Equivalence class formation in 11-month-old pre-linguistic infants

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Recibido, mayo 3/2017
Concepto de evaluación, julio 14/2017
Aceptado, septiembre 20/2017

Referencia: Quezada Velázquez, A.G., Padilla Vargas, M.A. & Flores Aguirre, C.J. (2018). Equivalence Class Formation in 11-month-old pre-linguistic infants. *Acta colombiana de Psicología*, 21(1), 271-279. doi: http://www.dx.doi.org/10.14718/ACP.2018.21.1.12

Abstract

Several studies have attempted to assess the role of naming in the emergence of equivalence relations, but results are inconsistent; on the one hand, there are reports of equivalence emerging without naming and on the other hand, some authors claim that naming is necessary for equivalence to emerge. The objective of the present study was to evaluate the emergence of equivalence relations in pre-linguistic infants. Five infants aged 11-to-12 months received training in four conditional discriminations (A1-B1, A2-B2, B1-C1, and B2-C2) in order to establish two three-member classes. The participants were tested in reflexivity, symmetry, transitivity and equivalence, and all scored higher than 75% on all tests. On the reflexivity tests, percentages were above 80%; on the symmetry tests, they varied from 75% to 100%; on the transitivity tests, they averaged 75%; while on the equivalence tests results ranged from 87.5% to 100% of correct responses. These results suggest that displaying some degree of expressive language is not necessary for the emergence of equivalence relations.
Key words: Equivalence relations, language development, naming, arbitrary matching-to-sample, pre-linguistic infants.

Formación de clases de equivalencia en niños prelingüísticos de 11 meses de edad

Resumen

En varios estudios se ha intentado evaluar el rol del nombramiento en la emergencia de relaciones de equivalencia, sin embargo, los resultados son inconsistentes, ya que existen reportes de emergencia de equivalencia en ausencia de nombramiento, y algunos autores señalan que el nombramiento es necesario para que emerja equivalencia. El objetivo del presente estudio fue evaluar la emergencia de relaciones de equivalencia en niños prelingüísticos. Se usó una muestra de cinco infantes de entre 11 y 12 meses de edad que fueron entrenados en cuatro discriminaciones condicionales (A1-B1, A2-B2, B1-C1, B2-C2) para formar dos clases de tres miembros. Los participantes fueron evaluados en reflexividad, simetría, transitividad y equivalencia, y todos lograron puntajes mayores al 75 % de aciertos en todas las pruebas. Como resultado, los porcentajes de respuestas correctas fueron mayores al 80 % en la prueba de reflexividad, variaron entre 75 y 100 % en la de simetría, promediaron 75 % en la de transitividad, y variaron entre 87.5 % y 100 % en la de equivalencia. Estos resultados apuntan a que no es necesario contar con algún tipo de repertorio lingüístico expresivo para que emerjan relaciones de equivalencia.
Palabras clave: Relaciones de equivalencia, desarrollo lingüístico, nombramiento, igualación arbitraria, niños prelingüísticos.

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This paper is based on the master's thesis of the first author, completed under the direction of the second and third author.

Formação de classes de equivalência em crianças pré-linguísticas de 11 meses de idade

Resumo

Em vários estudos, tem-se tentado avaliar o papel da nomeação na emergência de relações de equivalência, contudo os resultados são inconsistentes, visto que, por um lado, existem relatos de emergência de equivalência em ausência de nomeação e, por outro, alguns autores indicam que a nomeação é necessária para que emerja equivalência. O objetivo deste estudo foi avaliar a emergência de relações de equivalência em crianças pré-linguísticas; especificamente, usou-se uma amostra de cinco crianças de entre 11 e 12 meses que foram treinadas em quatro discriminações condicionais (A1-B1, A2-B2, B1-C1, B2-C2) para formar duas classes de três membros. Os participantes foram avaliados em reflexividade, simetria, transitividade e equivalência, e todos atingiram pontuações maiores a 75 % de acertos em todos os testes. Como resultado, as porcentagens de respostas corretas foram maiores a 80 % no teste de reflexividade, variaram entre 87.5 % e 100 % no de equivalência. Esses resultados apontam a que não é necessário contar com algum tipo de repertório linguístico expressivo para que relações de equivalência emerjam.
Palavras-chave: crianças pré-linguísticas, desenvolvimento linguístico, igualação arbitrária, nomear, relações de equivalência.

INTRODUCTION

An equivalence relation is defined as the emergence of a new relation between stimuli that arise from previously trained conditional discriminations (Sidman, 1990, 1994, 2000). In order to classify emerging relations as equivalent, an equivalence test should be performed (Fields, Verhave & Fath, 1984; Fields & Verhave, 1987), in which the subject must successfully pass a series of reflexivity, symmetry, and transitivity tests (Sidman & Tailby, 1982). Symmetry and transitivity can be evaluated simultaneously (Sidman & Tailby, 1982); this test was called equivalence test (Fields, Verhave, & Fath, 1984; Fields & Verhave, 1987).

Different theoretical positions have attempted to explain how equivalence relations emerge. According to Sidman (1990, 1994, 2000, 2009), equivalence is a direct result of the reinforcement contingencies to which an individual is exposed; whereas Dugdale and Lowe (1990) and Horne and Lowe (1996) argue that physically distinct stimuli cannot be assumed to be equivalent unless they are specifically named by the subject. Hence, they propose that stimuli become functionally equivalent through naming.

From this perspective, naming could be regarded as a linguistic skill that has special characteristics distinguishing it from others -like receptive (listener's behavior) and expressive (speaker's behavior) linguistic skills-, while at the same time it requires both. In addition, Horne and Lowe (1996) identify naming as a basic verbal behavior unit. Naming implies a by-directional relation between classes of objects or events and the individual´s behavior as a speaker-listener. Thus, children learn both listener's behavior and echoic responding separately and it is only when the by-directional relation emerges that one can say that naming has been acquired (Horne & Lowe, 1996). Under this model, when naming is established, the by-directionality extends through other verbal behavior as the mand, tact, and intraverbal. Therefore, these behavior classes become a variant of such bi-directional relation (Horne & Lowe, 1996).

Several studies have attempted to assess the role of naming in the emergence of equivalence relations, but results are inconsistent. On the one hand, there are reports of equivalence emerging without naming (Carr, Wilkinson, Blackman, & McIlvane, 2000; Lazar, Davis-Lang, & Sanchez, 1984; Luciano, Gómez-Becerra, & Rodríguez-Valverde, 2007; O'Donnell & Saunders, 2003; Sidman & Tailby, 1982). And on the other hand, some authors have questioned those results, claiming that naming is necessary for equivalence to emerge (Carp & Petursdottir, 2015; Horne, Hughes, & Lowe, 2006; Horne, Lowe, & Randle, 2004; Lowe, Horne, Harris, & Randle, 2002).

Other research has assessed the linguistic conditions under which equivalence relations may emerge (De Alcântara Gil, de Oliveira, & McIlvane, 2011; Carr et al., 2000; Devany, Hayes, & Nelson, 1986; Peláez, Gewirtz, Sanchez, & Mahabir, 2000). One of those studies (Devany et al.,1986) evaluated the relationship between the level of linguistic development and the establishment of equivalence relations. Three groups of children were trained (preschoolers with linguistic abilities, children with an intellectual disability and limited linguistic abilities, and children with an intellectual disability and no linguistic abilities) in four symbolic matching-to-sample (SMTS) tasks. Results showed that the participants with normal or limited linguistic abilities showed evidence of the formation of equivalence classes, whereas those without linguistic abilities responded at a random level. These results led the authors to conclude that linguistic abilities are closely related to the emergence of

stimulus equivalence relations, but that it is not necessary to have an extensive linguistic repertoire, as some limited linguistic abilities may suffice for that objective.

Peláez et al. (2000) noted that the results obtained by Devany et al. (1986) were not entirely clear, as it was difficult to determine whether the intellectual disabilities of the participants were associated with their difficulty in performing the equivalence test, or whether failure on it was a result of the deficit in their linguistic skills. Therefore, they replicated the work of Devany et al. (1986) with nine children aged 21-to-25 months with normal development but limited expressive linguistic skills. Because most of their participants passed the transitivity test with 80-to-100% correct responses, the authors concluded that: (1) it is possible for equivalence relations to emerge as a result of conditional discrimination training, and (2) the emergence of equivalence relations is likely related in some way to linguistic skills.

De Alcântara Gil, de Oliveira, and McIlvane (2011) conducted a study to assess whether pre-linguistic children between 16 and 21 months of age were able to learn to relate identical stimuli using the kind of conditional discrimination procedure usually employed to study equivalence relations. Initially, those infants were trained in a simple discrimination task, and later in an identity matching-to-sample (IMTS) task. The authors argued that their study revealed that pre-linguistic children were able to relate identical stimuli using a conditional discrimination task, and based on that finding, they suggests evaluating the equivalence of stimuli with infants younger than those of their study (16 to 21 months old) under the assumption that they are capable of learning symbolic relationships.

In another study, Carr et al. (2000) carried out two experiments in order to evaluate the possible emergence of equivalence relations in participants with minimal verbal repertoires. In the first experiment, three participants between 13 and 21 years of age with profound intellectual disabilities that precluded the ability to name were trained in six SMTS tasks and then were tested on the emergence of equivalence. Results showed that all participants passed the tests with scores ranging from 94-100% of correct responses. In the second experiment, they trained two different participants with intellectual disabilities, one 13 and the other 14 years old, in four SMTS tasks and assessed for equivalences. They reported that only one of those participants passed the tests.

Carr et al. (2000) concluded that since the majority of their participants were able to pass the test without naming the stimuli, the question arises as to whether the emergence of equivalence classes can only be found in individuals with well-established naming behavior. They observed that it is necessary to test individuals who have no kind of expressive linguistic skills in order to conclude whether or not naming are required.

Given the variability in the results obtained in experiments attempting to evaluate the role of naming, Horne and Lowe (1996) suggest that one way of testing the contribution of naming behavior to the emergence of equivalence relations is to analyze the phenomenon in pre-linguistic subjects (children who only have receptive verbal skills and have not learned naming yet). Also, Carr et al. (2000) stated that analyzing equivalence relations in such pre-linguistic participants would make it possible to eliminate the bias introduced by the process of assigning names, thus facilitating the identification of the role that naming plays in the emergence of equivalence relations.

The present study was designed to evaluate the emergence of equivalence relations in pre-linguistic children (without expressive language skills) aged between 11 and 12 months old. It is based on Horne and Lowe's (1996) proposal regarding the most effective strategy for identifying the role of naming in the establishment of equivalent stimuli relations, and on the findings reported by De Alcântara Gil et al. (2011) and Peláez et al. (2000).

It is important to point out that in none of the previous studies the researchers had worked with such young children. Peláez et al. (2000) was worked with children aged 21 to 25 months, while in the De Alcântara Gil et al.'s (2011) study, participants were children aged 16 to 21 months. Another difference between the present investigation and other studies such as the ones by Carr et al. (2000) and Devany et al. (1986) is that they worked with participants who had intellectual disability, whereas the present research did not include that type of participants. The latter was done in order to avoid confusion as to whether the inability to pass the tests is the result of a lack of language skills or intellectual disability, as mentioned by Peláez et al. (2000).

Given the aforementioned, the objective of the present study was to evaluate the emergence of equivalence relationships using arbitrary matching-to-sample tasks in pre-linguistic children (11-month-old).

METHOD

Participants

Five infants (three girls, two boys) aged 11-12 months who were under their mother's care in their homes served as participants. The age of each participant at the beginning and at the end of the experiment is shown in Table 1.

Table 1
Age of each participant when the experiment starts and ends

Participant	Time elapsed	
	Age at start	Age at end
1	12 months 5 days	13 months 26 days
2	11 months 2 days	12 months 22 days
3	11 months	12 months 15 days
4	11 months 23 days	13 months 8 days
5	11 months 8 days	12 months 7 days

The participants were pre-linguistic infants (i.e., they only had receptive verbal skills, but not expressive verbal skills). In order to determine those characteristics, the participants were assessed by means of the communication test of the BATELLE Development Inventory (Newborg, Stock, & Wnek, 1996) on the receptive and expressive subareas.

It is important to note that the parents of all participants signed the Informed consent. The children were observed with their mothers for 5 min before training and the mothers were asked if their infants had uttered any words, in order to verify that participants had not developed any expressive language skills during the study. Had this occurred, they would have been excluded from the experiment (but no such cases were identified).

Setting

The study took place in the participants' homes, usually in their living rooms, spaces that measured approximately 2 x 3 meters, and was illuminated by natural light. In general, the furniture consisted of sofas, a television set and a shelf. The only people present during all sessions were the child, the experimenter and an assistant who helped with the video recording.

Materials

The materials used were six different toys divided into two distinct classes of stimuli: a blue-and-white stuffed dolphin (A1), a black rubber ape (A2), a red plastic microphone (B1), a silver-colored plastic baby bottle with green cap (B2), a yellow plastic cross (C1), and a pink plastic hexagon (C2) (see photographs, Appendix). The toys used in this study were completely novel to the participants, none of the children had had previous contact with them, or similar ones; this was corroborated by asking their mothers and observing the play zone of the babies.

Selection of these stimuli was based on two criteria: (a) previous studies in which toys were used as stimuli (De Alcântara Gil et al., 2011; Luciano et al., 2007); and (b) the use of toys that differ in color and shape to preclude the presence of previous relationships. In addition, these toys had similar dimensions and materials so participants were able to manipulate them. A SONY® video camera (MHS-FS3) was used to film the sessions.

Procedure

At the beginning of each session, the participant sat on a high chair with the experimenter seated in front at a distance of 40 cm. A demonstrative trial was conducted at the onset of the training phase. It consisted of a side-by-side presentation of the A1 and B1 stimuli, each stimulus in one hand, at about the height of the participant's eyes and at a distance of about 20 cm. While sequentially waving the corresponding stimulus, the experimenter said: "Look, this one (A1) goes with this one (B1), this one (A1) goes with this one (B1)"; then both stimuli were withdrawn from the participant's view.

After this first trial, relations between A1-B1 were trained. A1 was presented to the participant as a sample stimulus (SS). The experimenter held it in the left hand at about the height of the participant's eyes and a distance of about 20 cm and said: "Look what I have here"; the objective was to have the infant make eye contact with the stimulus.

Next, the B1 and B2 comparison stimuli (CS) were presented by placing both on the high chair tray separated by 15 cm. The infant was then asked: "Which one goes with this one?", referring to the SS. In order to avoid positional-type bias, the position of the stimuli was alternated (right, left) across trials.

The expected response from participants was to touch one of the stimuli, no matter with which part of their bodies they did it. If they touched the correct CS they were told: "Very good, this goes with this" (showing them the SS with the correct CS) and a children's song was played for 10 s. The children´s song was selected among other songs, testing with which one the kids emitted a variety of responses like moving their hands, their head, or all their body, at the rhythm of the song. The same song was played for the entire experiment. Some of the participants responded with less intensity in the presence of the song, but continued emitting different responses until the end of the experiment.

If the incorrect CS, or both CS stimuli were touched, the experimenter made a disapproval move with her head, and the disapproval sound: "Hum, umm", then the SS was presented together with the correct CS, and the infant was told: "Look, this goes with this", and a new trial began.

If after a 10 s lapse the participant did not take any of the CS, the trial ended and a new one began after a delay of 10 s. Sessions were considered complete if the participant emitted no response after three consecutive trials. Each session lasted 10-15 minutes, depending on the participant's disposition.

Once a participant gave five consecutive correct responses for the A1-B1 relation, the A2-B2 relation was trained, in the

same way that the first relation was trained, and once this criterion was met for the second relation, the infant received training using both SS (A1 and A2). Blocks of 16 training trials were performed. Trials were presented randomly using both SS. Training concluded once the participant achieved at least 12 correct responses in two consecutive blocks; this meant that the participant had to obtain 75% or more correct responses in two consecutive blocks.

After these training, the babies were exposed to a block of test trials without feedback; they were first exposed to eight reflexivity trials (A1-A1, A2-A2, B1-B1, B2-B2), and then to eight symmetry trials (B1-A1, B2-A2). After that, but following the same procedure used in the A-B training, B1-C1 training began. Once the performance criterion was met (i.e., five consecutive correct responses), B2-C2 training began; as soon as the participant achieved five consecutive correct responses, training began with both SS (B1 and B2). Once again, blocks of 16 training trials were performed. Trials were presented randomly using both SS (B1 and B2). Training concluded when the participant gave at least 12 correct responses in two consecutive blocks.

After B-C training, the infants were exposed to another block of test trials without feedback; they were first exposed to four reflexivity trials (C1-C1, C2-C2), then to eight symmetry trials (C1-B1, C2-B2). After those tests, participants were exposed to a block of 16 trials, in which randomized trials of the four trained relations (A1-B1, A2-B2, B1-C1, and B2-C2) were presented; the children had to emit 12 correct responses at least to pass to the final test block. In the final test block, 16 test trials were presented: first, eight transitivity trials (A1-C1, A2-C2) and then eight equivalence trials (C1-A1, C2-A2).After that, the experiment was over.

RESULTS

Table 2 shows the number of trials that each participant needed to reach the achievement criterion in each training phase. The average number of trials required for the A1-B1 relation was 56.6, while for A2-B2 participants required 46.8 trials. In the randomized training (A1-B1, A2-B2) they required 141.4 trials to reach the criterion. In B1-C1 training, participants met the achievement criterion after 34 trials, while for B2-C2 they required only 14.2 trials. During randomized training (B1-C1, B2-C2), 72.6 trials were required to meet the criterion. In the final randomized training block (A1-B1, A2-B2, B1-C1, B2-C2) all the participants reached the criterion in the first block of 16 trials.

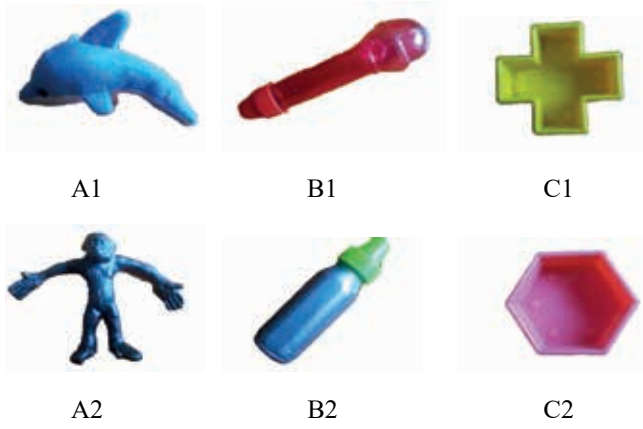

Figure 1. shows the percentage of correct responses achieved by each participant on each test. The reflexivity test was applied in different moments; the participants were exposed to A-A and B-B test after the A-B training, and the C-C test was applied subsequently to B-C training. However, the percentage of correct responses was calculated based on all test trials. The same was done with the symmetry test, and the result was obtained based on all test trials, although the participants were exposed to B-A test after the A-B training, and to C-B test after B-C training.

On the reflexivity test, all participants achieved scores above 80%, except Participant 3 who scored only 58.3%. On the symmetry test, participants 3 and 5 achieved 100% of correct responses, participants 2, and 4, 81.25%, and Participant 1, 75%.

Table 2
Number of trials required per participant to meet the established criterion in each training phase

	Training						
Participant	A1-B1	A2-B2	A1-B1, A2-B2	B1-C1	B2-C2	B1-C1, B2-C2	A1-B1, A2-B2, B1-C1, B2-C2
1	99	49	65	70	8	48	16
2	5	82	144	12	12	32	16
3	46	50	225	26	13	128	16
4	75	46	160	50	31	123	16
5	58	7	113	12	7	32	16
Group mean	56.6	46.8	141.4	34	14.2	72.6	16

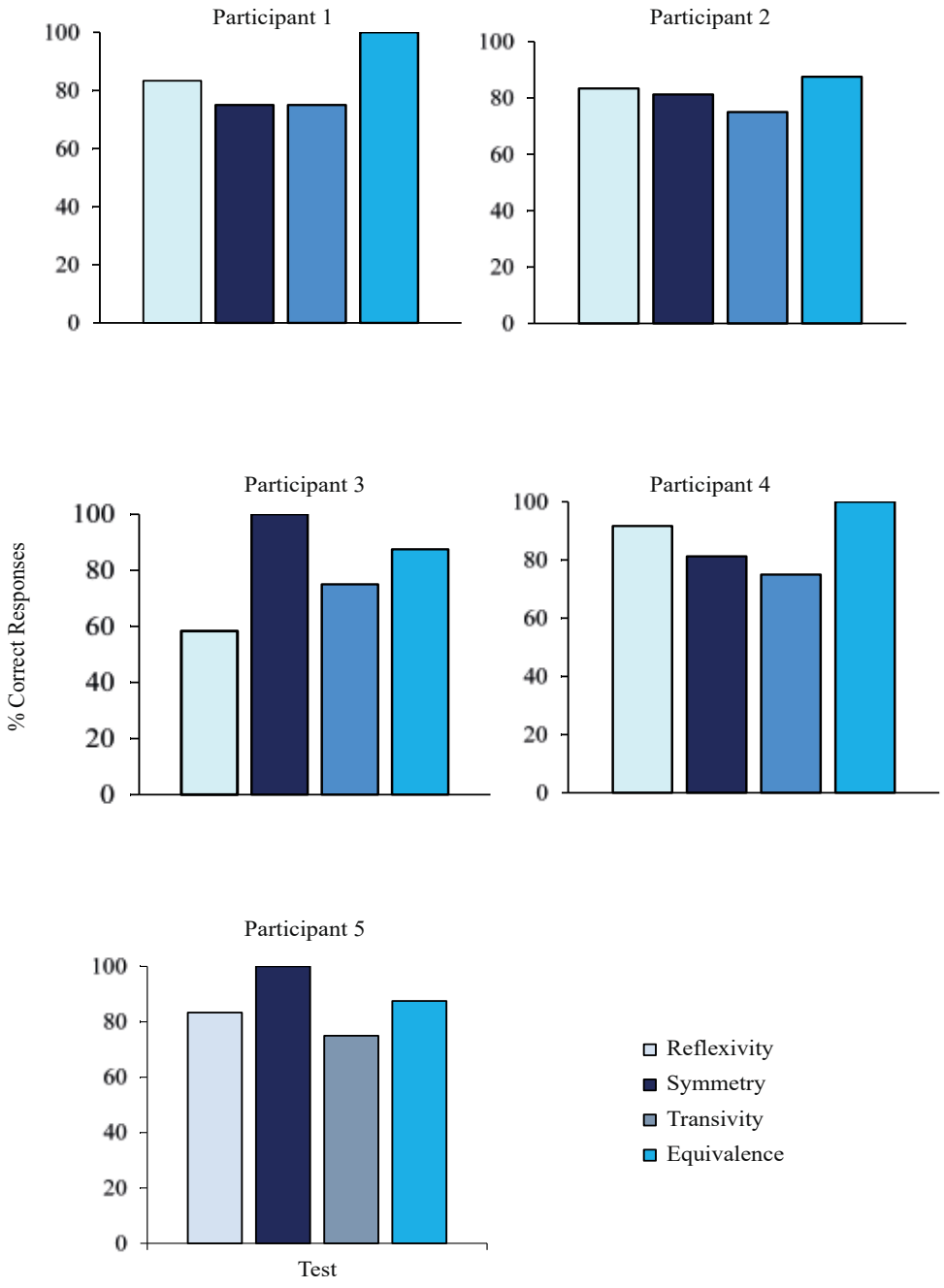

Figure 1. Percentage of correct responses achieved per participant on each test: reflexivity (A-A, B-B, C-C), symmetry (B-A, C-B), transitivity (A-C), and equivalence (C-A) tests.

On the equivalence test, all participants reached a higher percentage of correct responses compared to the 75% achieved on the transitivity test. Finally, during the equivalence test, participants 1 and 4 achieved 100%, while the others achieved 87.5% of correct responses.

A binomial test was performed to assess the likelihood that participants responded randomly during the test. The binomial test showed that the probability of responding at chance level in reflexivity test was .019 for participants 1, 2, and 5; for participant 4 was .003, while for participant 3 was .387 because he failed the test. In symmetry, the result of the binomial test was .038 for participant 1, .0106 for participant 2, and 4, whereas for participants 3 and 5 was .000015. The probability of responding at chance level

was .144 for all the participants in the transitivity test. Meanwhile, in equivalence was .0039 for participants 1, and 4, and .035 for participants 2, 3, and 5. In addition, the possibility that participants responded randomly during the training phase prior to test was assessed and the results of the binomial test was .038.

Two external observers reviewed the videos to determine whether the experimenter or the assistant provided some kind of cue or instigated the child to select a specific stimulus. The inter-observer agreement obtained was 91.66%; therefore, the external observers agreed that the participants did not receive any cue to choose a stimulus. Likewise, the external observers evaluated if the participants' responses were correct or incorrect in the training and the test trials; the inter observer agreement with respect to the responses in training trials was 94.14%, whereas in the test trials was 100%. The external observers agreed that the results obtained both in the training and test phases were reliable.

DISCUSSION

The objective of the present study was to assess the emergence of equivalence relations using SMTS tasks in pre-linguistic children. The results obtained in the different training phases show that all participants met the criterion. These findings provide evidence that 11 month-old pre-linguistic infants are able to learn SMTS tasks. The results found in this research thus extend the findings reported by De Alcântara Gil et al. (2011), in which they used an IMTS task with children aged 16-to-21 months, since they indicated the possibility that children of that age range learn symbolic relations, an aspect that the present work showed.

SMTS tasks have been widely used with adults and participants between 2 and 12 years old (Arntzen & Nikolaisen, 2011; Arntzen & Vaidya, 2008; Jordan, Pilgrim, & Galizio, 2001; Saunders, Drake, & Spradlin, 1999), but such tasks had not been used with participants in the age-group studied in the present experiment. Likewise, there are few works in the area of equivalence with young children or without expressive verbal skills, and the main reason for this is the difficulty associated with the acquisition of conditional discriminations during baseline (Pilgrim, Click, & Galizio, 2011). In addition, the procedures used to train participants with minimal verbal skills in simple discriminations are often successful, but the effectiveness of such procedures decreases when conditional discrimination training is used (McIlvane, Gerard, Kledaras, Mackay, & Lionello-DeNolf, 2016).

Observations showed that during testing all participants reached high percentages of correct responses. On the reflexivity tests, percentages were above 80%, on the symmetry tests they varied from 75% to 100%, on the transitivity tests they averaged 75%, while on the equivalence tests, results ranged from 87.5% to 100% of correct responses. These results seem to demonstrate the emergence of equivalence relations in pre-linguistic infants.

It is important to underline that most of the incorrect responses during the tests were emitted in the last trials, accompanied by emotional responses like crying, turning around, refusing to respond, and raising their hands to be taken out of the high chair. It is hypothesized that the emotional responses were the result of running the test sessions in extinction. That is to say, since the reinforcement was discontinued abruptly, the participants may not have been motivated to respond anymore; this suggests that the stimulus used as reinforcer was effective.

Previous studies have found diverse results when attempting to assess the emergence of stimulus equivalence related to expressive linguistic skills. Some of them have reported that linguistic skills are related to the emergence of equivalence relations (Devany et al., 1986; Peláez et al., 2000), while others do not assume that such skills are needed for stimulus equivalence to occur (Carr et al., 2000). It is possible that the differences reported are related to certain characteristics of the participants, such as intellectual disabilities or linguistic skills, given that those studies evaluated the emergence of equivalence in children with either limited or well-established linguistic skills, or with intellectual disabilities and absent, or limited, linguistic skills.

Devany et al. (1986), for example, reported that participants with limited or established linguistic skills responded correctly during equivalence tests, but similar results were not observed in children without linguistic skills. These results contrast with those reported by Carr et al. (2000), and with the present results, in which the establishment of equivalent stimuli classes in participants without (expressive) linguistic skills was observed. Devany et al. (1986) claimed that linguistic abilities are closely related to the emergence of stimulus equivalence relations, but the results of the present study seem to go against that claim. The problem with their assertion is that it is virtually impossible to test it empirically, because Devany et al. (1986) never specified the class of linguistic abilities (receptive or expressive) that the individuals had to display to approve equivalence tests.

It is important to note that Horne and Lowe (1996) suggested that using pre-linguistic children –i.e., those who still have not acquired naming behavior– would be the most effective way to demonstrate the role of naming in the emergence of equivalence relations, as it would eliminate the bias introduced by the process of assigning

names (Carr et al., 2000). This consideration allows us to identify whether or not naming behavior or some linguistic skills are necessary for stimulus equivalence to emerge.

According to Horne and Lowe (1996), naming behavior is required for equivalence relations to emerge; since the participants in the present study showed no evidence of naming behavior as specified by Horne and Lowe (1996) this would lead to expect them to be unable to perform the equivalence tests. However, all infants achieved a high percentage of correct responses during test trials; this result seems to prove that equivalence relations could emerge in absence of the naming behavior. Hence, the results cannot be easily explained by Horne and Lowe's assumptions.

The fact that participants passed the equivalence tests could be explained from Sidman's point of view (1990, 1994, 2000). According to this author, the emergence of equivalence relations is a direct result of reinforcement contingencies; thus, establishing stimulus equivalence even without linguistic skills could be expected.

Despite the fact that previous research have shown confounding results regarding whether linguistic skills are required for the emergence of equivalence relations (Carr et al., 2000; Devany et al., 1986; Peláez et al., 2000), the present study found that infants without expressive linguistic skills are capable to pass the equivalence tests. The results of the present study seem to indicate that such expressive verbal responses are not required for equivalence relations to emerge.

The discrepancy observed between the results of the present experiment and those reported by other authors (Devany et al., 1986; Peláez et al., 2000) who worked with toddlers, could be explained on the basis of methodological differences between the experiments. Firstly, the type of stimuli used in previous works (Devany et al., 1986; Peláez et al., 2000) were made-up animal-like figures of different colors, while in the present work diverse toys were used; the use of toys could help to maintain the infants on task. Secondly, their studies used a variety of reinforcers (praise, blowing soap bubbles, singing, balloons, juice, and cheese crackers), whereas in the present work the reinforcer used was a children´s song, selected among others, through the evaluation of the participants' preference. Probably, the use of a reinforcer selected by the participants was the reason why the children of the present work did not present satiation.

In addition, it should be considered that in the work of Devany et al.'s (1986) the test blocks consisted only of the transitivity and equivalence tests, which were presented at the end of all the training phases. On the other hand, in Peláez et al.'s study (2000) and in the present work, participants were exposed to symmetry tests just after meeting the achievement criteria of each of the training phases; and were exposed to the transitivity and equivalence tests after reaching the phase criterion of mixed training. This difference in the way of presenting the trials could be the reason why only a few participants in the study by Devany et al. (1986) passed the test. It is plausible to assume that presenting the test trials right after each training phase facilitates the emergence of equivalence relationships.

Although the number of CS used in the present study could be considered as a limitation because the probability of responding correctly is 50%, the criterion used during the training phase (12 correct trials out of 16) reduces the likelihood that the response was at random; and the result of the binomial test (.038) supports the previous statement. The evidence showing that the responses in the test phase were not given at random is that the children responded correctly in 87.5% or more of the equivalence trials. This means that the children obtained at least 7 correct responses out of 8 possible ones, and the binomial test shows that the probability of responding at random level in this case is low (.035). Lastly, it is important to point out that all procedures performed in this study were in accordance with the ethical standards of the institutional and national research committee.

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