

Article

Influence of Verbal Behavior Training on Performance for Sustainable Development in Childhood and Early Adolescence

Miguel A. Maldonado ¹, Francisco J. Alós ¹ and Amapola Povedano-Díaz ^{2,*}

¹ Psychology Department, Córdoba University, Córdoba 14071, Spain; z62mahem@uco.es (M.A.M.); ed1alcif@uco.es (F.J.A.)

² Education and Social Psychology Department, Pablo Olavide University, Sevilla 41013, Spain

* Correspondence: apovedano@upo.es; Tel.: +34-954-978-250

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Abstract: The effective teaching of language is an aspect of special relevance regarding the good adjustment of children in contexts such as school, family, or community. This article performs an experimental procedure to check which language teaching methodology is most effective in a sample of children. The objective was to analyze the influence of training, Condition 1 (pure tacts more intraverbal) or Condition 2 (pure tacts more impure tacts), on emergence of two tests involving impure tacts (AB-C, AB-D) and four new complex intraverbals (BC-D, BD-C) for each of two sets of stimuli (Set 1 and Set 2). The sample comprised 54 children aged between 6 and 12 years, divided into two groups of different experimental conditions. The results revealed statistically significant differences in performance on the tests of impure tacts and complex intraverbal, obtaining highly effective results in Condition 2. This teaching method using compound stimuli (impure tacts) clearly favors the expansion of language. The practical implications of this work can be more effective language teaching methodologies implemented that favor the good psychosocial adjustment of children in contexts such as family, school, or the community in general.

Keywords: verbal behavior; compound stimuli; tacts; intraverbals; psychosocial factors; children

1. Introduction

In this study, two very relevant aspects of verbal behavior and the procedures used to expand it are distinguished. First of all is the identification of possible psychosocial factors that promote or hinder the development of verbal behavior in children. Secondly, it is relevant to this work to emphasize that the role of the good development of language in the psychosocial adjustment of children in contexts such as the family, school, or community is exposed. In addition, the potential implications and benefits that this has for children and adolescents further enhance the importance of applying these procedures and taking into account said factors to achieve sustainable development, not only directly on verbal behavior, but also on its optimal development at a psychosocial level.

The family is one of the structures or contexts that is most important in the adequate development of human beings [1]. Specifically, the family climate has a crucial role in contributing to the development of specific aspects such as well-being, behavior, and development at the psychosocial levels [2], as well as language and thought [3]. One of the most outstanding aspects of the family climate is communication, that is, the linguistic and communicative interaction that is established between parents and children [4–6].

Family communication seems to be influenced by the parents' level of cultural education [7,8]. Thus, there seems to be a direct relation between the cultural level of parents and the amount of information about the world that they transmit to their sons and daughters. Another aspect is the way they do it,

being more structured, ordered, and with a richer vocabulary and language, broad in nuances and in semantic and syntactic constructions [9]. Furthermore, the differences in communication that affect the selection, combination, and organization of words influence the adequate psychosocial adjustment of the sons and daughters [10] to the different contexts of socialization, such as the school [9,11].

In the aforementioned context, there are various studies that affirmed the importance of some psychosocial factors that affect the good adjustment of children and adolescents at school, such as school performance [12], bullying [13,14], the school climate [15,16], and social skills [17]. These can directly influence the development of language, at the same time that the latter can influence all the psychosocial factors mentioned.

In reference to this, Schonhaut et al. [18] affirmed that language difficulties may be associated with learning difficulties and behavioral disorders. This can have an impact on a smaller repertoire of social skills, leading to problems at school related to bullying [6,13,19,20]. In this regard, the problem can persist into adulthood if adequate intervention is not carried out [16].

Another aspect to take into account is the school environment, understood as a social construction of interactions and perceptions that teachers and students develop about the school context [15]. Therefore, the positive school climate encourages participation in school activities; the degree of attention, interest, and participation of students in class activities; and a lower degree of absenteeism [16], favoring a better psychological, social and emotional fit in school [2]. All this cannot occur effectively if the students do not have a sufficient level of verbal development, among other abilities, so in this area their interactions can be reduced and the school environment can be perceived as negative by the students, affecting good psychosocial adjustment at school. Adolescents with an attachment and commitment to school, as well as a higher degree of acceptance of the rules, are less likely to engage in nonadaptive activities than those with weak ties [16]. Researchers such as Aparisi et al. [21] aimed to work with teachers and administrations to create educational environments that facilitate learning by promoting the socio-personal development of students [22,23].

The community is also a context related to language, so it is important to consider. In this regard, studies such as Jiménez et al. [24] and Gracia et al. [25] affirmed that there are risk and protection factors related to communication between parents and children and with nonadaptive behaviors such as juvenile delinquency [26] or substance use [27]. According to Beitchman et al. [28], children with language disorders who are around 5 years old are more likely to have behavioral problems in childhood and adolescence, compared to children with typical language development. Furthermore, language disorders can be a precursor to substance use and abuse. Some authors stated that the difficulty of self-regulation can be an explanatory cause of substance use and that the language disorder is closely related to this executive dysfunction [29,30]. Other studies affirmed that children with language disorders have a greater probability of presenting learning problems with an associated greater risk of presenting substance use problems between 12 and 19 years of age [31]. For this reason, language can be a protective variable in terms of nonadaptive behaviors that undoubtedly affect health and the community in general [32].

The maladjustments in any of the factors discussed can limit the different learning opportunities that are necessary for the good development of verbal abilities, so it is important to take them into account and develop strategies that favor these factors. From the contrary perspective, there is evidence that delayed language development produces negative effects on various psychosocial aspects [33]. Therefore, it was found that a good adjustment in the different psychosocial contexts has a favorable effect on cognitive development and language skills, in the same way that a good development of these language skills favors a good psychosocial adjustment in all mentioned aspects. We are, therefore, facing an interrelated phenomenon in which language and psychosocial factors mutually influence each other, so it is vitally important to take into account and enhance both aspects for the good development and better adaptation of children to all contexts in which they are immersed.

This study will focus on the development of language skills through the implementation of procedures for teaching verbal behavior in children, because of the implications it has for the psychosocial adjustment in the various contexts discussed.

Regarding the development of language skills, we assume that language is a form of operant behavior, that is, a type of behavior that is controlled by the effect it has on the surrounding environment, and that is affected or mediated by the behavior of other individuals [34]. Conceptually, the foundations have been laid for understanding language as a behavior and, therefore, it is supposed to be governed by the same laws as other behaviors. At the methodological level, this fact means being able to study verbal behavior empirically through experimental procedures that endorse the main ideas of this field of study. Language has begun to be framed within the paradigm of the analysis of verbal behavior, backed by laws that have proven to be replicable, empirical, and generalizable [35]. For this reason, there has been a considerable increase in the number of studies that follow this methodological approach [36–38].

According to Schlinger [39], this success is due to: (a) it being an interpretation of the slow, operational behavior of the speaker in accordance with scientific measurements, and (b) the proposed concepts being usable and applicable to the teaching of language. These are particularly useful for those groups of people with severe psychosocial developmental limitations [40–44].

In research the taxonomy of six verbal operants was created, two of which have received special attention from researchers because of their implications for the development of the verbal repertoire, the tact and intraverbal components [34,37,45,46]. An intraverbal is a verbal operant evoked by a verbal discriminative stimulus. There is no point-by-point correspondence between this stimulus and response and they are maintained by generalized conditioned reinforcement (such as social attention). These may occur as an exchange between speakers or as part of a verbal chain [34,45,47], and can be taught either directly [48,49] or indirectly [50–55]. For a general review of intraverbal research consult the work of Aguirre et al. [56].

It is possible for an intraverbal to emerge directly from the learning of discriminations with common elements. The fact that these elements are of a different modality or function (e.g., stimuli and responses) does not prevent their appearance, as demonstrated in a number of intraverbal studies [50,51]. An example of direct intraverbal teaching is the following: given a verbal discriminative stimulus such as the word /country/ and an answer such as /France/, this relation between both stimuli can be taught directly by applying a generalized social reinforcement. Another example of direct intraverbal teaching can be multiplication tables, in which the subject is presented with a verbal discriminative stimulus, for example / 2×2 /, and must answer /four/. This response should be reinforced so that the relation between both stimuli is established and the intraverbal is learned [57].

Indirect intraverbal teaching consists of its emergence (not taught explicitly) from the combination of verbal and nonverbal stimuli. For example, if a child learns two intraverbals: /name of a horse?/, /Rocinante/, and /name of a rider?/, /Don Quixote/, the child can respond to an indirect intraverbal: /Rocinante rider?/, whose answer is /Don Quixote/, without this relationship having been explicitly taught (Rocinante with Don Quixote). In fact, intraverbals can arise after learning other intraverbals, tacts, and selections. In this regard, Petursdottir et al. [58] studied the occurrence of intraverbal words in Icelandic and Spanish in four Icelandic children who knew these words (that is, they had learned the relations between verbal stimuli in Icelandic and their corresponding nonverbal stimuli). The children were taught to (a) tact the images in Spanish or (b) select an image after hearing the word in Spanish, and they tested the remaining relations. The results showed that the two children who learned the tacts responded above 83% on the Icelandic–Spanish and Icelandic–Icelandic intraverbal tests. The other two children did not respond above this level on most of the tests. Therefore, the results showed that children who were taught by tact obtained better results on intraverbal tests than children who were trained in conditional discriminations.

In another study, Petursdottir et al. [59] examined the emergence of intraverbal words in Icelandic and Italian in two Icelandic children who knew these words (that is, they had learned the relations between verbal stimuli in Icelandic and their corresponding nonverbal stimuli). They taught the children (a) to tact a drawing in Italian, (b) to select a drawing after hearing the Italian word, (c) the Italian–Icelandic intraverbal, or (d) the Icelandic–Italian intraverbal, and then tested the remaining relations. Intraverbals emerged in a single child in only two of the four conditions. The results of these

studies and other similar studies, such as that of Petursdottir et al. [58], indicated the difficulty of designing procedures that produce an expansive intraverbal emergence, therefore, it is necessary to continue investigating them.

Another classification is from the point of view of the number of antecedent verbal stimuli that control the response [48]. Therefore, there are two types of intraverbals (simple or complex).

For good language development in children, it is necessary that intraverbals appear on a scale according to their complexity. This has to do with the relationship they have with the antecedent stimulus [60]. Simple intraverbals would be those in which a child only has to attend to an antecedent stimulus to give a correct answer. For example, /What is your name?/, responding /César/, so the child only has to attend to the relevant antecedent “name,” not having to attend to the rest of the verbal stimuli. Therefore, simple discrimination will be established.

In the case of complex intraverbals, what is established is a conditional discrimination, whose response is controlled by an antecedent stimulus and a contextual stimulus that influences it [61], since the child will have to attend to the combination of several antecedents to give a correct answer [62]. Continuing with the previous example, if we asked the child /What is your father’s name?/ or /What is your mother’s name?/, the response would be controlled by the combination of two relevant stimuli “name” and “father” or “mother.” Given the combination of “name” plus “father” the correct answer would be /Miguel/ and for the combination of “name” plus “mother” the correct answer would be /Inés/. To go into detail about this concept of complex intraverbals, the works of Pérez-González et al. [63] can be used. This type of complex intraverbal is not usually used in research designs for teaching procedures that include intraverbals, as a simple intraverbal is usually used. However, in the present study, a simple intraverbal for the training phases and a complex intraverbal in the test phases were used to check whether further expansion of language was possible.

Furthermore, according to the literature review conducted by Petursdottir [38], the tact was one of the most researched topics during the last decade. A tact is a verbal operant that includes a vocal verbal response controlled by nonverbal stimuli or one of their properties, and it is supported and maintained by generalized reinforcement [34,45,47]. Hence, an example of a tact is the situation where a child says the word “ball” when he or she is in front of the object. However, there are times when an adult may ask, for instance, what it is used for, what shape it is, or what color it is; Skinner described this kind of verbal behavior as an abstract tact.

Greer et al. [45] described two kinds of tacts, pure and impure. Pure tacts are those that occur only under the control of nonverbal antecedents, while impure tacts are those that occur under the control of two antecedent stimuli (one verbal and the other nonverbal); for example, the child says “ball” when asked “what is this?” when in front of the object. In the latter case, what matters is that the correct response depends on two antecedent stimuli. Taking this into account, these authors pointed out that the tact is the most important verbal operant for the development of language. However, it must be noted that they did not specify whether they were referring to pure or impure tacts.

From a theoretical and procedural perspective, the specialized literature has described the appearance of two antecedent stimuli as compound stimuli. These have been investigated in both conditional discriminations [64–66] and simple discriminations [67–69]. In this type of discrimination there are four comparison stimuli (for conditional discriminations) or responses (for simple discriminations) (C1, C2, D1, D2) that can be related to the two stimuli: A and B. The discriminations that can be produced are: A1B1-C1, A1B2-D1, A2B1-C2, A2B2-D2.

Axe [48] and Michael et al. [70] pointed out the possibility that in some types of behavior there can be multiple types of control of stimuli and/or responses. These authors referred to the notion of convergent control for cases in which several stimuli control the same response, and they used the term divergent response when a single stimulus controls several responses. In impure tacts something similar but not equal to convergent control is produced, because in these cases the answer depends on the relation that is established between two stimuli and is not merely the sum of these two stimuli. Skinner stated that: “(a) the strength of a single response can be, and generally is, a function of more

than one variable and (b) a single variable usually affects more than one response" [34] (p. 227). In this way, several variables or stimuli can control a response (multiple convergent control) or a variable or stimulus can control several responses (multiple divergent control) [68]. In any case, the multiple control of stimuli or responses can favor the interdependence between the verbal operants. However, to date, the evidence regarding independence or interdependence between verbal operants is still somewhat contradictory [71,72].

Two studies are of special relevance for this article. In particular, these works examined the influence of pure tacts plus intraverbals [50] and impure tacts [69] on the emergence of new verbal operants.

Belloso-Díaz et al. [50] conducted two experiments in 5 and 6 year old children to test the effect of teaching tacts or tacts plus intraverbals on the emergence of new intraverbals. In Experiment 1, three children learned two tacts through the image of a woman. In this condition, they were asked /Name the country/ and they learned to tact her country (e.g., /Pakistan/ or /Ethiopia/). The same procedure was used for the tacts of /name the tribe/ (e.g., /The Kalash/ or /The Surma/). After this training, the two-country tribe and the two-tribe country intraverbals were probed without reinforcement (e.g., /Name the country of The Kalash—/Pakistan/) and the three participants demonstrated the emergence of these four intraverbals. In Experiment 2 seven children learned a tact (to name either the country or the tribe), as in Experiment 1, and an intraverbal (either /Name the tribe from Pakistan—/The Kalash/ or /Name the country of the Kalash—/Pakistan/, respectively). In this case, five out of seven participants demonstrated the emergence of the tested intraverbals. The authors claimed that both methods are effective for the emergence of new intraverbal relations, though the first procedure is slightly more effective than the second, taking into account the discriminative control exerted by verbal and nonverbal stimuli in each condition. The authors stated in their paper that teaching conditional discriminations involving the discrimination between the two tact types should suffice for the children to demonstrate the intraverbals. Therefore, in the study by Belloso-Díaz et al. [50], the data showed that the first procedure (teaching of tacts) is slightly superior to the second (teaching of tacts more intraverbals), although it will be necessary to replicate this study in a more extensive sample in order to more clearly confirm these findings. Moreover, in the aforementioned study there was no statistical support for the findings, which will be necessary in order to draw more solid conclusions. Furthermore, these authors did not make a terminological difference between the use of pure or impure tacts for teaching or testing, which can be important at the conceptual and applied levels.

In our study, therefore, we used a larger sample and employed statistical tests in order to address these limitations. Another methodological aspect to take into account in the previous study is that they did not balance the sample by sex (three boys in Experiment 1; one boy and three girls in Condition 1 of Experiment 2, and two boys and one girl in Condition 2 of Experiment 2) or equalize the number of subjects in the conditions of Experiment 2 (four participants in Condition 1 and three participants in Condition 2), so there may be some strange variables that influenced the results. In our study, these questions were resolved. In addition, in the cited study, simple stimuli and a reduced number of combinations of stimuli were used in the training and tests, intraverbal (simple intraverbal) and impure tacts were not tested. In contrast, in our study compound stimuli were used in teaching and testing (impure tacts), and complex intraverbals were tested, trying to clarify functional differences and their implications at the applied level. All of the above allowed for a greater number of stimulus combinations to exist in our study, which can lead to greater learning.

Guerrero et al. [69] examined the influence of discrimination training in the emergence of two conditional discriminations and four intraverbals. The participants were 12 children aged between 8 and 10 years randomized into two groups of six participants each in two experiments comprising a pre-test, a training session, and a post-test. The children were trained in different sets of stimuli relations between flags, countries, and capitals (A, B, C or D). The stimuli relations were A1B1-C1, A1B2-D1, A2B1-C2, and A2B2-D2. In the first experiment, participants received conditional discrimination training, while in the second they received simple discrimination training. The results revealed that conditional discrimination procedures using compound stimuli (Experiment 1) and simple discrimination (tacts) (Experiment 2)

had similar effects on the training phases. However, differences were found in favor of the simple discrimination (tacts) procedure in terms of the number of relations that emerged. In this study the use of pure or impure tacts was not specified, there was only a clarification of terminology regarding abstract tacts. In addition, it was not specified if the impure tacts served the same function as the presentation of pure tacts plus intraverbals. At the conceptual level, it can be of extraordinary relevance to understand whether impure tacts are the simple sum of pure tacts more intraverbal or have a different function. In an impure tact, two antecedent stimuli appear, one verbal and one nonverbal, so that the subject must pay attention to the combination or relationship between the two to give an adequate response. Therefore, it seems that the response depends on the relation that is established between two stimuli and is not merely the sum of such stimuli. However, in pure tact only one nonverbal stimulus appears (an image, for example). In intraverbal, something similar occurs in terms of the number of stimuli involved, although in this case it would be an antecedent verbal stimulus. In these last two operants, the subject does not have to attend to any combination or relation of stimuli. Thus, participants must respond to the combination of two stimuli with an impure tact, while, when faced with a pure tact and an intraverbal, participants must respond to only one stimulus, and not to the explicit combination of both. This can be of considerable relevance when it comes to teaching, particularly in individuals with certain developmental problems. Further, at the methodological level, the study by Guerrero et al. [69] used a lower number of combinations of compound stimuli, compared with our study, and thus a lower number of new operants emerged. Finally, the intraverbals used in the study by Guerrero et al. [69] were simple, while in the present study these are complex, which can lead to a greater combination of stimuli and therefore influence the learning.

According to the literature reviewed, it is not very clear which procedure is more effective for the expansion of language, since, as described, Beloso-Díaz et al. [50] claimed this to be conditional discrimination, while Guerrero et al. [69] claimed it to be simple discrimination. The use of compound stimuli seems to be along the same unclear lines. In any case, it seems that the effect of tact is of vital importance in promoting psychological development and learning. In other words, the ability to tact becomes essential for the expansion of new higher capacities that allow effective learning. This raises many questions about what to teach and how to teach it in a structured and sequenced way. Greer and Ross [45] stated that tacts are the most important verbal operant for language development, although it should be noted that it was not specified what kind of tacts, pure or impure. In the same way, the previously mentioned studies [50,69] did not clarify a terminological or conceptual difference between these, so at a methodological level they were used without taking into account that they can have different functions.

Therefore, these two studies [50,69] are relevant and closely related to the present study in which we aim to conduct a comparable experiment in children.

For all the implications that have been mentioned both at the level of verbal behavior and associated psychosocial factors, the following objectives are proposed.

The objective of this research is to analyze the influence of the training of two procedures on the performance in impure tact tests and in the emergence of four new intraverbals. With this we aim to determine whether or not the teaching of impure tacts improves performance on verbal operant tests in comparison with the teaching of intraverbals. In addition, this study also aims to analyze whether the use of impure tacts or intraverbals has different functions in learning (if there are differences in the results found between the performances of the participants in both experimental conditions, it is possible that these operants perform different functions). Two conditions are included in this study. The first incorporates the use of pure tacts plus intraverbals, while the second involves pure and impure tacts in the training phase. Therefore, the experimental hypotheses raised in the study are as follows: the use of teaching procedures that include impure tacts improves language expansion and the emergence of new operants versus the use of procedures that include pure tacts more intraverbals; the impure tacts have a different function in the teaching process, compared to the pure tacts more intraverbals.

2. Materials and Methods

2.1. Ethics Statement

The procedures used were innocuous and did not pose a greater risk or inconvenience to the participants; at the same time, an information sheet and informed consent were presented to be signed by the parents or legal representatives of the minors. The current study followed the standards established by the Ethics Committee of the University of Córdoba and approved by it (11 December 2019), and all procedures performed in this study involving human participants were in accordance with the ethical standards of the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

2.2. Participants

The sample was composed of 54 participants (29 boys and 25 girls) in the first grade of elementary school to the first grade of high school and aged between 6 and 12 years (mean = 9.8, SD = 1.55). The participants were children of typical development, with a level of reading–writing skills according to their school year, without any type of physical or psychological disability and no previous history with the list of stimuli that was used in this experiment. Participants were randomly assigned to one of two conditions. Of these participants, 27 took part in Condition 1 (15 boys and 12 girls, mean age = 9.66, SD = 1.66) and 27 took part in Condition 2 (14 boys and 13 girls, mean age = 9.92, SD = 1.46).

2.3. Setting, Materials, and Stimuli

Cards (6.9 cm × 9.2 cm) with four pictures of children printed in color were used as nonverbal stimuli and were administered manually. The other verbal stimuli were two words, /blue/ and /green/, vocally pronounced by the researcher. The responses were four names, /Milo/, /Coba/, /Yuli/, /Petu/, and four numbers, /ten/, /fifteen/, /sixteen/, /thirteen/, which the participant had to give verbal and vocally. The stimuli employed, along with the trained relations (solid lines) and tested relations (dashed lines) are shown in Figure 1; Figure 2 for both conditions.

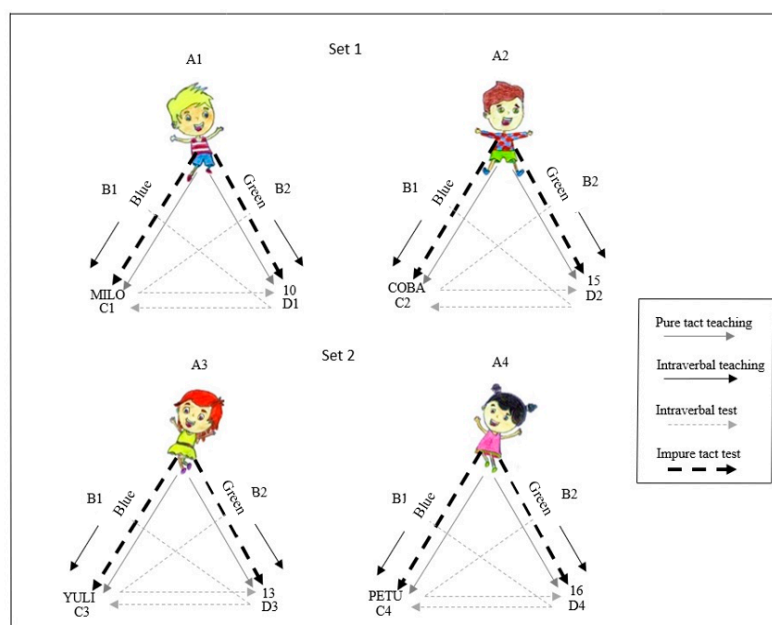


Figure 1. Stimuli, responses, and relations used during the experiment in Condition 1.

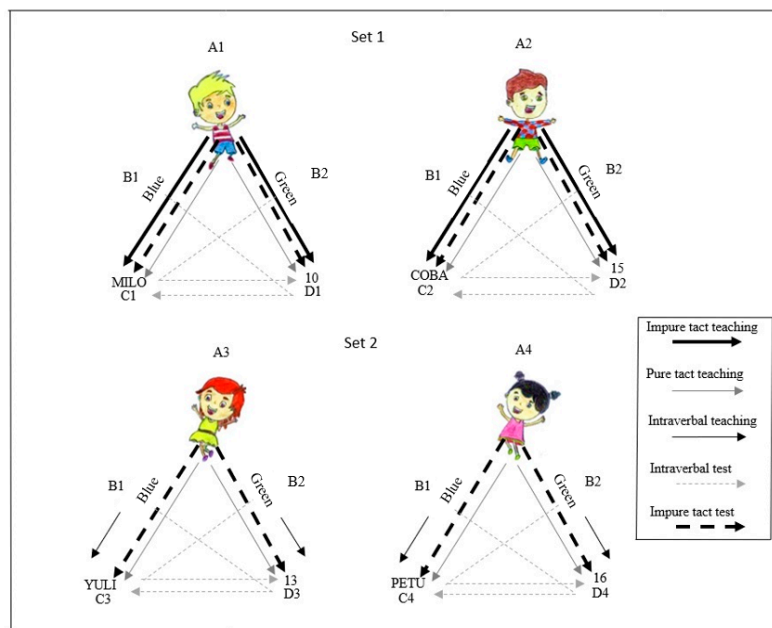


Figure 2. Stimuli, responses, and relations used during the experiment in Condition 2.

Each stimulus was designated by a capital letter and a number. The capital letters indicated the group of stimuli (A, B, C, and D) and the number (1, 2, 3, and 4) in the order of them. In the alphanumeric code the number of the stimulus was specified only in cases where the discrimination included a single stimulus of a group. When the discrimination was presented a verbal response, the letter “R”, was added. For example, the arbitrary word /milo/ as a stimulus was called (C1) and as a response (RC1). Compound stimuli included two terms: AB.

The experiments used sets of nonverbal stimuli. Set 1 was composed of two pictures of boys (A1 and A2) and Set 2 was composed of two pictures of girls (A3 and A4). Therefore, in this experiment, arbitrary images (A1), (A2), (A3), and (A4) were nonverbal stimuli. The verbal stimuli were /blue/ (B1) and /green/ (B2). Finally, the answers were /milo/ (C1) and /ten/ (D1) for image A1; /coba/ (C2) and /fifteen/ (D2) for image A2; /yuli/ (C3) and /thirteen/ (D3) for image A3; and /petu/ (C4) and /sixteen/ (D4) for the A4 image. Furthermore, to help participants to choose among all possible responses, they were printed and laid out in a row in random order and repeated (twice each): milo, coba, petu, yuli, 10, 16, 15, 13 (see Figure 3). This help was provided in all the phases of the experiment to the right of the participant, on a table at a distance of 50 cm from the participant.

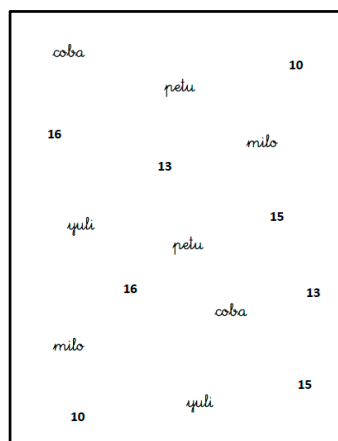


Figure 3. Help given during the experiment.

The experiment took place in a room where the researcher and the participant were facing each other. First, the participant’s guardians filled out an informed consent form with personal data giving

their consent to the participation in the experiment. The form also specified that the audio of the session would be recorded for data-gathering purposes. This can be observed in Appendix A.

2.4. Design

The entire procedure was carried out in Spanish. We used a random assignment, between subjects experimental design with two active conditions. The independent variable with two levels was the kind of training participants received: intraverbals (Condition 1) or impure tacts (Condition 2). The effect of the intervention was measured with the following dependent variables: the number of relations that emerged from impure tacts (tests) and the number of relations that emerged from intraverbals (tests), for Sets 1 and 2 in Condition 1 and Condition 2. Therefore, this study employed a simple, multivariable, and cross-sectional design with randomized independent groups (the sample was randomly selected from the population; the groups were randomly formed, so that any individual in the sample had the same probability of belonging to one or another group; the values of the independent variable were randomly assigned to experimental groups, so that all groups had the same probability of receiving one or another treatment) [73].

In addition, a pre-test was conducted using two sets of stimuli (Set 1 and Set 2) composed of arbitrary stimuli, comparing the data to ensure that no stimulus set was better than the other for the purposes of teaching. This allowed us to control the extraneous variable of learning history with the stimuli.

Table 1 displays the test and training phases that were common to both conditions of the experiment, as well as Phases 9 and 10 of training in Conditions 1 and 2, which were specific for each procedure, since Condition 1 involved intraverbal training and Condition 2 consisted of impure tact, which was the only independent variable manipulated in the experiment.

Table 1. Common and specific phases for each condition.

	Phases					
	Common	Common	Specific	Common	Common	Common
	Pre-Tests Set 1 and Set 2	Training Phases Set 1	Training Phases Set 1	Post-Tests Set 1	Training Phases Set 2	Post-Tests Set 2
Condition 1	Phase 1	Phase 7 Phase 8	Phase 9 Intraverbals	Phase 11 Phase 12	Phase 14 Phase 15	Phase 18 Phase 19
	Phase 2		Phase 10 Intraverbals			
	Phase 3			Phase 17	Phase 20	
	Phase 4		Phase 9 Impure Tacts			
Condition 2	Phase 5		Phase 10 Impure Tacts			
	Phase 6					

2.5. Instructions and Applied Consequences

The participants and their families were informed that they were going to take part in an experiment in which they had to give certain responses when shown cards with certain pictures. At the beginning of the experiment, each subject received the following verbal instructions: "Hello, It's great to have you here to play with us! In this game, I will sometimes show you pictures of two friends, other times I will say the name of a color /Blue/ or /Green/ and other times I will say some words /milo/, /coba/, /yuli/, /petu/, /ten/, /fifteen/, /thirteen/, /sixteen/. At times we will mix everything up, which will be even more fun. You will have to tell me the words /milo/, /coba/, /yuli/, /petu/, /ten/, /fifteen/, /thirteen/, /sixteen/ that you believe correspond to the pictures or colours I say. Try your best to guess it right. Sometimes I will not be able to tell you if you are doing it well or not, but you must try to do the best you can. Other times I will tell you how good you are doing and I will give you examples. Let's start the game!"

Before the test trials, it was specified that they would not be told whether or not the response was correct. Before the training trials, however, it was specified that they would be told whether or not the

response was correct and that examples would be given. During the training phases, correct responses were socially reinforced (“well done,” “that’s it,” “very well,” etc.), while if the participant made a mistake, a correction was applied, asking the participant to try again with another response. In the test phases (pre-tests and post-tests) no consequence was used.

2.6. Condition 1. Teaching of Intraverbals

2.6.1. Phases

This experiment consisted of 20 phases, each comprised of a block of randomized trials. The training phases detailed below are written in normal format, while the test phases are written in bold and italics for better differentiation, both in tables and in text. The pre-test and post-test phases were composed of blocks of 12 randomized trials in each phase. The training phases were composed of 10 or 12 randomized trials (depending on the phase), although the total number of trials of each phase performed by the subjects can vary, depending on their performance. The order in which the phases were executed was as follows: Set 1 and Set 2 pre-tests; Set 1 teaching and post-tests; Set 2 teaching and post-tests. Table 2 summarizes the procedure used in Condition 1. Each phase of the experiment is detailed below.

Table 2. Phases of Condition 1, teaching of pure tacts and intraverbals.

Condition 1					
	Phases	Conseq.	Trials	Stimulus Relation	
Pre-tests					
SET 1	Impure tacts	1. Test (AB)-RX	No	12	A1B1-RC1; A1B2-RD1; A2B1-RC2; A2B2-RD2
	Intraverbals	2. Test (B2C)-RD	No	12	B2C1-RD1; B2C2-RD2
		3. Test (B1D)-RC	No	12	B1D1-RC1; B1D2-RC2
SET 2	Impure tacts	4. Test (AB)-RX	No	12	A3B1-RC3; A3B2-RD3; A4B1-RC4; A4B2-RD4
	Intraverbals	5. Test (B2C)-RD	No	12	B2C3-RD3; B2C4-RD4
		6. Test (B1D)-RC	No	12	B1D3-RC3; B1D4-RC4
Teaching of Set 1					
	Pure tacts	7. Teaching A-RC	Yes	10	A1-RC1; A2-RC2
		8. Teaching A-RD	Yes	10	A1-RD1; A2-RD2
	Intraverbals	9. Teaching B-RX1	Yes	12	B1-RC1; B2-RD1
		10. Teaching B-RX2	Yes	12	B1-RC2; B2-RD2
Post-tests Set 1					
	Impure tacts	11. Test (AB)-RX	No	12	A1B1-RC1; A1B2-RD1; A2B1-RC2; A2B2-RD2
	Intraverbals	12. Test (B2C)-RD	No	12	B2C1-RD1; B2C2-RD2
		13. Test (B1D)-RC	No	12	B1D1-RC1; B1D2-RC2

Table 2. Cont.

Condition 1				
	Phases	Conseq.	Trials	Stimulus Relation
Teaching of Set 2				
Pure tacts	14. Teaching A-RC	Yes	10	A3-RC3; A4-RC4
	15. Teaching A-RD	Yes	10	A3-RD3; A4-RD4
Intraverbals	16. Teaching B-RX3	Yes	12	B1-RC3; B2-RD3
	17. Teaching B-RX4	Yes	12	B1-RC4; B2-RD4
Post-tests Set 2				
Impure tacts	18. Test (AB)-RX	No	12	A3B1-RC3; A3B2-RD3; A4B1-RC4; A4B2-RD4
Intraverbals	19. Test (B2C)-RD	No	12	B2C3-RD3; B2C4-RD4
	20. Test (B1D)-RC	No	12	B1D3-RC3; B1D4-RC4

Pre-Tests

Phase 1. Test (AB)-RX—Impure tact—Set 1. This consisted of 12 randomized trials. The participant was shown a card with a picture (nonverbal stimuli) (A1) or (A2) and the researcher said the name of a color (verbal stimuli), /blue/ (B1) or /green/ (B2). The participant then had to answer with /milo/ (C1), /coba/ (C2), /ten/ (D1), or /fifteen/ (D2). The following impure tacts were tested: A1-blue-milo (A1B1)-RC1; A1-green-ten (A1B2)-RD1; A2-blue-coba (A2B1)-RC2; A2-green-fifteen (A2B2)-RD2. The correct performance criterion was 10 or more correct trials to consider the test as correct.

Phase 2. Test (B2C)-RD—Intraverbal—Set 1. This consisted of 12 randomized trials. The participant was told the name of a color (verbal stimuli), /green/ (B2), followed by a word (verbal stimuli), /milo/ (C1) or /coba/ (C2). The participant then had to answer with either /ten/ (D1) or /fifteen/ (D2). The following intraverbals were tested: green-milo-ten (B2C1)-RD1; green-coba-fifteen (B2C2)-RD2. The criterion for considering the test as correct was the same as in the previous phase.

Phase 3. Test (B1D)-RC—Intraverbal—Set 1. This consisted of 12 randomized trials. The participant was told the name of a color (verbal stimuli), /blue/ (B1), followed by a random number (verbal stimuli), /ten/ (D1) or /fifteen/ (D2). The participant then had to answer with either /milo/ (C1) or /coba/ (C2). The following intraverbals were tested: blue-ten-milo (B1D1)-RC1; blue-fifteen-coba (B1D2)-RC2. The criterion for considering the test as correct was the same as in the previous phase.

Phase 4. Test (AB)-RX—Impure tact—Set 2. This consisted of 12 randomized trials. The participant was shown a card with a picture (nonverbal stimuli) (A3) or (A4) and the researcher said the name of a color (verbal stimuli), /blue/ (B1) or /green/ (B2). The participant then had to answer with /yuli/ (C3), /petu/ (C4), /thirteen/ (D3), /sixteen/ (D4). The following impure tacts were tested: A3-blue-yuli (A3B1)-RC3; A3-green-thirteen (A3B2)-RD3; A4-blue-petu (A4B1)-RC4; A4-green-sixteen (A4B2)-RD4. The criterion for considering the test as correct was the same as in the previous phase.

Phase 5. Test (B2C)-RD—Intraverbal—Set 2. This consisted of 12 randomized trials. The participant was told the name of a color (verbal stimuli), /green/ (B2), followed by a word (verbal stimuli), /yuli/ (C3) or /petu/ (C4). The participant then had to answer with either /thirteen/ (D3) or /sixteen/ (D4). The following intraverbals were tested: green-yuli-thirteen (B2C3)-RD3; green-petu-sixteen (B2C4)-RD4. The criterion for considering the test as correct was the same as in the previous phase.

Phase 6. Test (B1D)-RC—Intraverbal—Set 2. This consisted of 12 randomized trials. The participant was told the name of a color (verbal stimuli), /blue/ (B1), followed by a random number (verbal stimuli),

/thirteen/ (D3) or /sixteen/ (D4). The participant then had to answer then with either /yuli/ (C3) or /petu/ (C4). The following intraverbals were tested: blue-thirteen-yuli (B1D3)-RC3; blue-sixteen-petu (B1D4)-RC4. The criterion for considering the test as correct was the same as in the previous phase.

Teaching of Set 1

Phase 7. A-RC Training—Pure tact. This consisted of two prompted trials and 10 randomized training trials. The participant was given a card with the picture (nonverbal stimuli) (A1) or (A2) and had to answer with /milo/ (C1) or /coba/ (C2). On the prompted trials, after the antecedent stimuli were shown, the participant was told the correct answer so he/she could repeat it. The following pure tacts were trained: A1-milo (A1-RC1); A2-coba (A2-RC2). The correct trials were socially reinforced. In the incorrect trials, a correction was applied by re-presenting the trial and asking the subject to try again. The acquisition criterion to pass from this block of trials to the next was achieving 10 consecutive correct responses, however, if the subject came to repeat 100 trials in the phase, the experiment ended.

Phase 8. A-RD Training—Pure tact. This consisted of two prompted trials and 10 randomized training trials. The participant was given a card with the picture (nonverbal stimuli) (A1) or (A2) and had to answer with /ten/ (D1) or /fifteen/ (D2). The following pure tacts were trained: A1-ten (A1-RD1); A2-fifteen (A2-RD2). The acquisition criteria, corrections, reinforcement, and prompted trials were the same as the previous phase.

Phase 9. B-RX1 Training—Intraverbal. This consisted of six prompted trials and 12 randomized training trials. The participant was told the name of a color (verbal stimuli), /blue/ (B1) or /green/ (B2), and had to answer with /milo/ (C1) or /ten/ (D1). The following intraverbals were trained: blue-milo (B1-RC1); green-ten (B2-RD1). The acquisition criterion to pass from this block of trials to the next was achieving 12 consecutive correct responses. The corrections, reinforcement, and prompted trials were the same as the previous phase.

Phase 10. B-RX2 Training—Intraverbal. This consisted of six prompted trials and 12 randomized training trials. The participant was told the name of a color (verbal stimuli), /blue/ (B1) or /green/ (B2), and had to answer with /coba/ (C2) or /fifteen/ (D2). The following intraverbals were trained: blue-coba (B1-RC2); green-fifteen (B2-RD2). The acquisition criteria, corrections, reinforcement, and prompted trials were the same as the previous phase.

Set 1 Post-Tests

Phases 11 to 15 were post-tests, where participants received the same trials as presented in the Set 1 pre-tests (Phases 1 to 3).

Teaching of Set 2

In Phases 14 to 17 new pictures were introduced (nonverbal stimuli) (A3) and (A4) but the training phases were the same as in Set 1. In Phases 14 and 15 the following pure tacts were trained: A3-yuli (A3-RC3) and A4-petu (A4-RC4); A3-thirteen (A3-RD3) and A4-sixteen (A4-RD4). In Phase 16 the intraverbals trained were blue-yuli (B1-RC3) and green-thirteen (B2-RD3), and in Phase 17 these were blue-petu (B1-RC4) and green-sixteen (B2-RD4).

Set 2 Post-Tests

Phases 18 to 20 were post-tests, where participants received the same trials as presented in the Set 2 pre-tests (Phases 4 to 6).

2.7. Condition 2. Teaching of Impure Tacts

2.7.1. Phases

The phases were the same as in Condition 1, with the exception of the teaching phases of Set 1 (Phases 9 and 10), in which two phases of impure tact training were used. Therefore, in the teaching phases, there were four phases of pure tact training (Set 1: Phases 7, 8 and Set 2: Phases 14, 15), two

phases of impure tacts (Set 1: Phases 9, 10) and two phases of intraverbals (Set 2: Phases 16, 17). Table 3 shows the different phases of Condition 2.

Table 3. Phases of Condition 2, teaching of pure and impure tacts.

Condition 2		
Phases	Stimulus Relation	
Pre-Tests		
IDEM		
Teaching of Set 1		
Pure tacts	7. Teaching A-RC	A1-RC1; A2-RC2
	8. Teaching A-RD	A1-RD1; A2-RD2
Impure tacts	9. Teaching A1B-RX1	A1B1-RC1; A1B2-RD1
	10. Teaching A2B-RX2	A2B1-RC2; A2B2-RD2
Post-tests Set 1 IDEM		
Teaching of Set 2 IDEM		
Post-tests Set 2 IDEM		

Next, each new phase performed in the experiment is detailed.

Teaching of Set 1

Phase 9. A1B-RX1 Training—Impure tact. This consisted of six prompted trials and 12 randomized training trials. The participant was shown a card with a picture (nonverbal stimuli) (A1) and was told the name of a color (verbal stimuli), /blue/ (B1) or /green/ (B2). The participant had to answer with /milo/ (C1) or /ten/ (D1). The following impure tacts were trained: A1-blue-milo (A1B1)-RC1; A1-green-ten (A1B2)-RD1. The correct trials were socially reinforced. In the incorrect trials, a correction was applied by re-presenting the trial and asking the subject to try again. The acquisition criterion to pass from this block of trials to the next was achieving 12 consecutive correct responses, however, if the subject came to repeat 100 trials in the phase, the experiment ended.

Phase 10. A2B-RX2 Training—Impure tact. This consisted of six prompted trials and 12 randomized training trials. The participant was shown a card with a picture (nonverbal stimuli) (A2) and was told the name of a color (verbal stimuli), /blue/ (B1) or /green/ (B2). The participant had to answer with /coba/ (C2) or /fifteen/ (D2). The following impure tacts were trained: A2-blue-coba (A2B1)-RC2; A2-green-fifteen (A2B2)-RD2. The acquisition criteria, corrections, reinforcement, and prompted trials were the same as the previous phase.

2.8. Inter-Observer Agreement

The researcher registered the participants' responses and recorded the audio of the sessions so that an independent observer could later listen to all of the answers and compare them with the written responses to calculate agreement. In order to calculate agreement, the following formula was used: agreements divided by agreements plus disagreements multiplied by 100. Observers reached 98% agreement on all trials for all the sessions carried out with all the participants (54 sessions).

2.9. Data Processing

The data collected were condensed into a database created in Microsoft Excel version 2016. In this database, a template had been previously created, specifying all phases and stimulus relationships in

each of the two conditions, and then including the responses given by the participants. Data were collected including age, sex, what experimental condition they were assigned to, and all responses from the 54 participants, both from the testing and teaching phases. Once this was done, the data were dumped into SPSS version 25 software for subsequent analysis of the statistical data. A Student's t-test for independent samples was selected to perform these analyses, since it was tested to perform the ANOVA test for independent samples. However, for the data obtained in the experiment Levene's test was significant, so the homogeneity of variance was not complied with, which required the use of a non-parametric test or a t-test. We opted for the t-test, since it includes a value when equal variances are not assumed, so this test allowed us to statistically analyze the results obtained. In addition, parametric tests can be used when the sample is not very small ($n > 30$), and they have greater statistical power than non-parametric tests, which means they have a lower probability of error and require a higher validity condition (higher probability of detecting a significant effect when it actually exists). In addition, we performed a post hoc test for the effect size of the two independent groups, taking into account the mean, standard deviation and size of each of the two groups, calculating Cohen's d using the statistical program G-Power version 3.1.9.7.

3. Results

First, the socio-demographic variables of sex and age of the participants were analyzed in both conditions. The results revealed that for both sex (Fisher's exact test, $p = 1$) and age $t(52) = -0.885$, $p = 0.380$, no statistically significant differences were found, thus indicating that both groups were homogeneous.

Tables A1 and A2 in Appendix B show, individually, the execution in the pre-tests, teaching, and post-tests of the 27 participants of Condition 1 (intraverbal training) and of the 27 participants of Condition 2 (training in impure tacts). Regarding the number of tests performed correctly in the pre-tests of Condition 1, one impure tact test and two intraverbal tests were performed of Set 1 of stimuli, for each of the 27 participants (27 impure tacts tests and 54 intraverbal tests of Set 1, in total), of which only one participant successfully performed one intraverbal test. In this same condition, the same tests were performed with the Set 2 of stimuli, in which no participant performed correctly.

In relation to the number of tests performed correctly in the pre-tests of Condition 2, the same tests described above were performed with Set 1 of stimuli for each of the other 27 participants, of which no participant performed correctly. In this same condition, the tests were repeated for Set 2 of stimuli, in which only one participant correctly performed one intraverbal test. For a review of the individual data of each participant, see Tables A1 and A2.

In reference to the phases of teaching pure tacts more intraverbals (Condition 1) or pure tacts more impure tacts (Condition 2), all participants of both conditions reached the established learning criteria to move from one phase to the next and only in some cases did correction have to be applied, but in no case did the experiment have to be stopped. Specifically, in Condition 1, in the teaching phases of Set 1, it was necessary to apply correction in 11 of the 108 phases that were carried out in total for the 27 participants. In this same condition, in the teaching phases of Set 2, correction was applied in 16 of the 108 phases carried out by the total number of participants. Similarly, in Condition 2, in the teaching phases of Set 1, correction was applied in 12 of the 108 phases performed in total by all participants. In the teaching of Set 2 of this same condition, correction was applied in 14 of the 108 phases. As can be seen, the data of the phases in which the participants needed correction were very similar in both conditions, and therefore, the number of teaching trials carried out in both conditions was similar. These data can be consulted in Tables A1 and A2 of this manuscript; subjects with corrections appear in the tables by fractions of correct trials among total trials presented.

The following is a description of the differences found in the post-tests of Conditions 1 and 2 for stimuli Sets 1 and 2, both for the emergence of impure tacts and intraverbals. These data are summarized in Figure 4. In addition, data are provided regarding the percentages of efficacy, that is, the percentage of tests performed correctly and therefore emerged among the total number of tests performed by the participants. These can be found in Figure 5.

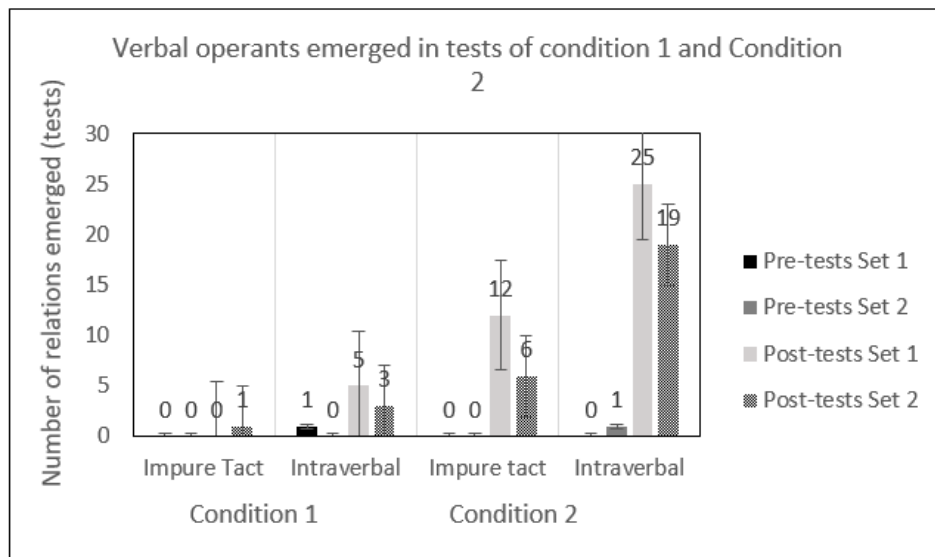


Figure 4. Number of verbal operants emerged in tests of Condition 1 and Condition 2.

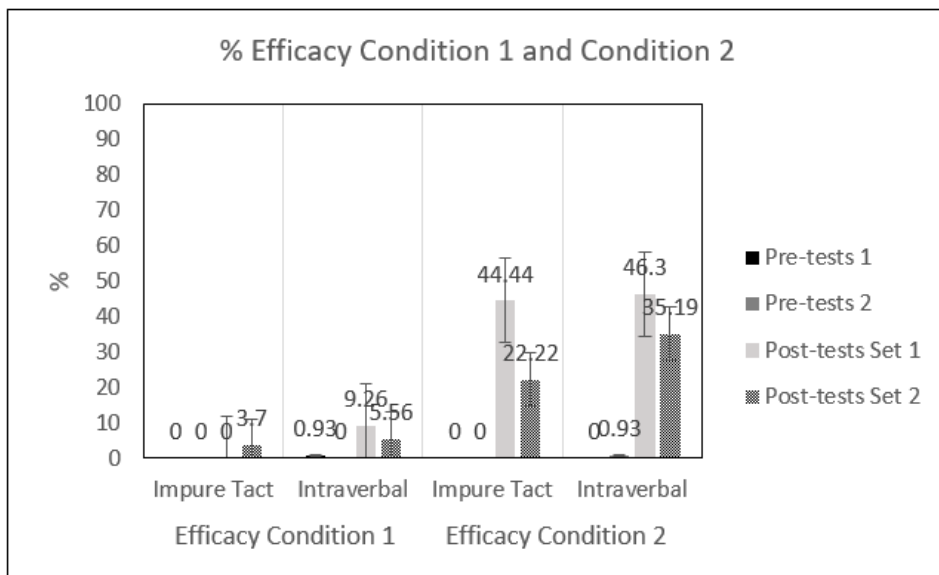


Figure 5. Percentage of efficacy in Condition 1 and Condition 2.

In the first condition, as for Set 1 of stimuli, the number of relations emerged from impure tacts (tests) correctly performed by all the participants was 0 of 27 (an impure tact test for each participant), that is, 0% efficacy of the impure tacts tests. Referring to Set 2 of stimuli, the number of relations emerged from impure tacts (tests) correctly performed by all the participants was 1 of 27 (an impure tact test for each participant), that is, 3.7% efficacy of the impure tacts tests.

In this same condition, the number of emergent intraverbal relations (tests) that were tested using Set 1 of stimuli was 5 of 54 (two intraverbals for each participant), that is, 9.3% efficacy of the intraverbals. As for Set 2 of stimuli, the number of relations emerged from intraverbal (tests) was 3 of 54 (two intraverbals for each participant), that is, 5.5% efficacy of the intraverbals.

In the second condition, as for Set 1 of stimuli, the number of relations emerged from impure tact (tests) correctly performed by all the participants was 12 of 27 (an impure tact test for each participant), that is, 44.5% efficacy of the impure tacts tests. Referring to Set 2 of stimuli, the number of relations emerged from impure tact (tests) correctly performed by all the participants was 6 of 27 (an impure tact test for each participant), that is, 22.2% efficacy of the impure tacts tests.

In this same condition, the number of emergent intraverbal relations (tests) that were tested using Set 1 of stimuli was 25 of 54 (two intraverbals for each participant), that is, 46.35% efficacy of intraverbals. As for Set 2 of stimuli, the number of relations emerged from intraverbal (tests) was 19 of 54 (two intraverbals for each participant), that is, 35.2% efficacy of the intraverbals.

In addition, the data obtained were statistically analyzed, finding statistically significant differences. The tests of both procedures were compared between the two conditions. There were no differences between the conditions according to the pre-tests. For the analyses we compared the means of independent samples through version 25 of the SPSS statistical program. However, there were statistically significant differences between the conditions for the post-tests on impure tacts, Set 1 $t(26) = -4.56, p = 0.000$ and Set 2 $t(36.29) = -2.06, p = 0.046$, and intraverbals, Set 1 $t(38.43) = -3.58, p = 0.001$ and Set 2 $t(35.88) = -2.95, p = 0.006$. Furthermore, we conducted a post hoc test for the effect size of the average of two independent groups, $d = 0.89$, a standard error of $\alpha = 0.05$ and a sample size of $n = 27$ in the first group and $n = 27$ in the second group, so the effect size, according to the established criteria ($d \geq 0.8$), was high.

4. Discussion

The results revealed a significant difference in the participants' performances on the impure tact tests according to the two conditions in Set 1 and Set 2 (post-tests), with better results being obtained in Condition 2 (impure tact training) than in Condition 1 (intraverbal training). For the four complex intraverbal tests (post-tests) there were significant differences, with better performance in Condition 2 (impure tact training) than in Condition 1 (intraverbal training) for both sets of stimuli (Sets 1 and 2). All these data are summarized in Tables A1 and A2 and in Figure 4; Figure 5.

According to the data obtained here, it appears that the training employed in the second condition of this experiment (training in impure tacts) clearly produced superior performance when testing impure tacts and the emergence of complex intraverbals when compared with the training given in the first condition (intraverbal training), so our first experimental hypothesis is proven.

The results showed that participants in Condition 2 (training in impure tacts) performed better in the post-test phases (Set 1 and Set 2) for impure tacts and intraverbals. We analyzed the influence of the teaching of both procedures on the performance in impure tact tests and in the emergence of four new intraverbals (complex). It was demonstrated that teaching impure tacts improves performance on verbal operant tests and produces better results than teaching pure tacts and intraverbals, and therefore, they have different functions in the teaching–learning process. With this, our second hypothesis is verified. For all of the above, the aim of this research is achieved.

Skinner [34] coined the term “abstract tact” that includes two antecedent stimuli, one of which is verbal and the other nonverbal. This verbal operant was used in this article under the name of “impure tact” [45]. With regard to this concept, the specialist literature is in disagreement concerning certain issues, including how to name them (tacts plus intraverbals or impure tacts), whether there are one or two verbal operants, and whether or not both of them perform the same role [50,69]. The data obtained in this study suggested that the teaching procedure (intraverbals versus impure tacts) affects performance on the tests, so we cannot conclude that these are the same or that they have the same role. On the contrary, all of the data seemed to indicate that impure tacts are more complex than pure tacts and intraverbals. Moreover, in Condition 2, creating an impure tact learning history (Set 1 training) appeared to improve performance on Set 2 post-tests, even though Set 2 training only included pure tacts and intraverbals. That is, the data appeared to indicate that the procedures used produce an execution differentiating the subjects in the impure tacts and intraverbal tests in favor of the procedure that includes the teaching of impure tacts. In addition, when a training history with impure tacts (Set 1) was created, if later taught intraverbals (Set 2), the participants also had better execution in both types of test than if their previous history had not included learning impure tacts.

The work in this article presents, for the first time, the adequate execution of this type of experiment, in which tests of new complex intraverbals and impure tacts are evaluated after training in impure tacts with compound stimuli [65,66,68]. The results obtained in this study are of special relevance at both a theoretical and an applied level.

From a theoretical perspective, our study aims to contribute towards an advance in this area by providing a conceptual clarification regarding the terminological and functional distinction between impure tacts and pure tacts and intraverbal. It demonstrates that impure tacts can favor the interrelations among language or verbal behavior. The participant needs to pay attention to two stimuli at the same time and respond to the combination of both, which promotes the relation between stimuli and their appearance in new discriminations. Considering this functional difference between impure tact and pure tact and intraverbal, this will have direct implications for how this type of verbal repertoire is taught to children. Children should learn to respond conditionally to the presentation of two stimuli, since this favors the expansion of language.

Authors such as Axe [48] and Michael et al. [70] described that two stimuli can control the same response—convergent control. However, in Condition 2 of this study (impure tact training) it was shown that the response depends on the relation that is established between two stimuli and is not merely the sum of such stimuli [68]. In addition, the use of compound stimuli and impure tacts in teaching seems to facilitate the learning of new stimulus relations (impure tacts and complex intraverbals), thereby overcoming a limitation in studies such as that of Belloso-Díaz et al. [50], in which they used simple stimuli and did not give training on impure tacts. Moreover, in the previously mentioned studies [50,69], complex intraverbals were not used, whereas in our study we performed complex intraverbals tests, which also seemed to favor the emergence of new intraverbals leading to a greater combination of stimuli and, therefore, greater learning.

Another methodological difference between this work and the aforementioned studies was the size of the sample and the strength of the data. The data obtained in our study were obtained using a large sample of children, and our results received statistical support to verify that the differences between the procedures were significant.

From an applied perspective, our findings indicated that this teaching method can accelerate language acquisition. Hence, teaching impure tacts to children with cognitive development difficulties can be beneficial for two main reasons: first, they will learn early how to respond to the combination of two stimuli, and second, those combined stimuli will be more likely to emerge in new, implicitly trained discriminations. Therefore, our study aims to develop learning methodologies that achieve a minimum error rate and are therefore more effective, thus allowing us to select the best procedure for teaching.

All the previously described questions have direct implications at the applied level, since the specific teaching of impure tacts can favor the appearance of intraverbal relations along with producing optimal performance on tests of new impure tacts. This may have relevance when teaching children or people with certain developmental difficulties [40–44]. In any case, research on the learning processes and the ways of teaching using the most appropriate procedures is of vital importance for the emergence of certain operants, which represents a fundamental process in the production of new language.

Furthermore, the results of our experimental study on language expansion can be related to the main psychosocial contexts and their adjustment in children and adolescents. This relationship can also be reversed, that is, psychosocial contexts can favor better performance in language skills. As Hoff [74] affirmed, when children have difficulties understanding others and expressing themselves [75], there is usually a higher risk of presenting social, emotional, and behavioral problems [76]. Therefore, these types of procedures, which were proven to be effective, can serve as language stimulation programs that can favor the learning abilities of groups with different developmental or cognitive limitations, as well as external factors that have to do with disadvantaged social contexts such as the family, school, or the community itself or where there is a psychosocial maladjustment.

As for the family context, an improvement in language [3], can foster a better family climate through communication, which has a crucial role in contributing to the development of specific aspects such as well-being, behavior and development, and social, physical, emotional and intellectual factors [2]. Another important aspect to take into account is the level of education of fathers and mothers [7,8], which is related to the linguistic and communicative interaction established between

parents and children [4,6]. From these results, it appears that it might be appropriate to specifically instruct parents in this area of language teaching to favor a better psychosocial adjustment for their sons and daughters.

On the other hand, school and its related psychosocial factors are another context of special relevance in the teaching–learning process of children and adolescents. An effective language teaching will favor an optimal adjustment of aspects such as school performance [12], the school climate [15,16], or the social skills [17]. In turn, these factors, as suggested in various investigations, prevent bullying and favor coexistence in schools [13,14]. As Schonhaut et al. [18] affirmed, language difficulties may be associated with learning difficulties and behavioral disorders, which can have an impact on a smaller repertoire of social skills and the aforementioned school problems. For these reasons, it will be interesting to introduce language teaching methodologies specifically adapted to the needs of boys and girls with different educational needs and delays in language acquisition at school, creating educational environments that promote student learning and socio-personal development [21–23].

Finally, regarding the community context, there are studies that are beginning to verify the relationship between good language development and factors related to this context. Good language teaching will have a positive impact on communication between parents and children, which can act as a protective factor against certain maladaptive behaviors [24,25]. Among the problems associated with a maladjustment in language development are criminal behavior [26], behavior problems in childhood and adolescence [28], and substance abuse [27,29–31]. For this reason, effective language teaching from early childhood can act as a protective factor against all these maladaptive behaviors, which are problems for health and good adjustment in the community in general [32].

As can be seen, children’s language-related skills are important from an early age for their interpersonal and academic success [77,78]. It is important to identify children with language disorders and understand the mechanisms of their acquisition, which can provide a base for optimizing the development of all children through adapted and effective teaching at an early age for a good adjustment throughout of their life.

Therefore, it is of special relevance to promote effective language teaching, since the good development of this can have benefits for the sustainable psychosocial development of children and adolescents, and therefore promote an adequate psychosocial adjustment in the different contexts of socialization, such as family, school, or community [79]. It is worth mentioning that the relationship that exists between all these psychosocial factors and language development is not unidirectional, but rather an interrelated process because a good performance or adjustment regarding these factors also has a positive impact on better development of the language skills; thus, they are contexts to take into account when carrying out any intervention.

As limitations of this article some methodological questions can be mentioned. Stimulus sets presented during testing and training were not randomized across participants. To overcome this limitation, Set 1 should be presented followed by Set 2 to half of the participants and the opposite sequence to the remaining participants. This will help with potential sequential effects. In future investigations they should be taken into account to overcome these limitations. Similarly, as a future line of research, the analysis of the implications of the presentation of compound stimuli in the emergence of new stimulus relationships can be deepened by trying to understand to what extent the combination of several simple stimuli have convergent control or whether the relationship between them as a single complex stimulus acquires such control.

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Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

The informed consent given by the parents or legal guardians of the minors who participated in the experiment is detailed below.

Consentimiento Informado

El presente estudio trata de comprobar aspectos relacionados con el aprendizaje y desarrollo de la conducta verbal de los niños. A continuación, se detallan aspectos relevantes sobre el desarrollo del estudio, que usted debe tener en cuenta:

- La prueba consiste en una evaluación de habilidades verbales inicial, la enseñanza de fotos de muñecos, palabras y números y por último una evaluación de habilidades verbales final.
- Al participante se le mostrarán fotos de muñecos y se le dirán palabras y números.
- El participante tan solo debe responder con las palabras y números que aparecen en un papel que se le entregará.
- En ningún caso es necesario tener contacto físico con el participante puesto que el estudio no recoge ninguna variable que implique dicho contacto.
- No se recoge ninguna muestra biológica (orina, pelo, muestra de sangre, etc.)
- El desarrollo del estudio puede ser grabado en audio con el fin de poder realizar la confiabilidad de datos con otro investigador del grupo de investigación.
- La duración del estudio será de aproximadamente 45 minutos.
- Los datos personales, así como los resultados obtenidos en el estudio, serán tratados según Reglamento (EU) 2016/679—Reglamento relativo a la protección de las personas físicas en lo que respecta al tratamiento de datos personales y a la libre circulación de estos datos y por el que se deroga la Directiva 95/46/CE (Reglamento general de protección de datos), aprobado el 14 de abril de 2016, por lo que no serán utilizados para ningún fin comercial ni serán cedidos a terceros.
- Los datos obtenidos tendrán como fin el estudio y el avance del conocimiento científico de la conducta verbal y el desarrollo de mejoras en dicho campo, a través de un Trabajo Final de Máster y una Tesis Doctoral de la Universidad de Córdoba.

D./Dña, con D.N.I ,
 acepto las condiciones anteriormente descritas y doy consentimiento de que mi hijo/hija
 menor de edad, participe en el presente estudio.

Fdo:

En Córdoba a de de 2019.

Appendix B

Table A1. Execution in the pre-tests, teaching, and post-test tests of the 27 participants of Condition 1 (intraverbal training).

			Participants																												
Phase	Conseq.	Trials	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27		
Pre-tests Set 1 and Set 2																															
Impure tact	1.	No	12	0	0	0	1	3	2	0	1	1	3	4	1	2	0	0	3	0	0	2	0	0	1	1	3	0	1		
Intraverbal	2.	No	12	1	0	2	2	0	1	0	4	1	0	0	4	4	7	0	1	12	5	2	3	4	4	1	4	1	6	3	
Intraverbal	3.	No	12	2	0	4	2	0	4	1	6	2	1	0	0	4	2	0	1	6	6	1	4	1	2	2	6	2	0	4	
Impure tact	4	No	12	0	0	3	1	3	1	2	5	1	0	2	2	2	3	2	1	2	0	3	0	2	0	2	4	3	6	1	
Intraverbal	5.	No	12	1	6	2	3	0	2	0	3	0	2	0	6	1	2	5	4	1	7	0	4	2	4	0	2	1	0	3	
Intraverbal	6.	No	12	4	3	1	0	0	2	0	2	1	1	0	2	2	1	3	3	0	3	3	1	2	2	1	1	0	0	0	
Training Set 1																															
Pure tact	7.	Yes	10	13/14	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	
Pure tact	8.	Yes	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	16/17	10	10
Intraverbal	9.	Yes	12	12	12	12	12	12	12	12	12	12	19/30	12	12	12	12	12	12	12	12	12	12	13/14	12	12	14/15	12	12		
Intraverbal	10.	Yes	12	12	12	12	20/21	12	12	13/15	23/28	12	23/24	12	20/21	12	12	12	12	12	16/18	12	12	12	12	12	12	12	12	12	
Post-tests Set 1																															
Impure tact	11.	No	12	6	0	1	6	8	2	3	2	6	3	6	6	3	6	5	3	6	3	1	4	4	2	1	6	4	0	2	
Intraverbal	12	No	12	4	1	1	5	1	0	0	0	5	2	5	1	2	11	1	1	6	5	0	5	1	0	4	6	1	0	5	
Intraverbal	13	No	12	10	0	2	9	0	2	0	3	2	0	0	0	1	12	1	5	12	6	0	12	2	3	3	6	5	6	3	
Training Set 2																															
Pure tact	14	Yes	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	
Pure tact	15	Yes	10	10	10	10	10	10	10	10	13/16	10	10	10	10	10	10	10	10	10	10	16/17	12/13	12/15	10	10	10	10	10	10	
Intraverbal	16	Yes	12	12	12	12	12	12	12	18/20	12	23/24	12	12	12	12	12	12	12	12	19/20	12	12	18/20	12	12	12	12	12	12	
Intraverbal	17.	Yes	12	12	12	12	13/14	28/30	12	12	17/20	21/24	16/17	12	12	12	12	12	12	12	12	22/23	12	32/34	12	12	12	12	12	12	
Post-tests Set 2																															
Impure tact	18	No	12	12	0	1	2	5	2	1	6	6	2	6	6	2	6	5	6	5	2	1	4	6	1	2	6	5	6	3	
Intraverbal	19	No	12	3	3	7	9	7	2	0	1	2	2	0	5	1	12	0	1	12	1	1	3	4	0	2	0	1	6	1	
Intraverbal	20	No	12	5	3	6	4	0	2	0	0	3	0	0	3	0	12	0	1	0	0	0	3	5	2	5	0	2	0	6	

Table A2. Execution in the pre-tests, teaching, and post-test tests of the 27 participants of Condition 2 (impure tact training).

			Participants																												
Phase	Conseq.	Trials	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54		
Pre-tests Set 1 and Set 2																															
Impure tact	1.	No	12	2	0	1	1	0	0	2	1	2	0	3	2	0	0	2	0	4	3	0	4	3	1	2	3	1	1	2	
Intraverbal	2.	No	12	2	3	4	0	6	0	3	2	2	1	2	1	2	4	2	6	4	2	5	2	1	3	0	0	0	2	1	
Intraverbal	3.	No	12	1	1	1	0	0	3	0	0	2	0	0	0	2	3	6	4	2	3	2	5	3	0	2	7	2	0		
Impure tact	4.	No	12	2	1	5	3	3	3	1	5	3	2	1	1	0	2	4	0	2	1	2	3	5	3	3	0	0	3	2	
Intraverbal	5.	No	12	1	2	2	0	5	0	2	6	2	0	2	4	2	4	1	3	2	1	0	0	0	2	6	1	2	1	2	
Intraverbal	6.	No	12	0	1	1	0	11	0	0	0	1	1	1	1	2	2	2	0	1	3	3	2	0	2	5	0	6	6	5	
Training Set 1																															
Pure tact	7.	Yes	10	10/11	10	10	10	10/11	10	10	10	10	10	10	10	10	10	10	10	10	10	11/17	10	10	10	10	10/11	10	10	10	
Pure tact	8.	Yes	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
Impure tact	9.	Yes	12	12	12/13	12	12	12	12	12	12	21/22	12	16/17	12	12	12	12	12	12	12	12	12	12	12	12	13/15	12	12	12	
Impure tact	10.	Yes	12	12	17/18	12	12	12	12	12	12	27/29	12	17/18	12	18/20	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
Post-tests Set 1																															
Impure tact	11.	No	12	9	10	3	12	12	0	2	12	12	12	9	6	7	12	6	11	3	4	12	11	9	12	2	7	5	6		
Intraverbal	12.	No	12	6	11	1	11	12	0	1	12	3	11	12	3	12	3	1	0	1	7	4	12	12	12	12	2	12	0	0	
Intraverbal	13.	No	12	7	12	2	12	12	0	3	12	0	11	12	6	12	12	1	12	4	6	0	12	12	12	2	0	0	1		
Training Set 2																															
Pure tact	14.	Yes	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	12/13	10	10	10	10	10	10	10	10	10	10	10	10
Pure tact	15.	Yes	10	10	10	10	10	10/11	10	10	10	14/15	10	10	11	10	10	10	10	12/13	10	10	10	10	10	10	10	10	10	10	10
Intraverbal	16.	Yes	12	12	20/21	15/17	12	13/16	12	12	12	12	12	12	12	12	12	12	12	12	12	13/14	12	12	13/15	12	13/15	12	12	12	
Intraverbal	17.	Yes	12	12	21/22	12	12	12	12	12	12	12	12	12/13	12	12	12	12	12	16/17	12	12	12	12	12/14	12	12	12	12	12	
Post-tests Set 2																															
Impure tact	18.	No	12	3	3	2	5	12	6	1	11	6	10	6	5	0	3	6	3	4	3	10	2	6	12	1	6	1	10		
Intraverbal	19.	No	12	0	0	0	12	12	0	3	12	2	12	2	0	11	1	0	6	1	4	3	11	7	12	12	0	12	0	2	
Intraverbal	20.	No	12	1	0	3	12	12	0	1	12	2	12	4	3	11	0	0	0	3	0	0	12	11	12	12	4	12	1	2	

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