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Article

Identity Matching-To-Sample and ASD: Effect of Pairs of Identical Stimuli as a Consequence for Correct Matching

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Abstract

In a replication of a study by Gomes (2011), the effect of the presentation of pairs of identical stimuli after correct matching was assessed in Typical and Multi-sample matching-to-sample tasks. Twenty-four individuals with Autism Spectrum Disorder (ASD) were distributed in two conditions, each with three blocks of trials: Typical, Multi-sample and a mix of both trial types. The order of exposure was counterbalanced across participants within a condition. The first two blocks of trials consisted of both training and testing trials; the third block consisted only of test trials. In Condition 1, the sample stimulus was removed from the screen upon correct matching; in Condition 2 correct matching was followed by presentation of a compound stimulus with two equal elements. Results showed that, regardless of experimental condition and order of exposure to matching-to-sample tasks, percentage of correct responses was higher in Typical Matching test trials. In Condition 2, scores were greater than in Condition 1. For individuals with ASD, control by the relation of identity may be affected by the visual organization of the tasks and by other procedural variables such as the consequences for matching responses, response topography (clicking or dragging) and the training criterion.

Keywords: Identity matching, multi-sample matching, conditional relations, autism.

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Emparelhamento por Identidade e TEA: Efeito de Pares de Estímulos Idênticos como Consequência de Pareamentos Corretos

Resumo

Em uma replicação parcial do estudo de Gomes (2011), foi avaliado o efeito da apresentação de pares de estímulos idênticos após pareamentos corretos em tarefas de emparelhamento Típico e Multimodelo. Participaram do estudo 24 indivíduos com Transtorno do Espectro Autista (TEA), divididos em duas condições, com três blocos de tentativas cada: Típico, Multimodelo e os dois tipos misturados. A ordem de exposição foi contrabalanceada entre os participantes de uma mesma condição. Os dois primeiros blocos continham tentativas de treino e de teste e o terceiro bloco apenas tentativas de teste. Na Condição 1, a cada pareamento correto o estímulo modelo era removido da tela e na Condição 2 era apresentado um estímulo composto com dois elementos iguais. Os resultados mostraram que, independentemente da condição e da ordem de exposição as tarefas, as porcentagens de acerto foram iguais ou maiores nas tentativas de teste de Emparelhamento Típico. Na Condição 2, os escores foram superiores aos da Condição 1. Para indivíduos com TEA, o controle pela relação de identidade pode ser afetado pela organização visual das tarefas e por outras variáveis de procedimento tais como as consequências para os pareamentos, a topografia da resposta (clicar ou arrastar), e o critério nos treinos.

Palavras-chave: Emparelhamento de identidade, emparelhamento multimodelo, relações condicionais, autismo.

Igualación de Identidad y TEA: Efecto de Pares de Estímulos Idénticos como Consecuencias para la Igualación Correcta

Resumen

En una réplica parcial del estudio de Gomes (2011), se evaluó el efecto de la presentación de parejas de estímulos idénticos después de emparejamientos correctos en tareas de igualación Típica y Multimuestra. Participaron del estudio 24 individuos con Trastorno del Espectro Autista (TEA), divididos en dos condiciones con tres bloques de ensayos: Típico, Multimuestra y los dos tipos mezclados. Los dos primeros bloques tenían ensayos de entrenamiento y prueba, mientras que el tercer bloque tuvo solamente ensayos de prueba. En la Condición 1, el estímulo muestra era retirado de la pantalla después de cada respuesta correcta mientras que, en la Condición 2, un estímulo compuesto con dos elementos iguales era presentado. Independiente de la condición y del orden de exposición a las tareas, el porcentaje de aciertos fue igual o mayor en los ensayos de prueba con emparejamiento Típico. Asimismo, los puntajes fueron iguales o más altos en la Condición 2. Para individuos con TEA, el control por las relaciones de identidad puede ser afectado por la organización visual de la tarea y por otras variables de procedimiento, tales como las consecuencias para las respuestas, la topografía de la respuesta y los criterios de entrenamiento.

Palablas clave: Igualación a la muestra, igualación multi-muestra, relaciones condicionales, autismo.

Dube (1996) described a program for teaching discrimination skills to individuals with learning difficulties, intellectual deficiency and/or Autism Spectrum Disorder (ASD). This program established a route, or sequence, that starts with teaching simple discrimination skills. More and more complex tasks are added according to the student's progress. Thus, teaching identity relations and verifying generalized identity (identifying any identical stimuli and not just those taught explicitly) must precede teaching arbitrary relations, such as relations between dictated words and figures, and between dictated words and printed words (Dube, 1996; Kelly, Green, & Sidman, 1998).

The literature reports difficulties in teaching conditional relations to individuals with ASD (Eikeseth & Smith, 1992; Kelly et al., 1998; Williams, Pérez-Gonzáles, & Queiroz, 2005). In general, these participants need a greater number of training trials to learn conditional relations when compared to individuals with typical development.

A common procedure used to teach conditional relations is the matching-to-sample task. For identity relations, in the presence of each sample stimulus, selecting the stimulus among other available alternatives (comparison stimuli) that presents similar physical characteristics to the sample is correlated to reinforcement (Albuquerque & Melo 2005; Stromer & Stromer, 1989). Visual organization of matching-to-sample tasks have been pointed out as a variable that affects participants' performance (Gomes, 2011; Gomes & de Souza, 2008; Mesibov, Schopler, & Hearsey, 1994).

Gomes and Souza (2008) compared the performance of 20 individuals with (mild/moderate and severe) ASD in two identity matching procedures that differed in visual presentation of stimuli. Trials from each task were presented in a binder with dividers (pages), in which cards with stimuli were inserted (familiar figures, words, letter sequences or abstract stimuli). For each trial in the Typical Matching task, the left page contained the response signal (wood stick with Velcro) and the page on the right displayed the sample stimulus at the top and three comparison stimuli at the bottom. Participants' selection responses consisted on getting the stick and placing it on the Velcro below one of the comparison stimuli. In each trial of the Multi-sample Matching task, the left page had three mobile comparison stimuli and the page on the right displayed three fixed sample stimuli. Participants had to get each stimulus from the left and place it over the "same" stimulus located on the sample page. Trials ended when all three comparisons matched the samples, indicated by the left page being empty. The procedure was composed of three blocks of trials: Multi-sample Matching, Typical Matching and, finally, a mix of both types of trials. With minimal training, the mean percentage of correct responses in Multi-sample Matching trials was significantly greater than in Typical Matching trials. However, performance was variable between tasks, especially for non-verbal participants.

In Gomes and de Souza's (2008) study, order of exposure to each task may have favored performance in Multi-sample Matching trials, which always came first. To control for this variable, Gomes (2011; Experiment 1) conduced a replication with 40 participants with ASD and 40 with intellectual disability. Half of the participants with ASD and half with intellectual disability performed the task on paper and the remaining on a computer. Order of exposure two both types of matching was counterbalanced. Tasks had a visual display similar to Gomes e Souza (2008). However, for Typical Matching trials in the computer, participants had to click on the comparison stimulus that corresponded to the sample. In Multi-sample Matching trials, participants had to click on each comparison stimulus on the left side of the screen and drag it to the corresponding sample stimulus (on the right side). For both trial types, participants could change their response before clicking the "end trial" button. Independently of order of exposure, most participants produced higher percentages of correct responses in Multi-sample Matching choices in both paper and computer tasks, replicating results from the previous study.

Gomes (2011) suggested that better performance for Multi-sample Matching may be related to the visual display of sample and comparison stimuli as well as topography of the response. In a Multi-sample Matching trial, participants had to place each comparison stimuli over its respective sample. This context may have favored responses of looking at the comparison as well as the sample stimuli, increasing the probability of correct responses and of control by the "sameness" relation. In each trial, when the participant places one stimulus over the other, the visual display of the task changes, reducing the number of stimuli from the left side. Moreover, reducing the number of comparison stimuli resulted in an increase of probability of correct responding from 33.33%, when there were three comparisons, to 100%, after the second matching, since only one option remained.

Topography of responses in computer tasks has also been pointed out as a relevant variable in establishing control by identity relations. Shimizu, Twyman and Yamamoto (2003) evaluated the performance of children with developmental delays in Typical Identity Matching tasks with two different responses. In the Click Condition, participants had to click on the comparison stimulus that matched the sample and, in the Drag Condition, they had to click and drag the sample with the mouse and place it below the correct comparison. The Drag Condition produced higher percentages of correct responding.

In another study, conducted with three children with intellectual disability, de Freitas (2012; Experiment 2) used a supplementary procedure to teach identity relations between three-letter words. The following response sequence was taught: look at sample, click on one comparison stimulus, drag it over to the sample, and let it go. During training phases, the comparison stimulus had to be dragged for smaller and smaller distances until it was no longer necessary to drag, only to click. With this procedure, all participants showed high percentage of correct responding (above 80%) and maintained similar performance in training with new identity relations.

Investigating procedural variables that affect learning of identity relations by individuals with ASD is relevant because these relations are the foundation for acquiring arbitrary relations (Dube, 1996) involved in symbolic behavior, such as language and concept formation (de Rose, 1993; de Rose & Bortoloti, 2007; Smith, 2001). Symbolic behaviors involve responding under control of arbitrary stimulus relations, such that impairments on learning identity and arbitrary relations may result in dysfunctional communication skills, delays in language development, failure in basic reading, writing and math skills, among others (de Sousa, Cortez, Aggio, & de Rose, 2012).

Characteristics of the Multi-sample Matching procedure used in Gomes (2011) and Gomes and de Souza (2008), should be analyzed in more detail. Precise performance in Multi-sample Matching may be related to visual display of stimuli (thee samples and three comparisons, simultaneously available) and the dragging response, as well as presentation of identical pairs (proximal comparison and sample stimuli form pairs of identical stimuli). The response topography required in Multi-sample Matching in Gomes (2011) and Gomes e de Souza (2008), involved moving one stimulus toward the direction of another. Thus, each response changed the visual display of the sample, which got closer and closer to the comparison stimulus until they were side-by-side, and finally placed one over the other. A pair of stimuli composed in such a way may be considered a compound stimulus with two identical elements. It is possible that the proximity between comparison and sample stimuli is an additional variable that favors control by physical similarity, or sameness, in identity matching. According to this analysis, a pair of identical stimuli may function as a consequence for the response of dragging and as an antecedent stimulus to the response of placing one stimulus over the other.

Results from the aforementioned studies (de Freitas, 2012; Gomes, 2011; Shimizu et al., 2003), however, do not allow us to conclude which characteristic from the Multi-sample Matching task is the critical variable: the response of moving each comparison stimulus and placing it on the respective sample (dragging response), or the compound stimulus with identical elements that results from approximating the comparison stimuli to the samples. In the previously described studies, these variables occurred simultaneously, since only the dragging response made it possible to move one stimulus next to the other. In the present study, we proposed as an alternative to use matching-to-sample tasks with two response requirements: clicking on the sample stimulus and clicking on the comparison, presenting the consequence of each match.

This was compared to a similar condition from Gomes (2011), in which each correct match in the Multi-sample task was signaled by removing the stimuli from one side of the screen, with a condition in which a pair of identical stimuli was presented.

The present study is a partial replication of Experiment 1 (Gomes, 2011) with ASD participants and computerized tasks. This study had the objective of evaluating the effect of presenting identical pairs of stimuli as a consequence of correct matching responses in identity training tasks using Typical and Multi-sample matching procedures.

Method

Participants

Twenty-four children with ASD, aged between five and 13, four females and 20 males, participated in this study. Four participants did not use speech to communicate. One participant had congenial progressive hearing loss and used an individual hearing aid on both ears (Table 1). Seventeen participants were recruited from special educational provision in a public educational institution in Teresina, Brazil. Seven children received care in a private educational institution in Belo Horizonte, Brazil. Participants were indicated by teachers from selection criteria, including: previous diagnosis of ASD; basic repertoire of using computers with a mouse (e.g., moving the cursor with the mouse; placing the cursor on requested locations and clicking); and no previous history of participating in research with matching-to-sample procedures.

The Childhood Autism Rating Scale (CARS - Schopler, Reichler, & Renner, 1988) was used with the objective of identifying participants' general skills. Interviews were conducted with parents or caretakers and scores were categorized as: Appropriate behaviors for age and context (15 – 29.5), Mild/Moderate autism (30 – 36.5) and Severe autism (above 37).

This study has been approved by an Ethics Committee and was conducted according to the Resolution of the National Health Council (*Conselho Nacional de Saúde* - CNS) 466/2012 in force at the time the project for the study was submitted. Caretakers were informed about the study and authorized their children's participation and video recording of sessions by signing a free and informed consent form and a specific form for using sound and image.

Location, Equipment and Materials

Data was collected in rooms in the educational institutions, which were equipped with two tables and two chairs. Participants sat on a chair in front of the table with the computer and the experimenter sat on a chair behind the participant. Toys (e.g., cars, dolls, plush animals, soap bubbles), children's books and videos were displayed on the other table.

The software *Contingência Programada*, version 2.0 (Hanna, Batitucci, & Batitucci, 2014), for Microsoft Windows, was used for experimental tasks and to record selection responses. Stimuli were presented on a Sony Vaio portable laptop with a 10.3" screen, connected to a Sony LCD 17" monitor. Sessions were recorded using a digital Sony cyber-shot camera placed on a tripod.

Stimuli

Visual stimuli were separated into five categories: 24 Abstract Symbols (AS), 30 Black-and-white Figures (BWF), 24 Printed words with one or two syllables (P), 15 four-digit Number Sequences (NS) and 36 Color Figures (CF). Figures were obtained from the free access Google Images website and edited using Paint 6.1 software. Words and number sequences were in Times New Roman font, size 60. Stimuli were presented at the center of a 4 x 6 cm white rectangle.

General Procedure

Participants were divided into four groups. Groups 1 and 2 went through Condition 1 and groups 3 and 4 to Condition 2. Each experimental condition was composed of three blocks of identity matching trials: Typical Matching, Multi-sample Matching, and a mixed block with

Table 1
General Characteristics of Participants: Age, Sex, CARS Classification, Presence or not of Vocal Verbal Repertoire and Type of Educational Institution/State of Brazilian Federation

Condition	Group	Part.	Age	Sex	CARS		Speaks	Institution
					Score	Class.		
C1	1	P3	8	F	27	A.B	Yes	Public (PI)
		P5	8	F	17	A.B	Yes	Public (PI)
		P6	5	M	32	M/M	No	Public (PI)
		P9	7	M	20	A.B	Yes	Public (PI)
		P13	7	M	28	A.B	No	Public (PI)
		P21	10	M	22	A.B	Yes	Private (MG)
	2	P2[a]	6	M	26	A.B	Yes	Public (PI)
		P10	9	M	24	A.B	Yes	Public (PI)
		P14	7	M	26	A.B	Yes	Public (PI)
		P17	12	F	27	A.B	No	Public (PI)
		P18	9	M	36	M/M	Yes	Private (MG)
		P22	10	M	25	A.B	Yes	Private (MG)
C2	3	P1	6	M	31.5	M/M	No	Public (PI)
		P7	10	M	23	A.B	Yes	Public (PI)
		P11	13	M	20	A.B	Yes	Public (PI)
		P15	11	M	32	M/M	Yes	Public (PI)
		P19	9	M	30	M/M	Yes	Private (MG)
		P23	6	M	37.5	S	Yes	Private (MG)
	4	P4	9	M	18	A.B	Yes	Public (PI)
		P8	6	M	31	M/M	Yes	Public (PI)
		P12	10	M	26	A.B	Yes	Public (PI)
		P16	12	M	35.5	M/M	Yes	Public (PI)
		P20	7	M	37.5	S	Yes	Private (MG)
		P24	10	F	22	A.B	Yes	Private (MG)

Note. A.B- Appropriate Behaviors for the situation; M/M- Mild/Moderate; and S- Severe.
[a] Congenital progressive hearing loss and utilization of individual sound amplification device in both ears.

both types of trials. One group from each condition was exposed to the sequence Typical-Multi-sample-Mixed, and the other group to Multi-sample-Typical-Mixed.

Typical and Multi-sample matching tasks in Condition 1 were similar to those in Gomes (2011), in which a stimulus from the left side was removed after each correct match in the Multi-sample task. However, in Condition 2, after choosing the comparison stimulus that matched the sample, a compound stimulus was presented on the screen, with two equal elements were displayed side-by-side (pair of identical stimuli). In Multi-sample Matching, each compound stimulus was presented on the location of the previously selected sample stimulus. In Typical Matching, the identical pair was presented with reinforcement for each match and after correct matching of the three samples with their respective comparisons (three simultaneous pairs).

Blocks of Typical and Multi-sample trials were composed of 10 training and 10 testing trials. The block with mixed trials only presented test trials, 10 of each. All test trials presented new stimuli, which were different from those used in training.

In training trials, to match the first three samples to their respective comparisons, the experimenter would give verbal instructions while pointing to the stimulus' location and, if necessary, would provide physical help for the clicking response. To end training trials and begin testing, the learning criterion was three consecutive correct within 10 trials, with no correction or help. If this criterion was not reached, the session was repeated, at most, twice. Participants that did not reach the learning criterion in three sessions were excluded from the study.

Test trials did not have differential consequences for correct and incorrect responses. Occasionally, social reinforcement was provided (e.g., "You are doing great!"; "Good job!"; "Very well!") to maintain the participants engaged in the task, and was unrelated to correct or incorrect responding.

Sessions lasted for 30 to 50 min, depending on participant performance, and were usually accompanied by a teaching assistant or intern from the institution, who would sit on a corner of the room and was instructed to intervene only if requested by the experimenter. Verbal cues (e.g., "Which figure will you choose now?") were used when participants did not emit a response in up to 15 s. In case of disruptive behaviors (e.g., echolalia, getting up, motor stereotypies), sessions could be interrupted for up to 5 min. In these occasions, the experimenter would offer a toy to the participant and give instructions such as "You need to sit on the chair to be able to play" and "Answer this one and you can play afterwards". After 5 min, if the behavior did not subside with this procedure and/or help from the caretaker, the session ended.

When the computer task ended, the participant was given a choice between playing with one of the toys or watching a video from those displayed on the table. This activity lasted for a maximum of 5 min and did not depend on correct responses in the computer task.

Typical Matching and Multi-sample Matching tasks for each experimental condition are described next.

Condition 1

Typical Matching. For all trials, the required response was to click on the sample stimulus to show three comparison stimuli at the bottom of the screen (Figure 2; left column; panels a and b). The participants' task consisted in selecting the comparison stimulus that was identical to the sample. In training trials consequences for correct (smiley face, short melody – indicated by the speaker in panel c –, and social reinforcement by the experimenter) and incorrect responses (red "X"; panel e) were presented for 1.5 s. Next, a gray screen (panel d) was displayed for 1.5 s (Intertrial Interval - ITI), followed by a new trial. In test trials, selection responses led to the ITI for 3.0 s.

Multi-sample Matching. A Multi-sample trial consisted of correct matching of three samples to their respective comparisons. For each set of three stimuli, initially three sample stimuli were presented on the left column and three comparison stimuli were fixed on the right column. The participant had to click on one of the stimuli on the left column and select (click) the identical stimulus on the column on the right. As shown in Figure 1 (second column from the left), clicking on the stimuli on the left column (panel a) removed it and displayed it at the top of the screen (panel b). In training trials, correct responses produced the same consequences as the Typical Matching task plus a pair of identical stimuli (panel c). This compound stimulus signaled correct matching of comparison to sample and was presented on the reinforcement screen to preserve trial duration. Each correctly matched stimulus was removed from the column on the left (panel d). Panel e shows the selection of the third sample after two previous matches. After correctly matching three sets of stimuli, the compound stimuli were presented on the left column (panel f) for 1.5 s. Incorrect responses led to a red "X" displayed on the center of the screen (panel e; first column to the left) for 1.5 s. For a more dynamic task of shorter duration, there was no ITI after correct and incorrect responses, nor after three correct matches.

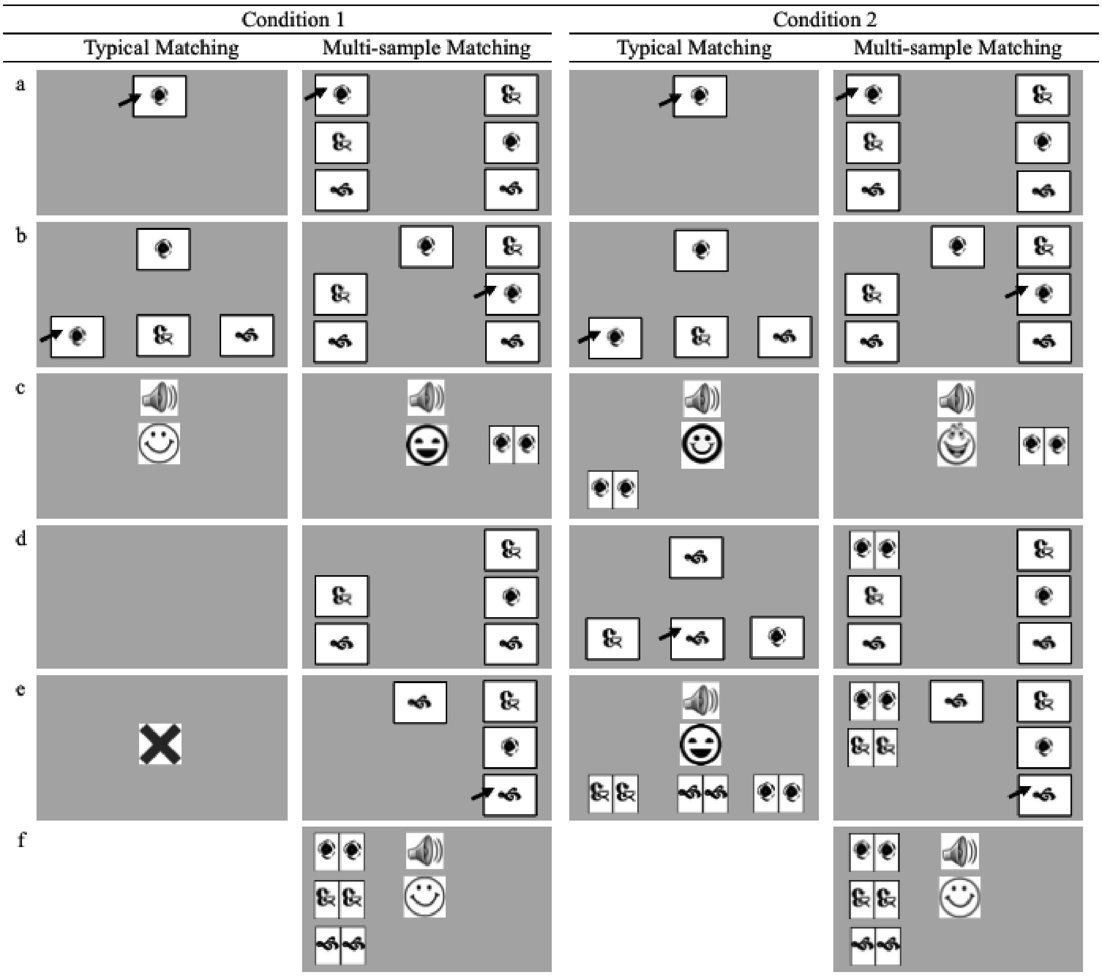

Figure 1. Illustration of screen displays for Typical and Multi-sample Matching tasks for Condition 1 and Condition 2 (Abstract Symbols stimulus category), including consequences for correct responding. Consequences for errors (panel e, first column on the left) and ITI (panel d) were the same for all conditions.

In test trials, each matching response (panels a and b) resulted in a 1.5 s ITI followed by a screen with the stimuli that had not yet been selected on the left column, similarly to training trials (panel d). When all three stimuli from each set had been matched, the ITI screen was presented for 3 s.

Typical and Multi-sample Matching mixed test trials. 10 Typical Matching trials and 10 Multi-sample Matching trials were presented randomly and had the same characteristics as the Typical and Multi-sample Matching test trials previously described.

Condition 2

Typical Matching. In Condition 2, correct selection responses resulted in the same consequences as Condition 1, plus a compound stimulus with two identical elements (the matched sample and the comparison stimulus). This compound stimulus indicated a pair had been formed (panels a, b and c; third column from left to right). Next, the ITI screen was displayed for 1.5 s and a new trial began (panel d). Another difference regarding Condition 1 was that, after all three matches, three compound stimuli were presented at the bottom of the screen for 1.5 s, along with a smiley, music and social reinforcement (panel e). Test trials had the same characteristics as test trials in Condition 1, previously described.

Multi-sample Matching. Unlike Condition 1, after each correct selection response (panels a, b and c), a compound stimulus composed of two identical elements (the matched stimuli: sample and comparison) was presented on the left column, in the same position where the individual stimulus was presented before the selection response (panel d – one compound stimulus; panel e – two compound stimuli). Consequences for correctly matching three stimuli from the same set were the same as Multi-sample Matching training in Condition 1 (panel f), which were also similar to Typical Matching in Condition 2 (panel e). Incorrect responses resulted in an "X" shown on the center of the screen (panel e; first column to the left), followed by stimuli displayed as they were before the error.

In test trials, independently of being correct or incorrect, each matching response resulted in a 1.5 s ITI followed by a screen showing white rectangles instead of the previously selected (sample) stimuli on the left column. This strategy was used to maintain similarity to training trials, in which matched stimuli were presented side-by-side and not removed as in Condition 1.

For all training and test trials using Typical and Multi-sample Matching in Condition 2, compound stimuli were ineffective, did not produce changes on the screen, and selection responses were not recorded as correct or incorrect.

Typical and Multi-sample Matching mixed test trials. This test was composed of 10 Typical Matching and 10 Multi-sample Matching trials from Condition 2, presented randomly and with the same characteristics as isolated test trials for Typical and Multi-sample Matching.

Results

Training trials showed more exposure to the Multi-sample Matching block of trials than to Typical Matching for both conditions; the amount of exposure ranged from 1 to 3. Two participants (P6 and P13) we exposed twice to Typical Matching training blocks while six needed 2 to 3 blocks to reach the training criterion with Multi-sample Matching (P1, P6, P8, P13, P18 and P23).

According to individual analysis of performance (Figure 2), the percentage of correct trials in the Typical Matching test was greater or equal to Multi-sample Matching, independently of order of exposure, except for P12. Performance in Condition 2 was higher than in Condition 1. Nine participants showed 100% correct responding in Typical Matching trials with mixed and isolated trials, six of whom also had precise scores for Multi-sample trials (P7, P11, P15, P4, P16 e P24). Only four participants in Condition 1 (P6, P14, P17 e P18) and two in Condition 2 (P8 e P20) had a percentage of correct responding below or equal to 60%, in one or both types of matching trials.

Since order of exposure to blocks did not affect participants' performance (Figure 2), mean percentage of correct responses was analyzed for 12 participants from groups 1 and 2, and 12 participants from groups 3 and 4, in Typical and Multi-sample Matching test trials, both isolated and mixed (Figure 3). Accuracy was greater in Condition 2 (light grey bars) than in Condition 1 (dark grey bars) for both types of matching tasks (Typical and Multi-sample). Scores were higher for Typical Matching trials in isolated (bars to the left of the vertical dashed line) and mixed blocks (bars to the right), compared to Multi-sample Matching. Multi-sample Matching shows a higher mean percentage of correct responding in blocks with mixed trials (last two bars to the right of the vertical line) compared to isolated trials, for both conditions. However, there was little variation (Condition 1: 70.8 - 75.8; Condition 2: 77.5 - 81.7).

A Wilcoxon Signed Rank Test, a non-parametric test to compare two independent condi-

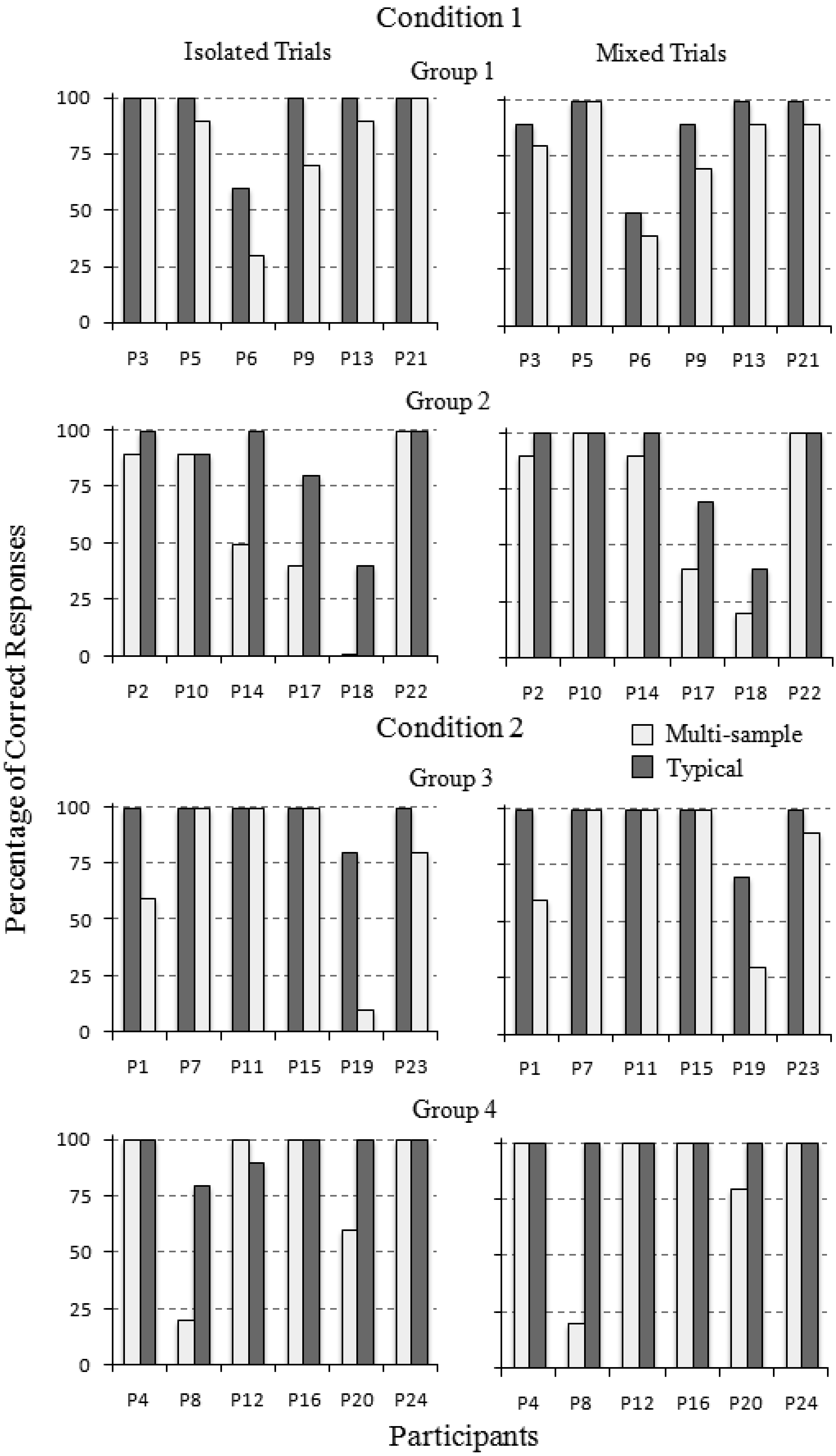

Figure 2. Percentage of correct responses for isolated and mixed trials for test blocks of Typical and Multi-sample Matching under two experimental conditions.

tions, confirmed that differences between mean percentages of correct responding in Typical and Multi-sample Matching were significant (*p* < .05), except for isolated trials in Condition 2, which was only marginally significant (*p* = .05).

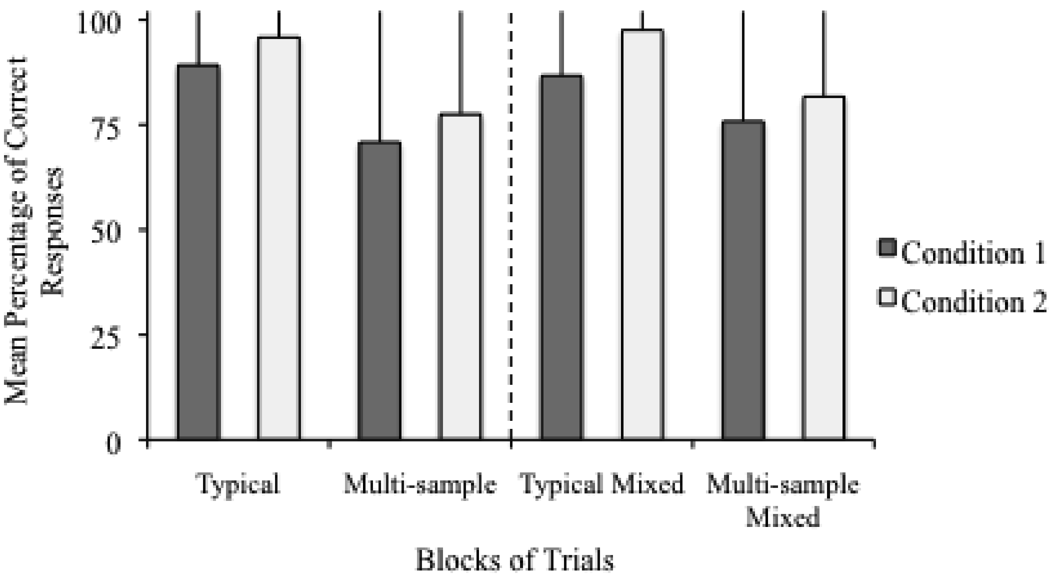

Figure 3. Mean percentage of correct responses for Condition 1 (groups 1 and 2) and Condition 2 (groups 3 and 4) for blocks of isolated trials in Typical and Multi-sample Matching tests (bars to the left of dashed line), and for blocks with mixed trials of both types of matching tasks (bars to the right). Continuous vertical line indicates one standard deviation.

Four participants, two in Condition 1 (P6 and P18) and two in Condition 2 (P8 and P19), responded correctly on less than 30% of Multi-sample Matching isolated and mixed trials. Test trials (isolated and mixed) for Multi-sample Matching were observed from recordings of sessions for each participant, and responding was categorized as correct, incorrect or unrelated to the task. The incorrect responses were classified according to the stimulus category presented in each trial. For unrelated responses, the number of clicks on inactive stimuli was recorded for the stimulus on the top center of the screen (Center); the stimuli on the right column before clicking on left column; or the stimuli on the left column (Columns) immediately after a selection response on one of the stimuli on the right column (see Figure 1). Table 2 shows that, although there were many errors (6-10), both experimental conditions yielded more correct responding in mixed Multi-sample Matching trials (range 2-4) than isolated trials (range 1-3). Errors were distributed throughout all five categories of presented stimuli and an excessive amount of unrelated responding occurred in inactive windows. It was observed a smaller amount of responding in the center window. When mixed trials were presented, responding in ineffective windows in the columns showed a tendency of increasing for three participants (P18, P8 and P19), especially P19.

Discussion

Independently of the Experimental Condition, the percentage of correct responses found for Typical Matching test trials was equal to or larger than for Multi-sample Matching, a finding that does not replicate the results in the study by Gomes (2011, Experiment 1), in which the majority of participants presented better performance on the Multi-sample Matching trials.

During training in the present study, different parameters were defined to favor stimu-

Table 2
Number of Correct and Incorrect Responses per Trial, within Five Stimulus Categories, and Number of Irrelevant Responses on Inactive Windows at Screen Center, Left and Right Columns, for Isolated and Mixed Multi-Sample Matching Test Trials

	Cond.	Part.	Correct	Errors					Inactive Stimuli Windows	
				Stimulus Categories						
				FPB	FC	SN	P	SA	Center	Columns
Isolated Trials	1	P6	3/10	1/2	2/4	1/1	1/1	2/2	20	50
		P18	0/10	2/2	4/4	1/1	1/1	2/2	41	45
	2	P8	2/10	1/2	3/4	1/1	1/1	2/2	31	47
		P19	1/10	1/2	4/4	1/1	1/1	2/2	28	51
Mixed Trials	1	P6	4/10	1/2	1/3	1/1	1/1	2/3	15	46
		P18	2/10	1/2	2/3	1/1	1/1	3/3	35	48
	2	P8	2/10	1/2	2/3	1/1	1/1	3/3	32	50
		P19	3/10	1/2	2/3	1/1	1/1	2/3	16	81

Note. Cond. - Condition; Subj. - Subject; BWF - Black and White Figures; CF - Color Figures; NS - Numerical Sequences; W - Words; AS - Abstract Symbols; Center - Responses of clicking inactive center window; and Columns - Responses of clicking inactive windows on left and right columns.

lus control by identity relations. The criterion to end training and start testing was defined as three consecutive correct matches, without any cues or help from the experimenter; participants could be exposed up to three times to the training block. Differently, in Gomes (2011; Experiment 1), the criterion was one correct trial, without correction, in a set of up to 9 trials; and each participant was exposed only once to the training block. In the present study, requiring a larger number of reinforced matches may have strengthened control by the identity relation. The effect of that parameter is shown in performances close or equal to 100% for most participants, on Typical and Multi-sample Matching test trials, for both conditions (Figure 2).

In Gomes (2011), participants could change the response or the selected stimulus as much as they liked, for both Typical and Multi-sample Matching. A trial ended only when the participant clicked the end trial button (a hand figure, at the bottom right corner of the computer screen). For example, on Multi-sample Matching trials, after choosing and dragging each stimulus from the left column and placing it over one from the right column, the participant could change the selected placement (comparisons over samples). The visually different organization of the Multi-sample Matching task together with the possibility of changing the response may have maximized the number of correct trials compared to the Typical Matching task.

In the present study, Typical Matching trials ended after each selection of one comparison stimulus whereas, for Multi-sample Matching, each trial ended after three matches. Neither type of task had the possibility of changing response choice. During Multi-sample training, if the stimulus selected from the right column was not equal to the one on the left, an “X” was displayed at the center of the screen, followed by a screen refresh where stimuli were displayed as shown before the incorrect response (Figure 1). Thus, using differential consequences for each incorrect match allowed a new matching response. However, this did not occur during test trials. This procedure resulted in a percentage of correct responses equal to or larger than 70% for Multi-sample trials for most participants, even though it was slightly lower than Typical Matching (see Figure 2).

Besides stimulus presentation, in Gomes (2011) the number of required responses for both types of matching was different. For Typical Matching trials the sample and comparison stimuli were shown on screen simultaneously and only one response was required, to select the comparison stimulus that was identical to the sample. This procedure did not require an observation response (i.e. touching or clicking the sample stimulus in order to display the possible matches; Dube & McIlvane, 1997, 1999). However, in the Multi-sample Matching task, the three stimuli on the left were displayed horizontally and those on the right were displayed vertically with two required responses, to move the left stimulus towards a right stimulus and to place one over the other. Those response arrangements for Multi-sample Matching may have favored the direction of observation for all stimuli, and Gomes (2011) considered that it increased the probability of success and the control by identity relations between stimuli.

For all tasks in the present study, the participant had to use two clicking responses in order to finish each match. For Typical Matching, the participant had to click on the sample and then click on the corresponding comparison stimulus. The Multi-sample Matching- required clicking on a stimulus from the left column and, then, clicking on the identical stimulus on the right column. Responding to the sample stimulus, or observation response, was required on both types of matching tasks to ensure visual contact with the sample and comparison stimuli. Observation responses have been used to reduce stimulus control by irrelevant aspects of the matching-to-sample task (e.g., Costa, Schmidt, Dominiconi, & de Souza, 2013; Dube, Iennaco, & McIlvane, 1993). It is possible that including the observation response was a relevant variable that lead to the more precise performance verified in this study for the Typical Matching tests, in comparison to lower performance described in Gomes (2011, Experiment I).

Participants exposed to Condition 1 obtained higher percentages of correct responding in Typical Matching tests than in Multi-sample Matching tests (Figures 2 and 3), in which each sample stimulus, after matched to a comparison stimulus, was removed from the test screen. In Condition 2, Typical Matching trials were different from Condition 1 because, at the end of each choice, the matched stimuli were presented side-by-side, forming a compound stimulus with identical elements (a pair), signaling a correct response on the consequence screen. On Multi-sample Matching trials, the compound stimulus was also shown on the consequence screen when stimuli were matched. Additionally, the pairs were inserted on the left column (trial screen) to show correct responding and the matched stimuli (Figure 1). Displaying the compound stimulus may have established, within a trial, control over the response of clicking on another left-column stimulus. However, it should be noted that this procedure did not ensure that participants looked at the elements of the compound stimulus. Results suggest that displaying the compound stimuli favored more precise performance in Typical and Multi-sample Matching tests, since the average percentage of correct responses for Condition 2 was higher than for Condition 1 (Figure 3).

In the present study the required response was to click on each sample stimulus and then on the identical comparison stimulus, which was different from the studies by Freitas (2012) and Gomes (2011; Experiment 1), which used a dragging response. Because of limitations of the software used in the present study, stimuli remained at the same position. However, a simulation of moving the stimulus from left to right was programmed (Figure 1, screens “b” and “e”). Regardless of that restriction, programmed tasks allowed evaluation of the effect of visual organization on Typical and Multi-sample identity matching and display of pairs of identical stimuli in a context different from Gomes (2011).

Gomes (2011) and Gomes and de Souza (2008) considered that changing the number of stimuli displayed on the computer screen, for each match, facilitated identification of the beginning and end of each trial, by removing each comparison stimulus from the left side. In the present study, a simultaneous display of sample and comparison stimuli was programmed for the Multi-sample task in Condition 1, but the stimuli were displayed in columns whereas in Gomes (2011) comparison stimuli were displayed horizontally and samples vertically. However, Condition 1 results diverged from those obtained by Gomes (2011) and Gomes and de Souza (2008), as the percentage of correct responses for Multi-sample Matching trials was lower than for Typical Matching trials. It should be noted that the various previously analyzed parameters, that are different from the other studies, may have affected the obtained results, suggesting the need for additional research. For example, the results could be the same if an observation response was not used for the Typical Matching task or if a touch-screen response was used, as in Gomes (2011).

Although the Multi-sample task in the present study was effective for most participants, four of them (P6, P8, P18 and P19) with mild/moderate autism (Table 1) showed less than 30% correct responding and issued a large number of responses in the presence of inactive stimuli (Table 2). It is possible that the criterion used for the training trials was not sufficient for learning the sequence of necessary steps to execute the Multi-sample Matching task. Low scores indicate that control by identity relations was not established or that other stimulus dimensions may have controlled performance (see Stimulus Control Topography Coherence Theory; Dube & McIlvane, 1996; McIlvane & Dube, 2003).

A contribution of the conducted study is the description and analysis of several parameters that must be considered when programming identity matching tasks for individuals with ASD, such as visual display of stimuli, using compound stimuli to indicate correct matching, observation responses, criterion to change from training phases to testing, and presenting consequences for the selection response. Investigating variables that affect the performance of tasks involving relations between stimuli, as in the present study, may contribute in planning teaching conditions in applied situations, especially for individuals from special education provision.

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