Facilitation of the equivalence - equivalence responding

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Equivalence-Equivalence responding, based on equivalence class formation, is a key concept of the functional-analytic model of analogical reasoning held by RFT theorists. Relational stimulus control is supposed to play an important role in this arbitrary relational response. Previous research showed that mere training of the prerequisites for equivalence class formation is not always enough for the derivation of equivalence-equivalence responding, even in adults. In the first experiment, with 12 adult participants, we designed a matching-to-sample training and testing procedure that, although it provided all necessary conditions, did not lead to Equivalence-Equivalence responding in most participants, so that the efficacy of a facilitation procedure could be assessed. In Experiment 2, with 32 valid participants, a matching-to-sample procedure based on non-arbitrary relations was introduced to assess its efficacy in enhancing stimulus control by the relational properties of sample and comparisons. Results showed a moderate effect: 40.6% of the participants passed the test after being exposed to a non-arbitrary relational matching task (but none without it). This research underlines the importance of non-arbitrary relational responses in the derivation of more complex repertoires.

Facilitación de la respuesta de equivalencia - equivalencia. La respuesta de equivalencia - equivalencia, basada en la formación de clases de equivalencia, es uno de los conceptos claves del modelo de razonamiento analógico analítico funcional propuesto por los autores de la TMR. El control de estímulos relacional juega un papel importante en esta respuesta relacional arbitraria. Investigaciones anteriores demostraron que el mero entrenamiento de los prerrequisitos para la formación de clases de equivalencia no es siempre suficiente para la derivación de la respuesta de equivalencia - equivalencia, incluso en adultos. En el primer experimento, con 12 participantes, diseñamos un procedimiento de entrenamiento y prueba que, a pesar de proporcionar todos los prerrequisitos, no condujo directamente a la respuesta de equivalencia - equivalencia, pero que permitía evaluar la eficacia de un procedimiento de facilitación. En el segundo experimento, con 32 participantes válidos, se puso a prueba la eficacia de un procedimiento basado en relaciones no-arbitrarias entre los estímulos para incrementar el control de estímulo por las propiedades relacionales de muestra y comparaciones. Los resultados mostraron un éxito moderado: el 40,6% de los participantes superaron el test tras ser expuestos a una igualación a la muestra relacional no arbitraria (pero ninguno la superó sin el procedimiento de facilitación). Estos hallazgos subrayan la importancia de las respuestas relacionales no arbitrarias en la derivación de repertorios más complejos.

Forty years ago Murray Sidman (1971) published an influential article about «emergent» or derived behaviour. His work demonstrated that when verbal humans learned different arbitrary conditional discriminations sharing common elements (e.g., A-B and B-C), they could later relate those stimuli in untrained but predictable ways.

Barnes, Hegarty and Smeets (1997) proved that this type of training could produce further outcomes. Participants later exposed to a non-reinforced matching to sample procedure with compound stimuli consistently matched equivalent samples with equivalent comparisons and non-equivalent samples with non-equivalent comparisons. For example, after training A1-B1-C1, A2-B2-C2 and A3-B3-C3, in the presence sample A1B1 participants choose A2C2 as comparison instead of A3B2 (equivalence-equivalence), while in the presence of A2C3 they choose A3B2 (non-equivalence-non-equivalence). This behaviour was generally labelled as Equivalence-Equivalence (Eq-Eq). As the authors noted, Eq-Eq behaviour (relating relations) closely resembles human analogical reasoning, despite some arguable differences (e.g., Carpentier, Smeets, & Barnes-Holmes, 2003a). The experimental paradigm of Eq-Eq responding was later refined and extended as a behaviour analytical model of human analogical reasoning (Carpentier et al., 2003a; Carpentier, Smeets, Barnes-Holmes, & Stewart, 2004; Lipkens & Hayes, 2009; Stewart, Barnes-Holmes, & Roche, 2004; Stewart, Barnes-Holmes, Roche, & Smeets, 2001, 2002). See Stewart & Barnes-Holmes (2004) for a review. In these works, Eq-Eq was found within a broad variety of experimental conditions: different stimuli, different number of classes and class members, and different training and testing procedures. See also García,

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Bohórquez, Pérez, Gutiérrez, & Gómez (2008); Pérez & García (2008).

However, not all subjects passing training and equivalence test showed a consistent Eq-Eq response, and researchers were also interested in explaining failures to obtain Eq-Eq responding. An obvious field for that kind of research was developmental psychology, where, in concordance with studies on classical analogies, Eq-Eq responding was found in adults and nine year old children, but not in five year old preschoolers (Carpentier, Smeets, & Barnes-Holmes, 2002b). Subsequent studies tried to identify the causes of the failure in young children and developed «facilitation» procedures to encourage relational responding, following the assumption that participants lacked the necessary relational abilities (Carpentier, Smeets, & Barnes-Holmes, 2002a; Carpentier et al., 2003a; Pérez, García, Gómez, Bohórquez, & Gutiérrez, 2004).

A complementary research area was the assessment of the conditions affecting Eq-Eq derivation in participants supposed to dominate its prerequisites, since not all adults passed the Eq-Eq tests, or required additional training and testing to do so. For example, in the Barnes et al., (1997) pioneering study, subjects required between two and six non-reinforced test blocks and additional training to demonstrate Eq-Eq responding; repeated training and testing was a constant since in most experiments. But again, a small number of adults did not show Eq-Eq responding despite of repeated training and testing. (See for example Stewart et al., 2001). Since the lack of prerequisites was not a plausible account in this case, some experiments analyzed the effect of alternative stimulus control topographies (Ray, 1969) competing with Eq-Eq to explain theses failures (Bohórquez, García, Gutiérrez, Gómez, & Pérez, 2002; Carpentier, Smeets, & Barnes-Holmes, 2003b; García, Bohórquez, Gómez, Gutiérrez, & Pérez, 2001; García et al., 2008; García, Gómez, Pérez, Bohórquez, & Gutiérrez, 2003; García, Gutiérrez, Bohórquez, Gómez, & Pérez, 2002; Stewart et al., 2001). For example, García et al., (2008) demonstrated that when Eq-Eq enters in competence with a non-arbitrary criterion two main manipulations influenced the probability of an arbitrary or non-arbitrary relational response: increasing baseline training and evaluating simple equivalence increased the number of subjects passing the Eq-Eq tests.

Since Eq-Eq behaviour can be considered as matching arbitrary relations, the behaviour of the participants must be under the control of the arbitrary relation (equivalence or non-equivalence) shared by the elements of the compound sample and comparisons. If competing stimulus control is a possible explanation for Eq-Eq failures, perhaps additional training or testing phases could improve the performance in Eq-Eq relations in adults by diminishing stimulus control from extraneous sources and / or facilitating the discrimination of the relevant sources of stimulus control.

Previous experiments addressed this issue with five year old children, using familiar instead of abstract stimuli, or fostering the relational response to the compound stimuli (Carpentier et al., 2002a, 2002b, 2003a). But these procedures failed to produce the expected results in most preschoolers, and also were applied sequentially and not in isolation, which prevented a detailed analysis of its respective effects. Furthermore, the effect of repeated baseline training and testing was not addressed. Eq-Eq tests were assumed to be extinction trials, since no feedback was provided. However, recent studies demonstrated that subjects can learn during typical Eq-Eq tests (Pérez & García, 2009). A consistent pattern of responding, trial after trial, appears to work as a reinforcer, an effect formerly assessed in simple equivalence experiments (Leonhard & Hayes, 1991). Therefore, the effect of repeated training and testing should be taken into account in order to assess the effectiveness of any manipulation. Otherwise, the facilitating effect could be confounded with improvement due to implicit learning through repeated testing.

Given that relational stimulus control is necessary for Eq-Eq, and that competing stimulus control could explain failures in Eq-Eq tests in adult subjects, a task intended to explicitly or implicitly reinforce relational stimulus control could facilitate the Eq-Eq response. Our aim was to develop an appropriate Eq-Eq training and testing procedure (Experiment 1) and use it to assess the effect of a procedure intended to strengthen relational stimulus control (Experiment 2).

Experiment 1

The objective of the first experiment was twofold. Regarding training, our aim was to develop a training and testing procedure that, although provided all necessary conditions, did not lead to direct Eq-Eq responding in most participants so that a facilitation procedure could be assessed. Regarding Eq-Eq testing, subjects were evaluated only twice: in the first occasion, to corroborate their failure to derive Eq-Eq responding, and in the second, to discard any improvement due to repeated testing.

Method

Participants

Twelve adults participated in this experiment, six women and six men, ranging between 18 and 52 years of age (mean= 28; standard deviation= 10.43). They were all volunteer university students and had no previous knowledge of the purpose of the experiment.

Our goal was to count with at least eight valid participants in each experiment. A valid participant was defined as one who successfully passed the conditional discrimination training and the equivalence test but failed the first Eq-Eq evaluation.

Apparatus and stimuli

The whole procedure was designed with Macromedia *Flash MX*, programmed in *Action Script* and then compiled. The resulting application displayed stimuli and consequences, and also recorded responses.

The stimuli used were images specifically designed for these experiments. Figure 1 shows these stimuli, each with a label indicating the equivalence class they were assigned to.

The general procedure consisted in an arbitrary matching to sample with an observation response to the sample. When the response was consistent with the arranged relation among stimuli, the message «GOOD» («BIEN» in Spanish) was presented for 1.4 sec. in a green background, and next trial begun. If the response was not consistent, the message presented in a red background was «NO, you made… errors. The maximum permitted is…» and the same trial started again.

The sequence of events in each trial was arranged as follows (see Figure 2): 1) The sample appeared alone in the bottom centre of the screen. 2) When the participant emitted the observation

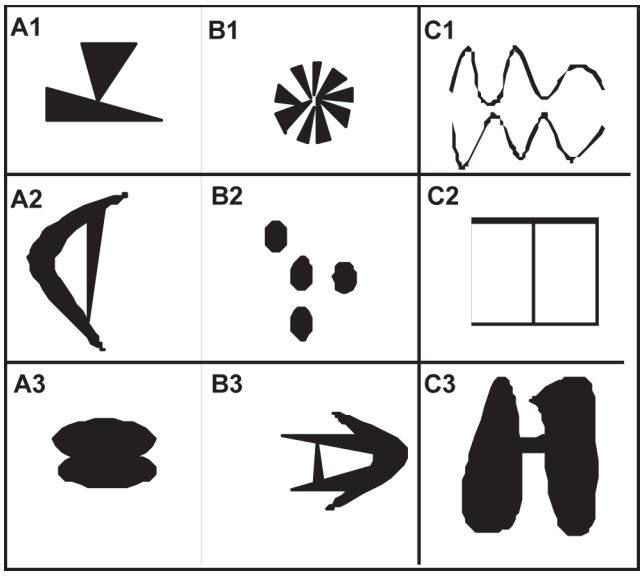

Figure 1. *Experiment 1. Stimuli used*

Figure 2. *Experiment 1. Standard sequence of trials and consequences. Left: sample stimuli. Middle left: sample (bottom) and comparisons (top). Middle right: positive reinforcer (GOOD). Right: positive punisher «NO, you committed x errors. The maximum allowed is y»*

response, comparisons appeared on the right and left top of the screen. 3) After the subject selected one stimulus with the mouse (without time restrictions) the programmed consequences were displayed (in training trials) or he/she was advanced to the next trial (in evaluation blocks).

Procedure

The procedure was designed to be completed in less than one hour, and never took more than 50 - 60 minutes. Participants were individually placed in isolated desks in front of a computer. Then the following instructions (in Spanish) were presented:

FIRST, WE WOULD LIKE TO THANK YOU FOR PARTICIPATING IN THIS STUDY

WE WOULD ALSO LIKE TO REMIND YOU OF THE FOLLOWING:

- THIS IS NOT AN INTELLIGENCE TEST.

- THIS IS NOT A PERSONALITY TEST.

- THIS IS NOT A TEST OF SPEED, YOU MAY TAKE AS LONG AS YOU NEED.

- USE ONLY THE LEFT MOUSE BUTTON, DO NOT USE THE KEYBOARD OR THE RIGHT MOUSE BUTTON

A SERIES OF STIMULI WILL NOW APPEAR ON THE SCREEN. A SAMPLE WILL ALWAYS APPEAR FIRST, WHICH YOU MUST CLICK ON. SOME POSSIBLE RESPONSE OPTIONS WILL THEN APPEAR AT THE TOP OF THE SCREEN. YOU MUST CLICK ON WHICHEVER YOU THINK IS CORRECT.

The structure of the experiment had four steps: 1) Conditional discrimination training and equivalence test. 2) Eq-Eq evaluation: Subjects passing this test finished the experiment. Otherwise, they advanced to the next phase. 3) Participants were exposed to a distraction task in the computer during four minutes (see below). 4) Eq-Eq was evaluated again, and the experiment finished.

Conditional discrimination training and equivalence evaluation

A «one-to-many» procedure was used, with «A» stimuli working as node. Training consisted of a block where A-B matching was reinforced (A1-B1, A2-B2 and A3-B3); next, A-C relations (A1-C1, A2-C2 and A3-C3) were reinforced in a separate block, and then a mixed block combining A-B and A-C relations. The first two blocks consisted of 21 trials each, and only three errors were permitted (86% correct). Subjects committing four or more errors repeated the block, with a maximum of three repetitions. The third block mixed 18 A-B training trials and 18 A-C trials. The learning criterion was five errors or less (86% correct).

After passing the three training blocks, a partial equivalence test was administered. Derived C-B conditional discriminations were assessed (C1-B1, C2-B2 and C3-B3). This block consisted of 15 non-reinforced trials where C1, C2 or C3 were the samples and B1, B2 and B3 as comparisons. The criterion fixed to pass this test was 2 errors or less (86% correct); in case it was accomplished, the subject advanced to the Eq-Eq evaluation phase. B-C relations were not tested to reduce its effect on Eq-Eq tests.

First Eq-Eq evaluation

This evaluation block was composed of 36 trials with both compound sample and comparisons. Two equivalent stimuli formed the sample in half of the trials, and two non-equivalent stimuli in the other half. One of the comparisons was formed by equivalent stimuli and the other by non-equivalent ones. Figure 3 shows an example of each type of trial.

If the participant responded in accordance with the Eq-Eq criterion (five errors or less, 86% correct) the experiment ended. In case the subject did not reach the criterion, he/she was exposed to the distraction task.

Distraction task and second Eq-Eq evaluation

The objective of this phase was to delay the second Eq-Eq evaluation four minutes, an interval similar to that of the facilitation procedure used in Experiment 2. In the beginning of the phase the following instructions were provided: «*Now, several stimuli will appear in different parts of the screen, you have to click on them*

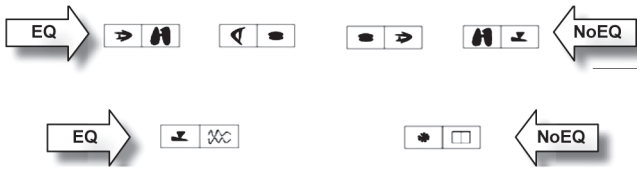

Figure 3. *Experiment 1. Examples of equivalence-equivalence (EQ) and no-equivalence (NoEQ) test trials*

before they disappear. If you manage to do it, the word «GOOD» will appear on a green screen. Click on the arrow to begin».

The task consisted in selecting diverse geometrical figures that appeared on the screen. The figures could appear for 0.5 or 1 seconds and then disappeared. When the subject clicked on a figure, a green screen with the word «GOOD» («BIEN» in Spanish) appeared for one second, otherwise next trial begun without feedback. Regardless of the results, the Eq-Eq evaluation phase described above was presented again and the experiment ended.

Results

All participants passed the conditional discrimination training and also the C-B evaluation block. Four out of the twelve participants succeeded in the first Eq-Eq evaluation (with 0, 1, 2, and 3 errors) and the experiment ended for them.

None of the remaining participants (eight) passed the second equivalence - equivalence evaluation. In fact, correct responses decreased 1.87 points on average (standard deviation= 3.31). The Wilcoxon matched pairs test confirmed the absence of differences between pre and post measures (z= 1,55; p= 0,12). Figure 4 shows the number of trials to pass the training blocks for valid participants and the number of correct responses during first and second Eq-Eq evaluation.

Discussion

Thirty three percent of the participants (4/12) passed the first Eq-Eq evaluation with the current training and testing procedure. In the comparable experiments revised in the introduction, the number of participants passing Eq-Eq in the first test considerably varied due to different training and testing conditions. For example, in the experiments carried out by Barnes et al., (1997, Experiments 1 and 2) none of the participants passed the test in the first occasion. Only one out of eight participants passed the first test in the work of Stewart et al., (2001, Experiment 1); but five out of seven adult participants succeeded in the systematic study by Carpentier et al., (2003c, Experiment 1, conditions 1 and 2). Thus, the percentage of participants passing the first Eq-Eq test in these experiments was 0%, 12% and 71% respectively.

There are too many differences between these experiments and with the present work to advance a definitive explanation of the different results (e.g., type of stimuli, number of classes and stimuli, payment for participation, etc.). But two variables appear to be particularly important to explain the low number of subjects (33%) passing the first test. First, our procedure included a slightly less restrictive learning criterion, and thus a lower number of training trials and shorter sessions than comparable experiments. And second, the partial equivalence test used (instead of a complete test) could also contribute to explain lower rates of success, since both factors proved to facilitate Eq-Eq responding (García et al., 2008).

Regarding the second Eq-Eq test, none of our valid participants passed it, and the number of errors was similar in both attempts. In contrast, the accumulated percentage of subjects passing the second Eq-Eq evaluation in the abovementioned experiments was 4/12 (33%), 4/8 (50%) and 7/8 (87%), which clearly shows an improvement compared with the first test. This negative result allows us to discard any implicit learning due to repeated testing, as reported by Pérez and García (2009).

In summary, our procedure reliably trained the conditional relations necessary to derive equivalence relations, but few subjects derived Eq-Eq in the first test, and repeated testing did not improve the results of the second evaluation. Therefore, we can use this procedure to systematically study the effect of a facilitation procedure introduced between the first and the second Eq-Eq evaluation.

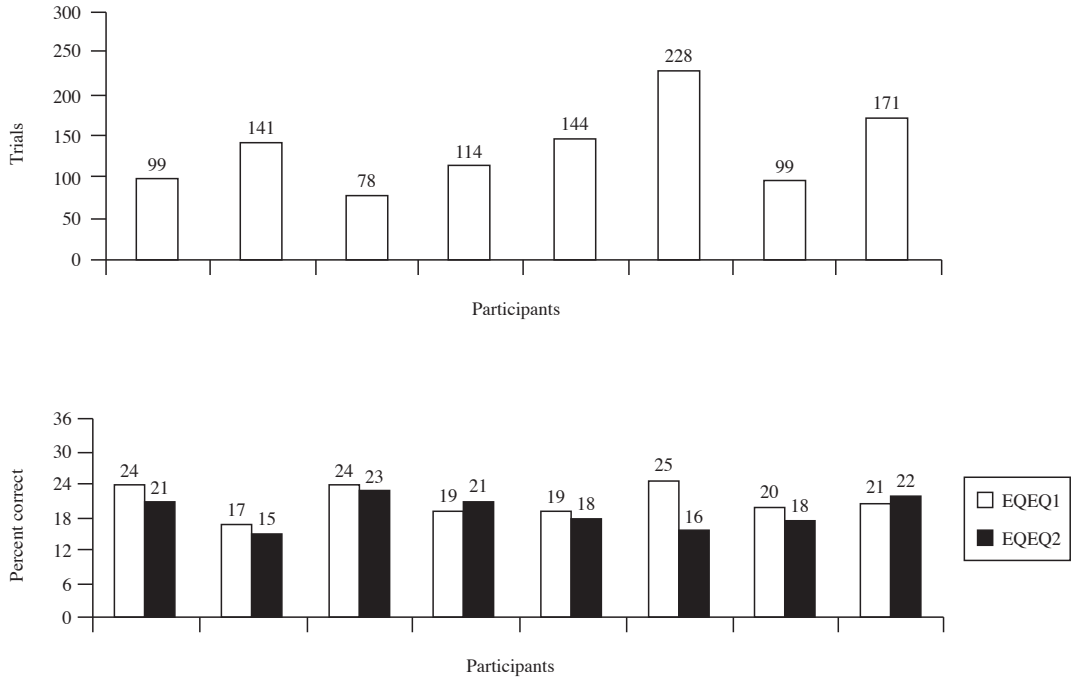

Figure 4. *Experiment 1. Top: Number of trials needed to pass training per valid participant; bottom: number of hits in both equivalence-equivalence tests (EQEQ 1 and EQEQ 2)*

Experiment 2

If adult participants are supposed to dominate the prerequisites of arbitrary relational responding (Carpentier et al., 2002b), extraneous stimulus control exerted by other sources than the experimenter-defined relation could be well responsible for the failure in Eq-Eq tests (Carpentier et al., 2003a, 2003c; García et al., 2008; Pérez et al., 2004). Verbal descriptions of the task offered by the participants who failed the tests provided additional support to this hypothesis (Pérez, 2007). Few participants alleged to choose randomly; the majority tried to found a rule applicable trial after trial, being the most popular 1) selecting equivalent comparison compounds, regardless the sample; and 2) simple equivalence relations between one element of sample and one element of the comparison. Thus, a facilitation procedure could contribute to enhance stimulus control by the experimenter-defined relevant features of the task (i.e., relating compound samples and comparisons, and enhancing the salience of the relation between the elements of the sample and comparison compounds).

Studies on competence between arbitrary and non-arbitrary response criteria in Eq-Eq demonstrated that a non-arbitrary relation was chosen by most participants and identified by all (García et al., 2002), and therefore a non-arbitrary relation could be used to enhance the stimulus control of the arbitrary relation if properly introduced. The effectiveness of such a procedure in promoting Eq-Eq was preliminarily assessed in a former study (Pérez et al., 2004). In these experiments with 10-11 year old children as participants, the facilitation procedure called «Same-Different» (or S/D, see description below) was introduced as a training phase and combined with other facilitation procedures, with partial success. In the present experiment, a between groups with repeated measures design was implemented. The S/D facilitation procedure was systematically tested, both as training and as an evaluation phase in separate conditions. Besides, the influence of an additional training block (A-A / A-B / A-C) before or after exposition to S/D evaluation was assessed in two additional conditions. Eq-Eq was evaluated before and after the exposition to the facilitation procedure.

Method

Participants

Forty two volunteer university students participated in this experiment, 8 males and 34 females, ranging from 20 to 54 years of age (mean= 30.17; standard deviation= 7.9). They had no previous knowledge of the purpose of the experiment.

Participants were randomly assigned to four conditions: Ten participants were assigned to condition 1 (3 men, 7 women); nine to condition 2 (1 man, 8 women); 12 to condition 3 (3 men, 9 women) and 11 to condition 4 (1 man, 10 women).

Apparatus and stimuli

The same apparatus as in Experiment 1 were used. The stimuli used for equivalence class formation were also the same. Nine geometric figures of different shapes and colours were used in the S/D facilitation procedure. See Figure 5.

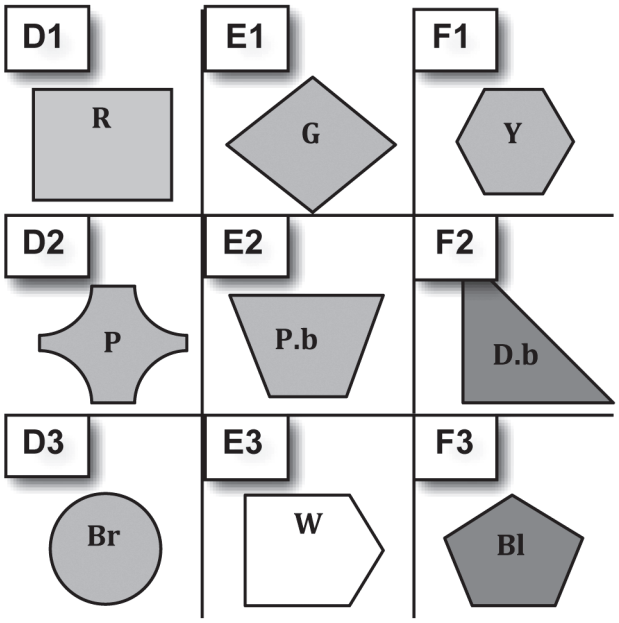

Figure 5. *Experiment 2. Geometric coloured shapes used in the facilitation procedure «Same / Different». R= Red; G= Green; Y= Yellow; P= Pink; P.b.= Pale blue; D. b.= Dark blue; Br= Brown; Bl= Black*

Procedure

The general procedure used was the same as in Experiment 1, except for the (S/D) facilitation procedure included between the first and second Eq-Eq evaluation. The experiment was divided in four conditions, depending on the specific arrangement of the facilitation procedure:

Condition 1. S/D evaluation.
Condition 2. S/D evaluation plus A-A / A-B / A-C training.
Condition 3. A-A / A-B / A-C training plus S/D evaluation.
Condition 4. S/D training

Facilitation procedure: «Same / Different»

This procedure consisted in a matching to sample task with compound stimuli. The sample could be formed by two identical or different geometric figures (e.g., D1D1 or D2D3), while one of the comparisons was always formed by identical figures (e.g., F1F1) and the other by different figures (e.g. F2F3). Sample and comparisons never shared individual elements. The S/D block was composed of 24 trials; a response was considered correct when the sample and the chosen comparison maintained the same relation (i.e., same-same or different-different). In condition 4, the feedback provided was the same as in the conditional discrimination training of Experiment 1. The maximum number of errors allowed either in training or evaluation was 2 (91%). A participant with three or more errors was dropped from the experiment. Eq-Eq was evaluated again.

Results

All participants passed the conditional discrimination training and the C-B equivalence test. Eight out of 42 participants (19%)

passed the first Eq-Eq test (mean= 3.12 errors; standard deviation= 1.80). Of the remaining 34 participants, 2 (6.2%) failed the S/D training block (all of them in condition 4). According to our definition, we counted with 32 valid participants, eight per condition. Nineteen of them (59.4%) failed to meet the criterion in the second Eq-Eq test, while 13 (40.6%) passed the second Eq-Eq test. The Wilcoxon matched pairs test showed a significant increase in the number of hits in the second Eq-Eq test measures (z= 3,02; p= 0,03).

Three number participants passed S/D and then Eq-Eq in conditions 1, 2 and 3 (3/8, or 37%). The mean increase of correct responses was also similar: 2.62 in conditions 1 and 2 and 3.87 in condition 3. In condition 4 (S/D training only) 50% of the participants (4/8) reached the criterion in the second Eq-Eq test. The increment in the number of correct responses was 9.12 on average. Nevertheless, Kruskal-Wallis analysis showed no difference between groups in the number of correct responses in the second Eq-Eq test (p= 0.93). Figure 6 shows a resume of the results of the participants in both Eq-Eq evaluations by condition.

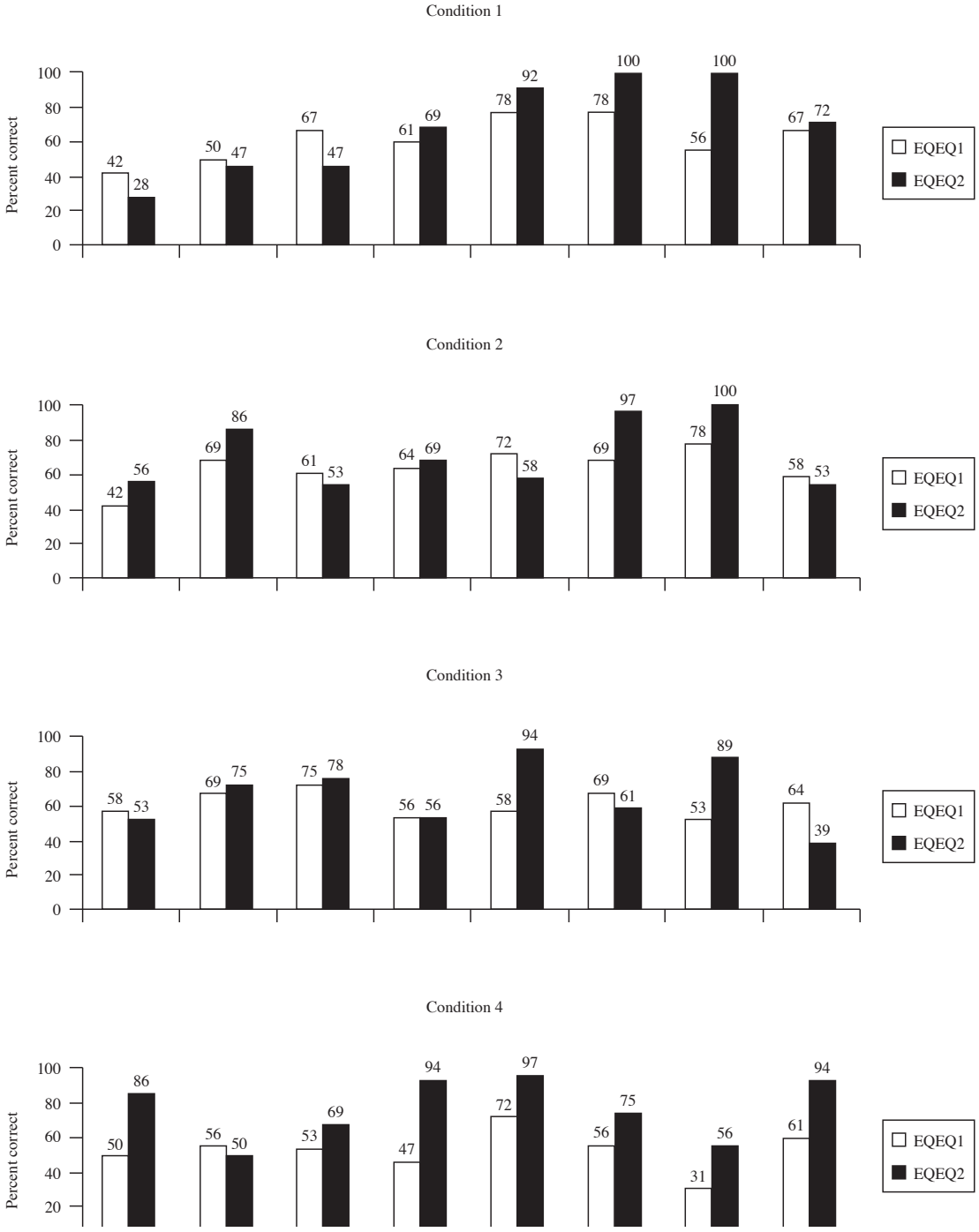

Figure 6. *Experiment 2. Results in both equivalence-equivalence evaluations (EQEQ1 and EQEQ2) for every valid participant per condition*

Discussion

Nineteen percent of the participants passed the first Eq-Eq test, a percentage similar to that obtained in Experiment 1. For those who failed, the exposition to the non-arbitrary relational response phase had a moderate positive effect. The introduction of the S/D facilitation procedure as an evaluation block (S/D evaluation, conditions 1, 2 and 3) increased the number of participants showing Eq-Eq responding in the second test. The inclusion of additional baseline training before or after the facilitation procedure had no effect on these results. Explicit training of non-arbitrary relational responses (S/D training, condition 4) also increased the probability of Eq-Eq responding.

The fact that the exposition to a non-reinforced block (not explicitly reinforced, at least) in condition 1 modified the subsequent behaviour of the participants in the second Eq-Eq test suggests that some kind of learning occurred. The non-arbitrary relational responding was easily identified by all valid participants in this experiment, as well as in former studies (García et al., 2002), where the salience of non-arbitrary relations proved to be higher. A possible explanation of the improved results in the second test is that the non-arbitrary relational response was applicable trial after trial (Pérez & García, 2009), and thus reinforced relational stimulus control. The higher increase of correct responses observed in condition 4, though statistically non significant, would be consistent with the fact that explicit reinforcement is usually more intense, and thus shapes behaviour more efficiently. An independent assessment of the relative magnitude of both types of reinforcement should be carried out to confirm this point.

General discussion

In Experiment 1 none of eight adult participants passed the Eq-Eq test in two consecutive occasions, despite they all learned all its training prerequisites and showed derived equivalence. The introduction of a facilitation procedure augmented the number of participants passing the second Eq-Eq test in Experiment 2, although the improvement was moderate (13/32, or 40.6%). The results of Experiment 2 could be hardly attributed to implicit learning, since no improvement was noticed in Experiment 1.

The results of Experiment 2 support the stimulus control topography account of equivalence - equivalence failure in adults supposed to dominate its prerequisites, since performance could be improved by enhancing the salience of the relational properties of sample and comparisons and the importance of choosing the compound comparison in relation to the compound sample. These results are compatible with the findings of previous studies (Pérez et al., 2004) and also with those reported by Carpentier et al., (Carpentier et al., 2003a, 2003b), where the authors assumed that a failure in Eq-Eq could be explained because participants did not respond to the arbitrary relations among the elements of compound samples and comparisons.

Future research efforts should be devoted to backup this view by clearing up the role of the different stimulus control topographies in arbitrary relational response, its relative importance and behavioural prerequisites. Although relational stimulus control of samples and comparisons appears to be necessary for the Eq-Eq response, there are many potential behavioural mechanisms that can be employed to enhance relational stimulus control, and participants may pass or fail the tests using different strategies. Moreover, the modest facilitative effect obtained in Experiment 2 should be improved with refinements in the facilitation procedures that can throw more light about the behavioural process involved in arbitrary relational responding.

As behaviour analytic authors argued (Hayes, Barnes-Holmes, & Roche, 2001; Skinner, 1957; Stewart et al., 2001, 2002), analogies, metaphors and analogical reasoning in everyday language, educational settings, psychological treatments, or even in scientific language, relay on the abstraction of both formal (non-arbitrary) an arbitrary relations. Consider the example provided by (Barnes et al., 1997): «apple is to orange as dog is to sheep» (instead of, say, book). The analogy holds because apple and orange are equivalent in the equivalence class «fruit», as the same as dog and sheep are equivalent in the class «animals» (while dog and book are not). But as Stewart et al. (2002) noted, oranges and apples (as well as dogs and sheep) also share non-arbitrary relations: Apples and oranges are small and round; sheep and dog are hairy, four legged, etc. (p. 377). The abstraction of formal properties and relating its non-arbitrary relations (as in the S/D procedure) are part of everyday analogies, and probably play an important role in its development (Hayes et al., 2001; Skinner, 1957; Stewart et al., 2001).

Prior studies demonstrated that non-arbitrary relations are easily identified and can block or overshadow arbitrary relational responses (García et al., 2001; García et al., 2003; García et al., 2002). However, this study showed that in some occasions the simpler non-arbitrary relational response can facilitate the more complex arbitrary relational response. A better knowledge about the conditions in which non arbitrary relational responses prevent or facilitate arbitrary relational responses may help us to understand how this type of reasoning develops, how to teach it, or how to use it effectively. Perhaps facilitation procedures as those described could be systematically used in the future as a systematic training programme for individuals lacking the relational prerequisites for analogical reasoning (Stewart & Barnes-Holmes, 2009).

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