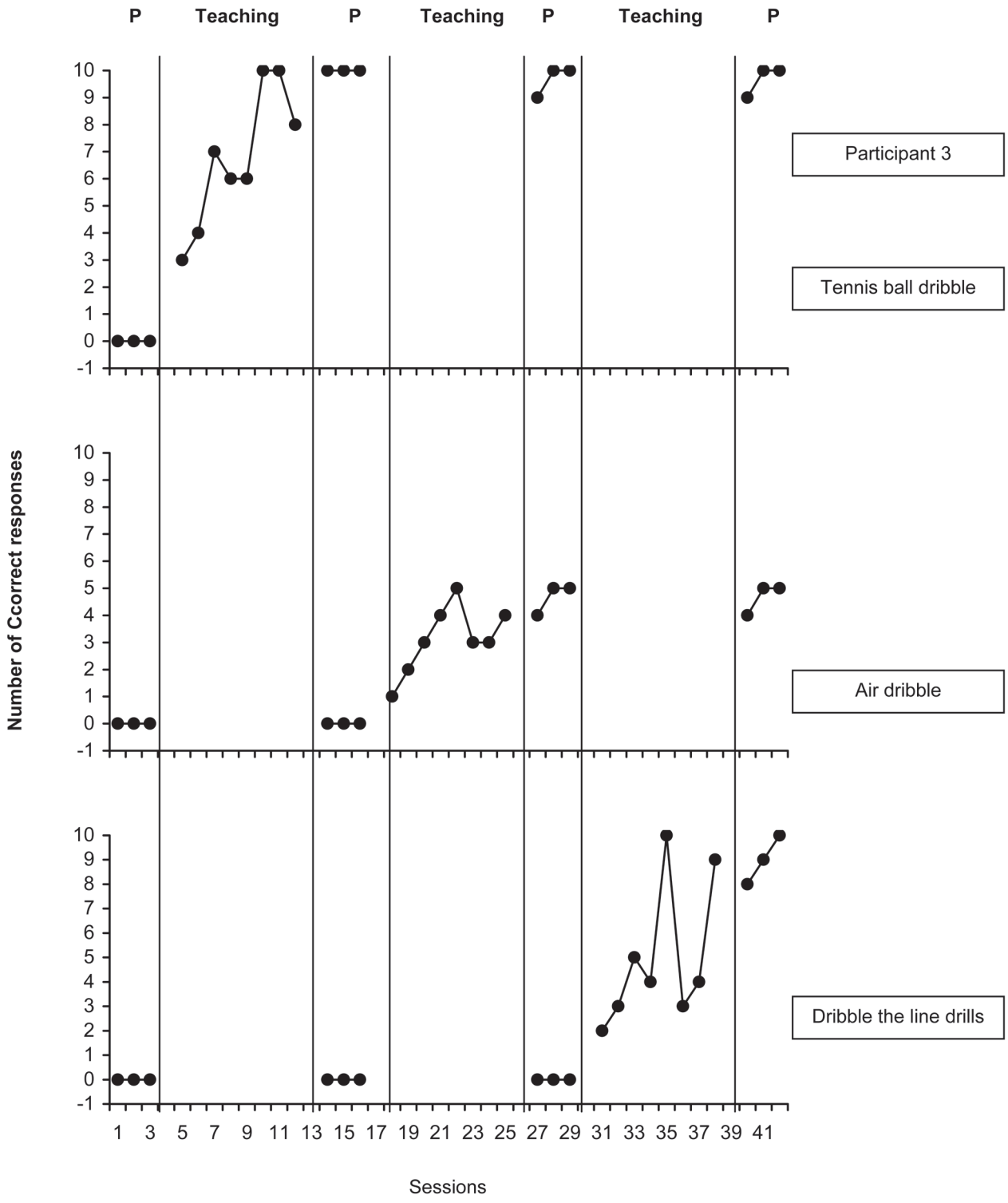

Figure 3. Number of correct responses for Participant 3 during probes (P) and teaching sessions.

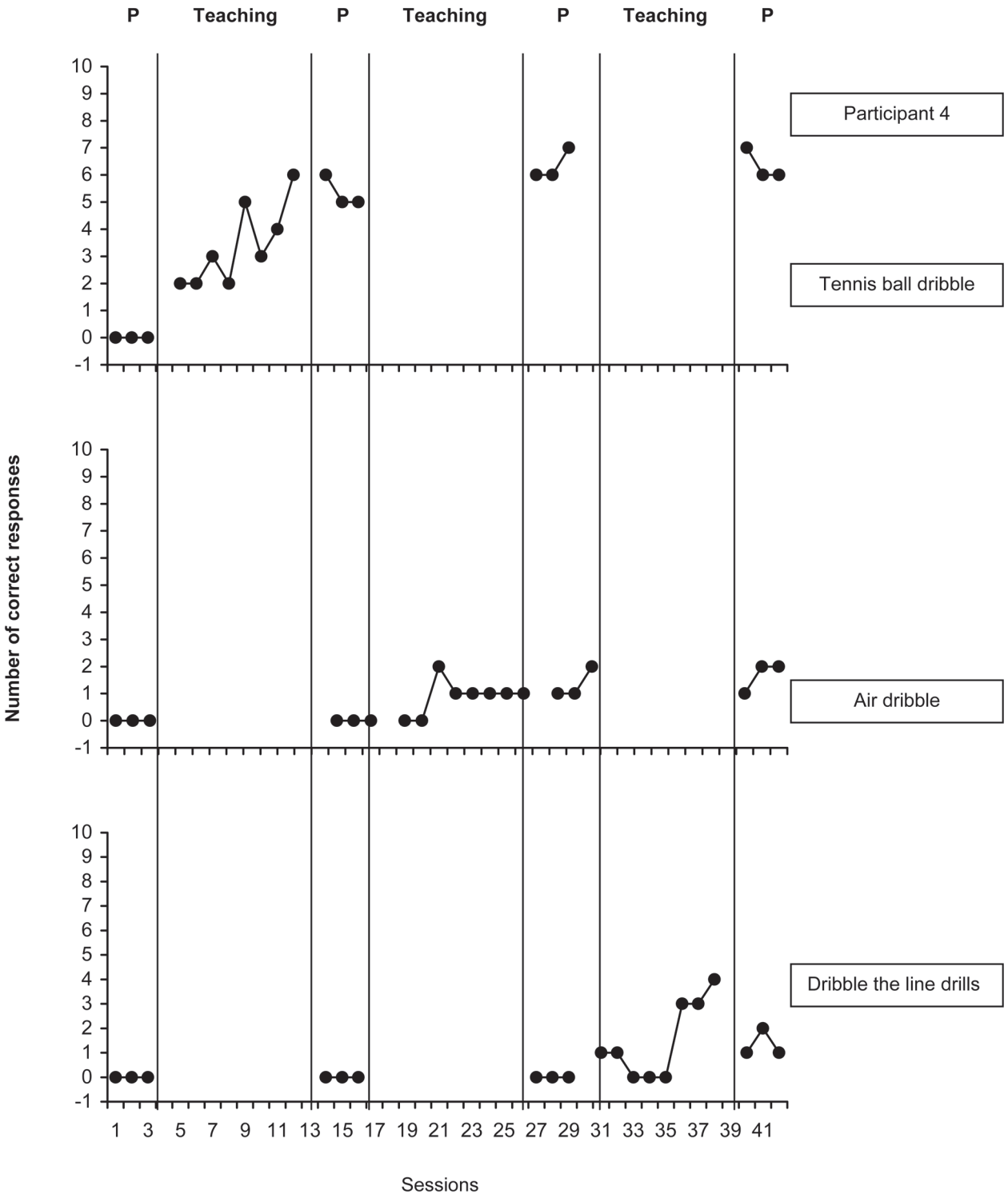

Figure 4. Number of correct responses for Participant 4 during probes (P) and teaching sessions.

of correct responses of the participants during the probe and training sessions for Participant 1, 2, 3 and 4, respectively.

The closed circles represent the number of correct responses during the probe and teaching sessions. As seen in Figures 1 through 4, all the subjects increased their correct basic tennis skills after the introduction of LTM prompting procedure.

Reliability data

Dependent variable reliability (inter-observer reliability) data indicated 93% on probes (range= 86–100%), 100% on teaching sessions for Participant 1. For Participant 2 there was an agreement of 96% on probes (range=86–100%) and 100% on teaching sessions. For Participant 3 there was an agreement of 90% on probes (range=85–100%)

and 100% on teaching sessions, and for Participant 4 there was an agreement of 93% on probes (range=89–100%), 100% on teaching sessions.

Results of independent variable reliability (procedural reliability) revealed that the trainers implemented the planned steps with 100% accuracy for all the participants.

Discussion and conclusions

The main purpose of this study was to determine the effects of LTM prompting procedure on basic tennis skills learning of children with autism. Results of the study were analyzed using graphic illustrations and showed that all subjects increased considerably their correct basic tennis skills during the intervention phase.

Inter-observer agreement reliability measures were between 85-100%. In literature the recommended procedural reliability minimum is 80%, and above 90% is regarded as high (Alberto & Troutman, 2009; Kennedy, 2005). This study showed that reliability measures were very high for all the participants. This means that the teachers applied efficiently the procedures of LTM prompting during the intervention phases.

A literary review shows that LTM prompting procedure is an effective method to teach the use of visual supports to children with autism (Johnston, et al., 2003), the acquisition of the commenting function in a special day class program (Buzolic, et al., 1991), and teaching manual signs to adolescents with severe mental retardation (Bennett, et al., 1986). One study investigated the comparison of the effects of the most-to-least (MTL) and LTM prompting on the acquisition of solitary play skills for children with autism. Results of the study showed that all subjects learned to build Lego play structures when teachers used MTL, which resulted in fewer errors than LTM. However, all subjects learned more quickly with LTM than with MTL (Libby, Weiss, Bancroft, & Ahearn, 2008). These findings were consistent with some other studies examining the effectiveness of LTM prompting on play and behavior skills (Bennett, et al., 1986; Buzolic, et al., 1991; Johnston, et al., 2003; Libby, et al., 2008).

During the teaching and probe sessions, Participant 2 and Participant 4 displayed a poorer performance than the other two participants while performing air dribble and dribble the line drills. Participant 2 dribbled the ball 3-4 times correctly, whereas Participant 4 dribbled the ball 1-2 times correctly according to the criterion, which required dribbling the ball ten times for each target skill. Participant 4 was younger than the other participants and he had not participated in any physical activity or motor program until this study, so that these factors could have affected his dribble performance. Participant 2 was the twin brother of Participant 1, but his motivation and eye contact duration were lower than in Participant 1, so that these features were a disadvantage for him when trying to maintain the performance correctly. Therefore, both participants need physical education sessions in their daily routines.

The study findings are important in two aspects: a) the survey of the previous research revealed the support of literature that LTM prompting was an effective method to teaching chained sports skills to individuals with disabilities, such as dribble the line drills in tennis, and b) the first research attempt to determine the effects of LTM prompting procedure on the basic tennis skills teaching to children with autism.

Results of this study provide several recommendations for future research. First, LTM prompting provided almost no error at the end of the final session and the subjects performed the correct skills without any error. Therefore, it is feasible to use LTM prompting procedure for certain chained and sports skills. However, this should be investigated with different subjects and tasks. Second, although it was not planned, the subjects trained together as a group with one-to-one student-to-teacher ratio, and this interaction caused a kind of observation effect on learning, so that the subjects improved their skills through observing each other. We believe that the effects of observational learning should be warranted in future studies.

Data were collected over the course of 6 weeks, five times a week, and an hour per session, such a data collection dynamics was enabled by the summer vacation of the participants. This is a limited intervention time but the families were informed about the purpose of the study and verbal and visual demonstration of tasks were provided for them with a written instruction. Moreover, researchers suggested continuing the practice of the learned tennis drills during the leisure time of children, so that the results of this study were shown to them and the families were encouraged to do this.

A limitation of the present study is the similarity of the initial steps of the task analyses for all the tennis skills introduced (the criterion for each tennis skill was the correct performance of the last step of the task in ten repetitions). Another limitation of the study could perhaps be the lack of participants' motor skills evaluation. However, evaluation was not the aim of this study. The aim was to instruct the tennis drills in order to play with autistic children during their leisure time.

Consequently, the findings of this study indicate that LTM prompting is an effective method of increasing the basic tennis skills in autistic children. Also, it can be concluded that teachers can teach many different racket activities and games (such as table tennis and badminton) via these basic tennis skills. However, further studies should investigate

the effects of LTM prompting procedure on a variety of sports skills, different disability types, and different age categories of both boys and girls with autism.

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UČINCI METODE OD NAJMANJEGA DO NAJVEĆEGA PODRAŽAJA U POUČAVANJU DJECE S AUTIZMOM OSNOVNIM TENISKIM VJEŠTINAMA

U ovom istraživanju proučavani su učinci metode od najmanjega do najvećega podražaja u poučavanju djece s autizmom osnovnim teniskim vještinama (npr. vođenje teniske loptice reketom, žongliranje loptice reketom, vježbe vođenja loptice po linijama teniskoga igrališta). U istraživanju je primijenjen dizajn višekratnoga testiranja pojedinačnoga slučaja u uvjetima različitih oblika ponašanja. Ispitanici su bili četiri autistična dječaka u dobi od 7 do 9 godina. Podaci su prikupljeni tijekom istraživačkoga perioda od 6 tjedana tijekom kojega su ispitanici provodili jednosatne treninge pet puta tjedno. Međuocjenjivačka pouzdanost bila je 93% tijekom testiranja i 100% tijekom treninga učenja za prvoga ispitanika, 96% tijekom testiranja i 100% tijekom treninga učenja za drugoga ispitnika, 90% tijekom testiranja i 100% tijekom treninga učenja za trećega ispitanika te 93% tijekom testiranja i 100% tijekom treninga učenja za četvrtoga ispitanika. Proceduralna pouzdanost ukazala je na činjenicu da su treneri primijenili planirane korake 100%-tnom preciznošću kod svih ispitanika. Rezultatima je utvrđeno da je metoda od najmanjega do najvećega podražaja učinkovit obrazovni pristup i svi ispitanici su tijekom intervencijskoga programa poboljšali svoje teniske vještine.

Ključne riječi: *autizam, metoda najmanjeg do najvećeg podražaja, osnovne teniske vještine*