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TITLE:

RBDT: A Computerized Task System Based in Transposition for the Continuous Analysis of Relational Behavior Dynamics in Humans

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KEYWORDS:

Relational behavior, dynamics of behavior, transposition task, behavioral patterns, behavioral continuum, perceptual activity, relational matching to sample.

SUMMARY:

RBDT integrates behavioral patterns based on discrete responses (e.g., stimuli selection, placement of figures) and continuous responses (e.g., tracking of cursor movements, figure dragging) to study relational behavior with humans. RBDT is a challenging task based on transposition, in which the participant sets up stimuli compounds with a relational criterion (more/less than).

ABSTRACT:

The most extensively employed paradigm for the analysis of relational behavior is the transposition task. Nevertheless, it has two important limitations for its use in humans. The first one is the “ceiling effect” reported in linguistic participants. The second limitation is that the standard transposition task, being a simple choice task between two stimuli, does not include active behavioral patterns and their recording, as relevant factors in emergence of relational behavior. In the present work, a challenging multi-object task based on transposition, integrated with recording software, is presented. This paradigm requires behavioral active patterns to form

stimuli compounds with a given relational criteria. The paradigm is composed of three arrangements: a) a bank of stimuli, b) sample relational compounds, and c) comparison relational compounds. The task consists of the participant constructing two comparison relational compounds by dragging figures of a bank of stimuli with the same relation shown by the sample relational compounds. These factors conform an integrated system that can be manipulated in an individual or integrative manner. The software records discrete responses (e.g., stimuli selections, placements) and continuous responses (e.g., tracking of cursor movements, figure dragging). The obtained data, data analysis and graphical representations proposed are compatible with frameworks that assume an active nature of the attentional and perceptual processes and an integrated and continuous system between the perceiver and the environment. The proposed paradigm deepens the systematic study of relational behavior in humans in the framework of the transposition paradigm and expands it to a continuous analysis of interaction between active patterns and the dynamics of relational behavior.

INTRODUCTION:

The ability to recognize and respond based on the relational qualities of objects regardless of absolute attributes that each one possesses is named relational behavior. From an ecological view, relational behavior could be critical to the adjustment of the organisms, humans and not humans, to complex and dynamic natural environments. In social and ecological contexts, the organisms are constrained to respond to permutable aspects of the environment (e.g., food, predators) that vary in relation to given qualities (e.g., size, color, smell, the intensity of a given sound, etc.) of the objects, events, and other organisms. One of the most exciting and controversial issues in the history of behavioral science is the emergence of relational behavior. This is, do animals (non-humans and humans) perceive and respond to relational qualities of stimuli, regardless of the absolute attributes that each one possess?[1–5]. The affirmative answer implies that organisms' responses integrates segments of stimulation that vary in degree in, at least, one relevant dimension or quality, such as the size or saturation of the stimuli[6, 7]. In spite of the cited controversy, there is strong evidence that supports the emergence of relational behavior in animals[4, 8–10] and humans[11–18].

Different paradigms have been used for the analysis of relational behavior. The most extensively employed has been the transposition task[5, 8]. In the transposition task, the participant responds to a given stimulus in such a way that its relevant property (e.g., 'shorter than') is relative to the property of other stimuli in the context of a composed gradient of multiple values (at least three) in a given dimension (e.g., size). Different specific values of the stimuli can take different relational values within the gradient; this is, the specific value of each stimulus can permute its relational values in a given dimension. In simple words, the same stimuli could be 'shorter than' or 'bigger than' depending on comparison stimuli within a size gradient. Some of the reasons of why the transposition task has been a central paradigm for the study of relational behavior are the following: a) the paradigm is susceptible to be extended to different stimuli dimensions[2, 19–25]; b) by consequence, it is useful for the study of relational behavior in different species (e.g., chickens, pigeons, chimpanzee, turtles, horses, humans)[2, 4, 10, 11, 18, 26]; c) it clearly shows changes of the relational value of the stimuli[9]; d) the task allows parametrical variations of different relevant factors involved in relational behaviour[9] and; e) the task allows to conduct comparative studies between different stimuli dimensions and different species or organisms[27–30].

The study of relational behavior in animals is more extensive, systematic and has stronger evidence than in humans. The main reason of this is the 'ceiling effect' frequently observed when the participants are humans[11]. In this context, recently challenging tasks have been proposed based on transposition for the study of relational behavior in this population[6, 7, 11]. In this way, the present work advances from the previous ones and presents a paradigm based on a modified-transposition task for the continuous analysis of relational behavior in humans.

Relational behavior under the transposition paradigm has been usually studied in simple choice situations, with only two stimulus options, and a reduced number of values along a single stimulus dimension in which participants are not allowed to display active patterns with respect to stimuli (e.g., inspecting, dragging, moving, and placing figures). Nevertheless, the experimental analysis of relational behavior might include situations with a) a greater number of stimulus values that allows to permutate or change the relational value of the stimuli; b) more than one relevant stimulus dimension and c) active behavioral patterns requirements, beyond the usually discrete dichotomous selections of the participants. These modifications would allow to evaluate factors not previously considered, mainly, the role of active patterns (e.g., inspecting, dragging, moving and placing figures) in relational behavior, and might prevent the "ceiling effect" observed when linguistic humans solve the standard task [11].

RBDT allows the integration of patterns based on discrete responses (e.g., stimuli selection, placement of figures) and continuous responses (e.g., tracking of cursor movements, figure dragging) to analyze the emergence of relational behavior. Two different relational compounds, comprising two stimulus each one, show the same relational properties. They are presented as a sample to compose two new stimulus segments, by means of the active patterns of the participant. The task requires the relational comparability of the stimulus segments. This involves that each one of the two constructed stimulus-segments can be compared to one another as equivalent in terms of their relational properties, but also with respect to the two-sample stimulus-segments. The relations are identified in terms of "greater than" or "less than" magnitude (i.e., size or saturation).

To exemplify some of the possibilities of the experimental arrangements allowed by the presented paradigm, two experiments were conducted. The first experiment shows an exploration of relational behavior under different relational criteria without restriction of active patterns of behavior. The second experiment contrasts the dynamics of relational behavior under restriction of behavioral patterns adding a continuous recording and analysis of dragging and inspection activity with the mouse cursor.

PROTOCOL:

Both protocols follow university guidelines to conduct behavioral research with human participants. RBDT software and the user's manual can be downloaded from https://osf.io/7xscj/

1. Experiment 1: Relational behavior under different relational criteria without restriction of active patterns of behavior

NOTE: Five elementary school children, between 10 to 11 years-old, volunteered to participate in this study, with the informed consent of their parents and teachers.

1.1. Apparatus and experimental situation

1.1.1. Use five Pentium laptop computers, each one with a 14” monitor, keyboard, and optic mouse as response device.

1.1.2. Program the experimental task in Java as it automatically records responses and presents a graphical representation of data. The program to conduct the experimental task will be available for download.

1.1.3. Perform experimental sessions daily between 9 and 11 am, in individual stations of the Sidney W. Bijou mobile laboratory at University of Veracruz.

1.1.4. Use stations equipped with one-way mirrors, air conditioning, desks, and chairs, and the before mentioned computers.

1.2. Experimental design and task

1.2.1. In the experimental task, present 15 stimulus objects (SOs) consisting of different shapes. Five of these SOs were relevant to the completion of the task and 10 were irrelevant, as shown in the left part of **Figure 1**.

1.2.1.1. Use five different shapes as relevant stimulus objects: pentagon, rectangle, horizontal rhomboid, parallelogram, and figure in V.

1.2.1.2. Use ten different shapes were used as irrelevant stimulus objects: hexagon, triangle, circle, trapezoid, oval, rhombus, square, vertical rhomboid, trapeze, and irregular figure in L.

1.2.1.3. Vary the SOs in color saturation or size. In this experiment, we employed SOs with four different degrees of saturation: black (#000000), dark gray (#474747), gray (#A7A7A7) and light gray (#E7E7E7). The size remained constant.

[Insert **Figure 1** here]

1.2.2. Present the SOs in a computer screen, divided in three zones, as shown in the left part of **Figure 2**.

1.2.2.1. In the upper left part of the screen, present the zone of *Sample Relational*

Compounds 1 and 2 (SRC 1, 2). Show two different pairs of figures that set a relationship criterion. Each pair exemplified two degrees of saturation relationship “darker or lighter than” with the same shape.

1.2.2.2. In the lower left part of the screen, present the zone of *Comparison Relational Compounds 1 and 2 (CRC 1, 2).* Show two pairs of empty spaces in this zone. The participant had to form two new pairs of figures that fulfilled the exemplified criteria by choosing figures from the *Bank*.

1.2.2.2.1. On the right side of the screen, present the *Bank* zone. In each trial, the bank contained 18 different figures that acquired different relational properties, depending on the criteria exemplified by the SCR 1, 2.

NOTE: Six figures met the criteria set by the SRC (permutable figures), six figures were eligible to be used correctly but under another criteria (non-permutable figures), and six figures did not meet the criteria set by the SRC (irrelevant figures).

1.2.2.3. To place the figures in the CRC zone, have the participant select the figure with the mouse pointer and drag it to the blank spaces in the CRC zone. Placements of figures could be in different sequences and they could be changed.

[Insert **Figure 2** here]

1.2.3. Use a single-subject AB design with two replications and three phases (**Table 1**). Each phase consisted of three training sessions: S1 to S3 (phase 1), S4 to S6 (phase 2), and S7 to S9 (phase 3), consisting of 36 trials (18 “darker than” and 18 “lighter than”, randomized) per session (a total of 108 training trials per phase), and one test session consisting of 36 trials (18 “darker than” and 18 “lighter than”, randomized).

NOTE: Each phase involved a different relationship criterion in terms of the SOs being used. Examples of the screens of each relationship criteria are shown in **Figure 3**.

1.2.4. During training, give the participant feedback after completing the CRC 1, and 2. After each trial, present the word “correct” or “incorrect” depending on if the CRC conformed fulfilled the criteria exemplified by the SRC 1, 2.

1.2.4.1. Use a corrective procedure when the CRC was incorrect. Display the same trial up to two more times (these trials were called corrective trials). If the answer was wrong again, display a new trial. If the answer was correct, display a new trial immediately.

1.2.5. Present test trials without feedback and show only once.

1.2.6. Each phase involved a different relationship criterion in terms of the SOs being used.

1.2.7. Before the first experimental phase, conduct one session of an “ordering task” to verify that participants could place each type of stimulus component along a saturation continuum.

[Insert **Table 1** here]
[Insert **Figure 3** here]

1.3. Procedure

1.3.1. Ordering task

1.3.1.1. Present the ordering task on a screen with two zones, as shown in the left part of **Figure 4**. The upper zone of the screen showed a row of four empty boxes.

1.3.1.2. In the lower zone, show four figures with each varying on a saturation continuum.

1.3.1.3. Have participants order, from “darker to lighter” (or vice versa), the four figures in each one of the upper empty boxes, using the mouse pointer.

1.3.1.4. When stimuli were correctly placed, present a new trial. If stimuli were incorrectly ordered, withdraw the stimuli and have a text indicating “incorrect” in the right upper side of the screen. Then repeat the trial two more times.

1.3.1.5. After this, present a new trial.

1.3.1.6. Present two blocks of 6 different trials, one for the “darker to lighter” sequence and one for the “lighter to darker” sequence.

1.3.1.7. At the beginning of the task, present participants with the following instructions on the screen: “In the upper section of the screen four empty spaces are presented, you must fill them by placing in order the figures located in the lower section.” When the ordering criterion changed, present a text informing that figures should be place in the opposite order.

[Insert **Figure 4** here]

1.4. Comparison task

1.4.1. Have participants form two relational compounds (CRC) involving two stimuli, each one according to the exemplified relation shown by a pair of sample relational compounds (SRC).

1.4.2. Form comparison compounds by placing stimulus objects taken from the bank zone.

1.4.3. Arrange stimuli according to the features above described in terms of modality, absolute value, and relational value relative to a relationship criterion, in this case, saturation.

1.4.4. Form each comparison compound (CRC) with the same stimulus object (shape) but with two different values in saturation, according to a "darker than" or "lighter than" relationship criteria shown by SRC.

1.4.5. In each experimental phase, a different relationship criterion applied regarding the stimulus objects being compared (**Table 1**).

1.4.5.1. In the first phase, have each trial include a similar stimulus object in terms of its shape in the four compounds (left screen in **Figure 3**).

1.4.5.2. In the second phase, use a different stimulus object (shape) for the sample and comparison compounds (middle screen in **Figure 3**).

1.4.5.3. In the third phase, have both sample and comparison compounds include different stimulus objects in each of the two relational pairs (right screen in **Figure 3**).

1.4.5.4. Vary stimulus shapes in every trial from a set of five relevant shapes.

1.4.5.5. Place stimuli in each box of the comparison compound by using the mouse pointer.

1.4.5.6. There was no restriction regarding the order of placements in CRC. The set of placements to complete each trial was called a placement sequence.

1.4.5.7. Have participants make as many placements and stimulus changes as they wanted before placing the fourth stimulus and completing both CRC.

1.4.5.7.1. The minimum number of placements to complete a trial was four, one placement for each empty box in the CRC zone. Changes of placed figures were called excessive placements.

1.4.5.8. At the beginning of the first training session, present participants with the following instructions on the screen: "There are two spaces in the upper left part of the screen, each with a pair of figures that exemplify how the figures have to be set. In the lower left part of the screen there are two spaces, each with two empty boxes, you must fill these boxes with two figures that go together, as the ones in the upper left, you do this by selecting the figures from those presented in the right side of the screen. To select the figures, place the cursor on the figure you want to use, click on the figure with the left mouse button and drag it to the space where you want to place it. Release the left mouse button, the figure will be placed in the space you choose. If you want to change the figure you chose, follow the same procedure, and place the new figure on the space of the previous figure. If your answer is correct, you will advance to the next window. If your answer is incorrect, the word "incorrect" will appear in the upper right part of the screen, the figures will disappear from the spaces where you had placed them and you will have to choose other figures, following the same procedure. For each window you have a maximum of 3 possible errors, if you accumulate 3 errors, you will automatically advance to the next window".

1.4.5.9. At the beginning of the first test session, present participants with the following instructions on the screen: "Solve the task in the same way as in the previous block. When you have completed all four spaces with the arrangement that you consider correct, click the "Continue" button, located at the bottom right of the screen to proceed to the next window. This time you will not be told if your answer is correct or incorrect".

2. Dynamics of relational behavior under restriction of behavioral patterns

NOTE: Two sophomore students, 19 and 21 years old, respectively, participated. Students were awarded an extra point in one of their subjects, regardless of their scores obtained in the experiment.

2.1. Apparatus and experimental situation

2.1.1. Use the same ones described in Experiment 1.

2.2. Experimental design and task

2.2.1. Use the task as described in Experiment 1.

NOTE: The difference was that in this experiment, the employed SOs varied in four different sizes: smaller (50 x 33 pixels), small (66 x 42 pixels), large (82 53 pixels), and larger (106 x 66 pixels), with four different colors randomly assigned: blue, yellow, red, and black, as shown in the right part of **Figure 1**.

2.2.2. Present SOs in a computer screen, divided in three zones, as shown in the right part of **Figure 2**. In this case SRC 1 and 2 exemplified two degrees of size relationship "larger or smaller than" with the same shape.

2.2.3. As in Experiment 1, in order to place the figures in the CRC zone, have the participant select the figure with the mouse pointer and drag it to the blank spaces in the CRC zone.

2.2.4. Place figures in different sequences (called placement sequences) and change (figure changes were called excessive placements) depending on the experimental condition. Placement sequences and excessive placements were considered as local patterns.

2.2.5. Two sub-experiments of restriction of local patterns were used (**Table 2**), each participant was assigned to one of two sub-experiments.

2.2.5.1. Conform each sub-experiment according to the combination of restrictions or non-restrictions of placement sequences and excessive placements.

2.2.5.2. In both sub-experiments, employ three training sessions with 36 trial each (18 "larger than" and 18 "smaller than", randomized), and one test session consisting of 36 trials each (18 "larger than" and 18 "smaller than", randomized). In addition, training and test sessions involved a relationship criterion in terms of the SOs being used.

NOTE: An example of the screen of relationship criteria is shown in **Figure 5**.

2.2.6. During training, after each trial, present the word "correct" or "incorrect", depending on the CRC conformed.

2.2.6.1. If the answer was correct, display a new trial. If the answer was wrong, display the same trial up to two more times (corrective trials).

2.2.6.2. Present test trials without feedback and show only once.

2.2.7. As in Experiment 1, before the first experimental phase, conduct one session of an "ordering task". In this case, participants could place each type of stimulus component along a size continuum.

[Place **Table 2** here]
[Place **Figure 5** here]

2.3. Procedure

2.3.1. Ordering task

2.3.1.1. Use the ordering task as described in Experiment 1. The difference was that four figures shown in the lower zone varied on a size continuum. So, participants had to arrange the figures from "larger to smaller" (or vice versa), as shown in the right part of **Figure 4**.

2.3.2. Comparison task

2.3.2.1. Use the task as described in Experiment 1, the difference was that in each condition, in training and test sessions, a relationship criterion was set in terms of the size (larger or smaller than) and the type (shape) of SOs (see **Table 2**).

2.3.2.2. Have the stimulus objects used in the CRC zone comply with the "larger or smaller than" relationship, had to vary the degrees of size and be different in shape with respect to the SRC (see the right part of **Figure 2**).

2.3.2.3. Differ each sub-experiment in terms of restriction or not of local patterns: 1) in the first one, the placement sequences could vary, and it was allowed to have excessive placements, 2) in the second one, placement sequences and excessive placements were restricted. In the condition with restrictions participant were not informed about it.

REPRESENTATIVE RESULTS

EXPERIMENT 1:

The behavioral continuum of each participant was analyzed. Analysis included comparison of excessive placements and variety of placement sequences, latencies in seconds between placements, choice of permutable, non-permutable and irrelevant stimuli, and correct (correct trials regardless of the number of placements or use of corrective trials) and accurate trials (correct trials with four placements and without corrective trials).

In the ordering task, which was used only to ensure that participants differentiated the values of the saturation continuum, correct trials ranged from 17% to 100%.

Figures 6 to 8 shows the behavioral continuum of Participant 1 (P1, **Figure 6**) who established relational behavior, Participant 2 (P2, **Figure 7**) who moderately established it, and Participant 3 (P3, **Figure 8**) who did not establish relational behavior. In each figure, the horizontal axis shows trials throughout the experiment, the vertical axis shows ordinality of placements, that is, the order in which the figures were placed in the empty spaces of CRC zone, vertical lines inside each panel indicate session changes (every 36 trials), training sessions (S1 to S9) and test sessions (1 to 3).

For **Figures 6 to 8**, the first, upper panel shows sequences of placement in the CRCs. Each bar represents a trial, inside these, each color represents one of four empty spaces of CRCs (upper left-red, upper right-green, lower left-gray, lower right-purple), vertical color variation in each bar indicates sequence of placements in each trial. The height of the bars indicates the use of excessive placements and/or the use of correction trials. Two points sequences are shown at the top of the first panel, blue dots (first sequence) represent accurate trials (correct trials with four placements and without corrective trials). Black dots (second sequence) represent correct trials (correct trials regardless of the number of placements or use of corrective trials). The second, lower panel of the figures shows the type of stimuli chosen in each trial: permutable (red), non-permutable (green) and irrelevant (gray).

There are several aspects of the figures that are important to notice to account for the differences in relational behavior for each participant. 1) Uninterrupted sequences of at least three accurate and correct trials are important since they are an indicator of the establishment of relational behavior. 2) Variation in the horizontal-colored tiles in the first panel. This indicates variety in the placement sequences, instead of single-color segments, that indicate that the participant did not vary the placement sequences from trial to trial, which would be considered stereotypical patterns. 3) The height of the bars, their increases, and decreases. This indicates excessive placements to conform the CRC and the use of corrective trials. 4) Predominance of red color in the second panel, which indicates predominance of choosing permutable stimuli.

Figure 6 shows the behavioral continuum of P1. Although point sequences are observed in the first phase, these had interruptions. Starting the second phase, more stable point sequences were observed, which remained constant until the last phase of the experiment. Regarding placement sequences, varied colored mosaics are observed, therefore placement sequences varied throughout the experiment. The height of the bars showed excessive placements on phase one, but this decreased starting the second phase, with some minor increments in the third phase. In the second panel, a predominance of red color is observed, indicating predominance in the selection of permutable stimuli.

[Insert **Figure 6** here]

Figure 7 shows the behavioral continuum of P2. In the first phase, the point sequences were inconsistent, but from the second half of S3 (which corresponded to phase two) more stable point sequences were observed, especially the sequencing of correct trials (blue dots). During Test 2, P2 had no correct neither accurate trials. In the third phase, the point sequences emerged again in training but during Test 3 all trials were incorrect. A variety of placement sequences was observed, although it was less varied in comparison to P1. In Test 3 a stereotyped pattern (single color segments) was observed, which indicates that there was no variety in the placement sequences. Regarding excessive placements, in general, the height of bars decreased after the second phase, although some high bars were observed in training sessions of phases 2 and 3, unlike their test sessions, which indicates that in these sessions P2 did not use excessive placements. In the second panel, a predominance of the selection of permutable stimuli is observed, although in the second and third phase selection of non-permutable stimuli is observed.

[Insert **Figure 7** here]

Figure 8 shows the behavioral continuum of P3. Concerning correct and accurate trials, a few correct and accurate points, although very scatted were, observed in S1. Subsequently, no point sequences were observed. Variety of sequences were observed only in S1 of the first phase. From the second session and until the end of the experiment, stereotyped patterns (single color segments) were observed. The height of the bars during the training sessions remained practically constant in 12 placements, this is because correction trials were used and there were few excessive placements. In second panel, the predominance of the selection of permutable stimuli was observed only in S1 of the first phase. Subsequently, the selection of non-permutable and irrelevant stimuli predominated.

[Insert **Figure 8** here]

In **Figure 9**, the left and middle panel shows the percentages of variety of sequences, involving only four placements, and the percentages of exceeding placements, respectively for the three participants. The first one was computed by dividing the number of different sequences with four movements by 24 (the total of possible sequences). Training sessions (S1 to S9) and test sessions (1 to 3) are shown on the horizontal axis and the percentages of variety of sequences are depicted on the vertical axis. A decreasing function is observed with the highest percentage obtained during the first phase. Starting Phase 2, the value of the percentages systematically decreased. The percentage of the participant who established relational behavior (P1) remained higher than the rest of the participants. The percentages of the participant who did not establish relational behavior remained always below the percentages of P1 and P2.

The second (percentages of exceeding placements) was calculated by dividing the number of excessive placements by the total number of sequences (comprising four or more placements) produced by the participant overall. Although a variable trend was observed for all participants, the percentages of P2 remained above the percentages of P1 and P3. The percentages of P3 remained below the percentages of P1 and P2, except for S1 in which the percentage obtained was like the one obtained by P2.

The right panel shows the latency in seconds between placements for the three participants. Training and test sessions are shown on the horizontal axis and seconds on the vertical axis. For the three participants, a descending function was observed with the highest latency obtained during the first phase. There was no difference in the latencies of the three participants since the values remained very close to each other.

[Insert **Figure 9** here]

EXPERIMENT 2:

The behavioral continuum of each participant was analyzed in the same way as in Experiment 1. **Figure 10** shows the behavioral continuum of P1 of Experiment 2, who had the unrestricted local patterns (see **Table 2**, sub-experiment 1). A sequence of accurate trials dots (blue dots) is observed with some interruptions from the beginning to the end of the experiment. An uninterrupted sequence of correct trial dots (black dots) is observed from the first training session to the last training session, some interruptions are observed in the test session. Because P1 could vary the placement sequences and have excessive placements, in the first panel varied colored mosaics are observed, therefore placement sequences varied throughout the experiment. The height of the bars showed excessive placements on first training session (S1), but this decreased starting the second session (S2). In the second panel, a predominance of red color is observed, indicating predominance in the selection of permutable stimuli.

[Place **Figure 10** here]

Figure 11 shows the behavioral continuum of P2 of Experiment 2, who had restricted local patterns (see **Table 2**, sub-experiment 2). An uninterrupted sequence of accurate trials dots (blue dots) and sequence of correct trials dots (black dots) are observed almost from the beginning to the end of the experiment. Because P2 was unable to vary placement sequences or have excessive placements, colored segments (red, green, gray and purple) are observed in the first panel, indicating the only possible sequence of figure placement and the height of the thirteen bars showed only the use of corrective trials. In the second panel, a predominance of red color is observed, indicating predominance in the selection of permutable stimuli.

[Place **Figure 11** here]

For **Figures 12 to 14** each row corresponds to one participant (P1 and P2), each column corresponds to training (S1, S2 and S3) and test sessions. In **Figure 12** every point represents the position of the cursor at the x and y coordinates of the screen, every five frames per second. Each color represents a zone of the screen, the blue one represents the SRC zone, the red one represents the CRC zone, and the green one represents the bank zone.

In the participant with unrestricted local patterns (P1), the points are observed, to a greater extent, in the CRC and bank zones, unlike the participant with restricted local patterns (P2) in which point distribution is observed in the three zones of the screen.

[Place **Figure 12** here]

In **Figure 13** the dragging figures through the cursor (blue points), cursor movements (red points) and the cursor repose (green points) are shown for each participant trough Experiment 2. In both participants, figures are being dragged from the bank zone to the CRC zone, and in some cases (S2, S3 and Test) figure dragging is observed inside the SRC zone. In P1 less density of red points is observed (less cursor movement), furthermore, red points are observed to a greater extent in the CRC and bank zones, green points are observed only during S1, later disappears and density of red points increases, but not to the same degree as in P2. In participant with restriction of local patterns(P2) red points are observed in SRC zone, this indicates that the participant moved the cursor within this zone, even, from S3, movements are observed in the CRC zone, in addition to the movements observed in the bank zone, the green points that indicate that the cursor was in repose are observed to a greater extent during S1 and S2, later disappear almost completely and the density of red points increases.

[Place **Figure 13** here]

In **Figure 14** transitions between zones are shown. Each letter and color depict one zone: A (light blue) for SRC zone, B (dark blue) for CRC zone and C (orange) for the Bank zone. From left to right, gray lines indicate the starting point and the ending point of the cursor. The thickness and length of the gray lines indicate the extent of the transitions, thinner lines indicate fewer transitions, while ticker lines indicate greater number of transitions. In participant with unrestricted local patterns (P1), fewer transitions are observed in zones B-A, C-A, A-B and A-C, while the transitions in zones B-C and C-B remain constant throughout the experiment, the transition from zone C to zone B being dominant. In participant with restricted local patterns (P2) fewer transitions are observed in zones B-A and A-B, but unlike P1, an increase in transitions between C-A and A-C is observed while the sessions pass, in addition C-B decreases from S2. This indicates that the participant with restricted collocations or local patterns (P2) traveled more through the bank (C) to SRC (A) zone and vice versa, unlike the unrestricted participant, who traveled to a greater extent from the bank zone (C) to the CRC zone (B).

[Place **Figure 14** here]

Figure 15 shows the latency in seconds between placements for both participants. Training and test sessions are shown on the horizontal axis and seconds on the vertical axis. In the participant without restrictions in the local patterns (P1), a slight decreasing function is observed, while in the participant with restrictions (P2) a notable decreasing function is observed, in addition, P2 was always kept above P1.

[Place **Figure 15** here]

Figure 1. Example of relevant and irrelevant figures used as stimulus objects (SOs) in each experiment.

Figure 2. Screens showing a comparison trial in Experiment 1 and 2. In the upper left zone are located the sample relational compounds (SRC), in the bottom zone the boxes to complete de comparison relational compounds (CRC), and in the right section the bank of stimuli.

Figure 3. Examples of screen of each relationship in the three phases of the Experiment 1.

Figure 4. Examples of screen in ordering task in Experiment 1 and 2. In the upper zone are the empty spaces to order the figures shown in the lower zone.

Figure 5. Example of screen of relationship criteria in the four sessions of the Experiment 2.

Figure 6. Behavioral continuum of Participant 1 (P1) of Experiment 1. First panel shows sequences of placement in the CRCs, each color represents one position in the four empty boxes of the comparison compounds (A-upper left, B-upper right, C-bottom left, and D-bottom right). Second panel shows type of stimuli chosen in each trial. For both panels, on the horizontal axis are the trials, divided every 36 trials by training sessions (S1 to S9) and tests (1 to 3) respectively and on the vertical axis is the ordinality of placements. Dots at the top represents accurate (blue dots) and correct (black dots) trials.

Figure 7. Behavioral continuum of Participant 2 (P2) of Experiment 1. First panel shows sequences of placement in the CRCs, each color represents one position in the four empty boxes of the comparison compounds (A-upper left, B-upper right, C-bottom left, and D-bottom right). Second panel shows type of stimuli chosen in each trial. For both panels, on the horizontal axis are the trials, divided every 36 trials by training sessions (S1 to S9) and tests (1 to 3) respectively and on the vertical axis is the ordinality of placements. Dots at the top represents accurate (blue dots) and correct (black dots) trials.

Figure 8. Behavioral continuum of Participant 3 (P3) of Experiment 1. First panel shows sequences of placement in the CRCs, each color represents one position in the four empty boxes of the comparison compounds (A-upper left, B-upper right, C-bottom left, and D-bottom right). Second panel shows type of stimuli chosen in each trial. For both panels, on the horizontal axis are the trials, divided every 36 trials by training sessions (S1 to S9) and tests (1 to 3) respectively and on the vertical axis is the ordinality of placements. Dots at the top represents accurate (blue dots) and correct (black dots) trials.

Figure 9. Left panel shows percentages of variety of sequences involving only four placements. Middle panel shows percentages of exceeding placements. Right panel shows latency in seconds between placements. All for the three participants of Experiment 1. Training (S1 to S9) and test (1 to 3) sessions are shown on the horizontal axis, percentages, and latency in seconds on the vertical axis.

Figure 10. Behavioral continuum of Participant 1 (P1) of Experiment 2. First panel shows sequences of placements in the CRCs, each color represents one position in the four empty boxes of the comparison compounds (A-upper left, B-upper right, C-bottom left, and D-bottom right). Second panel shows type of stimuli chosen in each trial. For both panels, on the horizontal axis are the trials, divided every 36 trials by training sessions (S1 to S3) and test session respectively, and on the vertical axis is the ordinality of placements. Dots at the top represents accurate (blue dots) and correct (black dots) trials.

Figure 11. Behavioral continuum of Participant 2 (P2) of Experiment 2. First panel shows sequences of placements in the CRCs, each color represents one position in the four empty boxes of the comparison compounds (A-upper left, B-upper right, C-bottom left, and D-bottom right). Second panel shows type of stimuli chosen in each trial. For both panels, on the horizontal axis are the trials, divided every 36 trials by training sessions (S1 to S3) and test session respectively, and on the vertical axis is the ordinality of placements. Dots at the top represents accurate (blue dots) and correct (black dots) trials.

Figure 12. Shows the position of cursor in the screen throughout the Experiment 2. Each row corresponds to each participant (P1 in unrestricted condition, and P2 in restricted condition), each column corresponds to training (S1, S2 and S3) and testing sessions.

Figure 13. Shows the patterns of figure dragging, cursor movement and repose throughout the Experiment 2. Each row corresponds to each participant (P1 in unrestricted condition, and P2 in restricted condition), each column corresponds to training (S1, S2 and S3) and testing sessions.

Figure 14. Shows the transitions between zones in the Experiment 2. Each row corresponds to each participant (P1 in unrestricted condition, and P2 in restricted condition), each column corresponds to training (S1, S2 and S3) and testing sessions. From left to right, gray lines indicate the starting point and the ending point of the cursor. The thickness and length of the gray lines indicate the extent of the transitions, thinner lines indicate fewer transitions, while ticker lines indicate greater number of transitions.

Figure 15. Latency in seconds between placements of two participants of Experiment 2. Training (S1 to S9) and test (1 to 3) sessions are shown on the horizontal axis and seconds on the vertical axis.

DISCUSSION:

The proposed paradigm expands and deepens the systematic study of relational behavior in humans in the framework of the transposition paradigm. On the one hand, it allows the analysis of some factors and parameters previously studied in the area - e.g., stimulus modality[2, 5, 10, 23, 26]; difference or disparity between stimuli[4, 19, 20]; intersection of modalities[20, 22, 23, 26]; among others- while also provides the opportunity of intersecting them with different factors related to active patterns (e.g., patterns of placement figures, exceeding movements or allocations in the placement figures; variety of patterns of placement figures; dragging and inspection patterns; among others).

The first study revealed high variation and exceeding movements in the first stages of the establishment of relational behavior and in the change of phase when new relational criteria were presented. In addition, the data suggest that the activity patterns and their dynamics are relevant for the emergence of relational behavior. This approach to the study of the process is not feasible to conduct with the standard transposition paradigm, among other reasons, because of the typical 'ceiling effect' observed with in humans and the non-requirement of activity patterns of the participants to solve the task beyond a simple click as a response.

The second study allowed to evaluate the role of some factors not previously explored, such as inspecting, dragging, and moving stimuli/objects on the emergence of relational behavior. This study showed an increment of inspecting and dragging patterns as an emergent of an imposed restriction on colocation patterns of stimuli (i.e., limitation on the variation of colocation sequences and exceeding movements). These findings suggest a unitary system between colocation patterns and displacement patterns, so when colocation patterns are restricted (e.g., restriction in variation and exceeding movements), their function was subsumed for the displacement patterns, and then an increment of inspecting, dragging, zones visiting, was observed; basically, in the first phases of the establishment of relational behavior.

The methodological proposal, the Relational Behavior Dynamics Task (RBDT), extends the study of relational behavior, relational cognition, and other related areas. RBDT is akin to other methodological procedures, aside from the transposition task, such as Relational Matching to Sample task (RTMS) [31]. In relation to that task, RBDT presents some advantages: 1) RBDT employs the same-different relation as standard RTMS tasks; but in addition, less-greater-than and transposition relations, which actually are the core of the paradigm; 2) RBDT works with extended stimulus arrays, and not just with a couple of stimuli pairs; 3) the extended stimulus arrays in RBDT have modifiable degrees of variation in different dimensions and values; which could be conceptualized as modifiable perceptual entropy [32]; 4) RBDT allow the exploration of the cross-dimensional relations [33]; 5) finally, in RBDT the participant compounds the comparison arrangement through his/her activity and not only choices a given arrangement; the record of this activity, both cursor tracking, dragging, and figures allocation; and the analysis of associated dynamics and its role in the emergence of relational behavior is a novel approach that our proposal allows. Then, RBDT could be a valuable paradigm for the research focusing on RTMS and extend the scope of the research on relational behavior from a methodological akin paradigm.

Thus, the proposed paradigm is especially useful in the framework of approaches that assume:

a) an active nature of the attentional and perceptual processes[34–39], and b) an integrated and continuous system between the perceiver (i.e., their active patterns) and the environment (i.e., the relation between stimuli)[34–38].

The proposed method allows to manipulate four groups of factors related to the arrangement of stimuli and behavioral patterns, these are: a) factors related to the Sample Relational Compounds, b) factors related to Comparison Relational Compounds, c) factors related to the Bank of Stimuli, d) factors related to the active behavioral patterns. These four groups of factors conform an integrated system that can be manipulated and studied in an individual or integrative manner.

RBDT, and the complementary proposed data analysis and representation, are compatible with the previously mentioned frameworks. They allow empirical research on the role of behavioral patterns based on both discrete and continuous responses in the emergence of relational behavior and open the door to a potential new field in the area: the dynamics of relational behavior in humans.

ACKNOWLEDGMENTS:
None.

DISCLOSURES:
The authors have nothing to disclose.

REFERENCES:

1. C. Lloyd Morgan, L. d *An Introduction To Comparative Psychology*. at <http://archive.org/details/in.ernet.dli.2015.174177>. (1903).
2. Köhler, W. Simple structural functions in the chimpanzee and in the chicken. *A source book of Gestalt psychology*. 217–227, doi: 10.1037/11496-018 (1918).
3. Spence, K.W. The differential response in animals to stimuli varying within a single dimension. *Psychological Review*. **44** (5), 430–444, doi: 10.1037/h0062885 (1937).
4. Lazareva, O.F., Wasserman, E.A., Young, M.E. Transposition in pigeons: reassessing spence (1937) with multiple discrimination training. *Animal Learning & Behavior*. **33** (1), 22–46, doi: 10.3758/BF03196048 (2005).
5. Reese, H.W. *The Perception of Stimulus Relations: Discrimination Learning and Transposition*. Academic Press. (2013).
6. Ribes-Iñesta, E., León, A., Andrade-González, D.E. Comparison patterns: An experimental study of transposition in children. *Behavioural Processes*. **171**, 104024, doi: 10.1016/j.beproc.2019.104024 (2020).
7. Andrade-González, D.E., León, A., Hernández-Eslava, V. La pertinencia de la tarea de transposición como un caso para el estudio de los contactos funcionales de comparación. *Acta Comportamentalia: Revista Latina de Análisis de Comportamiento* (En prensa).
8. Lazareva, O.F. Relational learning in a context of transposition: A review. *Journal of the experimental analysis of behavior*. **97** (2), 231–248, doi: https://doi.org/10.1901/jeab.2012.97-231 (2012).

9. Lazareva, O.F., Young, M.E., Wasserman, E.A. A three-component model of relational responding in the transposition paradigm. *Journal of Experimental Psychology: Animal Learning and Cognition*. **40** (1), 63–80, doi: 10.1037/xan0000004 (2014).
10. Leighty, K.A., Grand, A.P., Pittman Courte, V.L., Maloney, M.A., Bettinger, T.L. Relational responding by eastern box turtles (Terrapene carolina) in a series of color discrimination tasks. *Journal of Comparative Psychology*. **127** (3), 256–264, doi: 10.1037/a0030942 (2013).
11. Lazareva, O.F., McInnerney, J., Williams, T. Implicit relational learning in a multiple-object tracking task. *Behavioural processes*. **152**, 26–36 (2018).
12. Vatsuro, E.G., Kashkai, M.D. A Comparative Investigation of Transposition of Learning: (In Normal Children of Various Ages and in Mental Deficients; in Apes and in Monkeys). *Soviet Psychology and Psychiatry*. **4** (1), 16–25, doi: 10.2753/RPO1061-0405040116 (1965).
13. Kuenne, M.R. Experimental investigation of the relation of language to transposition behavior in young children. *Journal of Experimental Psychology*. **36** (6), 471 (1946).
14. Rudel, R.G. Transposition of response by children trained in intermediate-size problems. *Journal of Comparative and Physiological Psychology*. **50** (3), 292–295, doi: 10.1037/h0041920 (1957).
15. Rudel, R.G. Transposition of response to size in children. *Journal of Comparative and Physiological Psychology*. **51** (3), 386–390, doi: 10.1037/h0049331 (1958).
16. Zeiler, M.D. Transposition in adults with simultaneous and successive stimulus presentation. *Journal of Experimental Psychology*. **68** (1), 103–107, doi: 10.1037/h0046082 (1964).
17. Alberts, E., Ehrenfreund, D. Transposition in children as a function of age. *Journal of Experimental Psychology*. **41** (1), 30–38, doi: 10.1037/h0060291 (1951).
18. Johnson, R.C., Zara, R.C. Relational learning in young children. *Journal of Comparative and Physiological Psychology*. **53** (6), 594–597, doi: 10.1037/h0042545 (1960).
19. Lazareva, O.F., Miner, M., Wasserman, E.A., Young, M.E. Multiple-pair training enhances transposition in pigeons. *Learning & Behavior*. **36** (3), 174–187, doi: https://doi.org/10.3758/LB.36.3.174 (2008).
20. Marsh, G. Relational learning in the pigeon. *Journal of Comparative and Physiological Psychology*. **64** (3), 519–521, doi: 10.1037/h0025210 (1967).
21. Pushkina, A.G. Mechanisms of Transposition of Relations in Preschool-Age Children. *Soviet Psychology*. **9** (3), 213–234, doi: 10.2753/RPO1061-04050903213 (1971).
22. Jackson, T.A., Dominguez, K. Studies in the transposition of learning by children: II. Relative vs. absolute choice with multi-dimensional stimuli. *Journal of Experimental Psychology*. **24** (6), 630–639, doi: 10.1037/h0060958 (1939).
23. Jackson, T.A., Jerome, E. Studies in the transposition of learning by children: IV. A preliminary study of patternedness in discrimination learning. *Journal of Experimental Psychology*. **26** (4), 432–439, doi: 10.1037/h0060903 (1940).
24. McKee, J.P., Riley, D.A. Auditory Transposition in Six-Year-Old Children. *Child Development*. **33** (2), 469, doi: 10.2307/1126459 (1962).
25. Riley, D.A. Experiments on the development of pitch and loudness as psychological dimensions. *Anthropology & Medicine*. **13** (5), 312–318 (1965).
26. Jackson, T.A. Studies In The Transposition Of Learning By Children: III. Transpositional Response As A Function Of The Number Of Transposed Dimensions. Jo*urnal of Experimental*

Psychology. **25** (1), 116–124 (1939).

27. Lawrence, D.H., Derivera, J. Evidence for relational transposition. *Journal of Comparative and Physiological Psychology*. **47** (6), 465 (1954).

28. Derenne, A., Garnett, A.M. Effects of Successive and Simultaneous Stimulus Presentations on Absolute and Relational Stimulus Control in Adult Humans. *The Psychological Record*. **66** (1), 165–175, doi: 10.1007/s40732-015-0161-0 (2016).

29. Stevenson, H.W., Iscoe, I., McConnell, C. A developmental study of transposition. *Journal of Experimental Psychology*. **49** (4), 278–280, doi: 10.1037/h0043491 (1955).

30. Yamazaki, Y. Transposition and its generalization in common marmosets. *Journal of Experimental Psychology: Animal Learning and Cognition*. doi: 10.1037/xan0000027 (20140505).

31. Kroupin, I., Carey, S. Population differences in performance on Relational Match to Sample (RMTS) sometimes reflect differences in inductive biases alone. *Current Opinion in Behavioral Sciences*. **37**, 75–83, doi: 10.1016/j.cobeha.2020.11.006 (2021).

32. Wasserman, E.A., Young, M.E., Castro, L. Mechanisms of same–different conceptualization: entropy happens! *Current Opinion in Behavioral Sciences*. **37**, 19–28, doi: 10.1016/j.cobeha.2020.06.001 (2021).

33. Kotovsky, L., Gentner, D. Comparison and Categorization in the Development of Relational Similarity. *Child Development*. **67** (6), 2797–2822, doi: https://doi.org/10.1111/j.1467-8624.1996.tb01889.x (1996).

34. Gibson, E.J. *Principles of perceptual learning and development*. Appleton-Century-Crofts. East Norwalk, CT, US. (1969).

35. Lombardo, T.J. *The Reciprocity of Perceiver and Environment: The Evolution of James J. Gibson's Ecological Psychology*. Routledge. (2017).

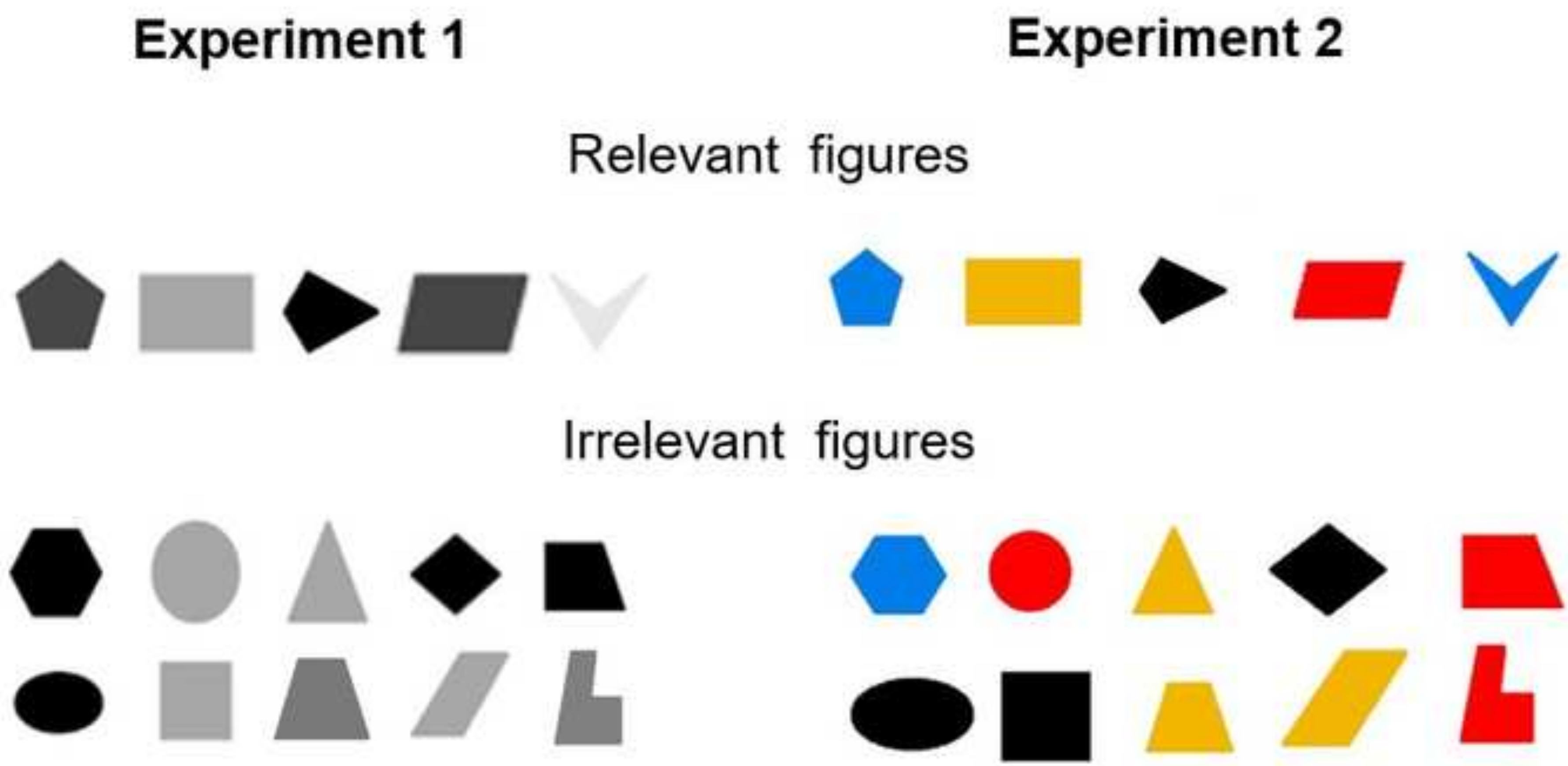
36. Turvey, M.T. *Lectures on Perception: An Ecological Perspective*. Routledge. (2018).

37. Gibson, J.J. *The Ecological Approach to Visual Perception: Classic Edition*. Psychology Press. (2014).

38. Gibson, J.J. A theory of direct visual perception. *Vision and mind: selected readings in the philosophy of perception* (2002).

39. Zinchenko, V.P., Chzhi-tsin, V., Tarakanov, V.V. The Formation and Development of Perceptual Activity. *Soviet Psychology and Psychiatry*. **2** (1), 3–12, doi: 10.2753/RPO1061-040502013 (1963).

Example of relevant and irrelevant figures used as stimulus objects (SOs) in each experiment.



Screens showing a comparison trial in Experiment 1 and 2. In the upper left zone are located the sample relational compounds (SRC), in the bottom left zone the boxes to

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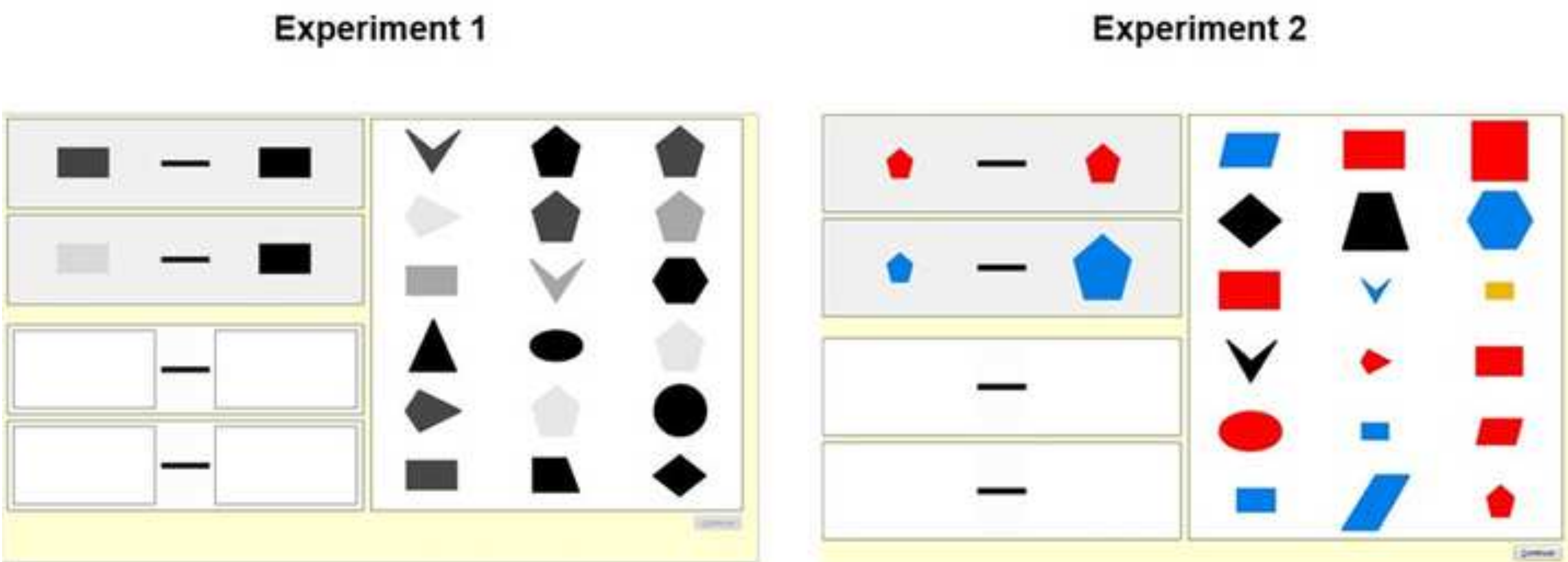
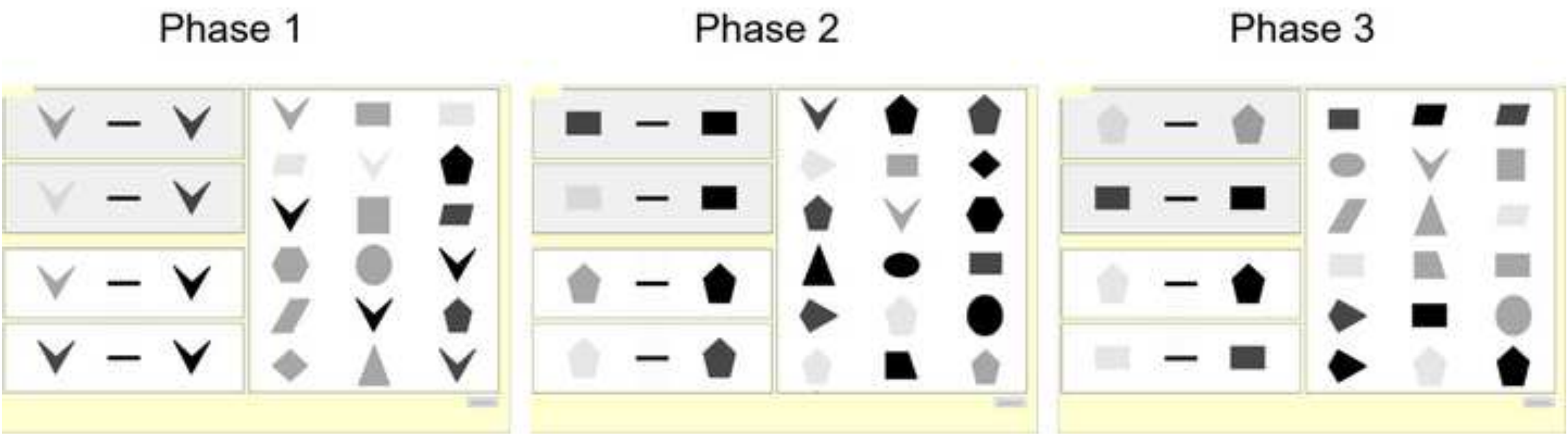


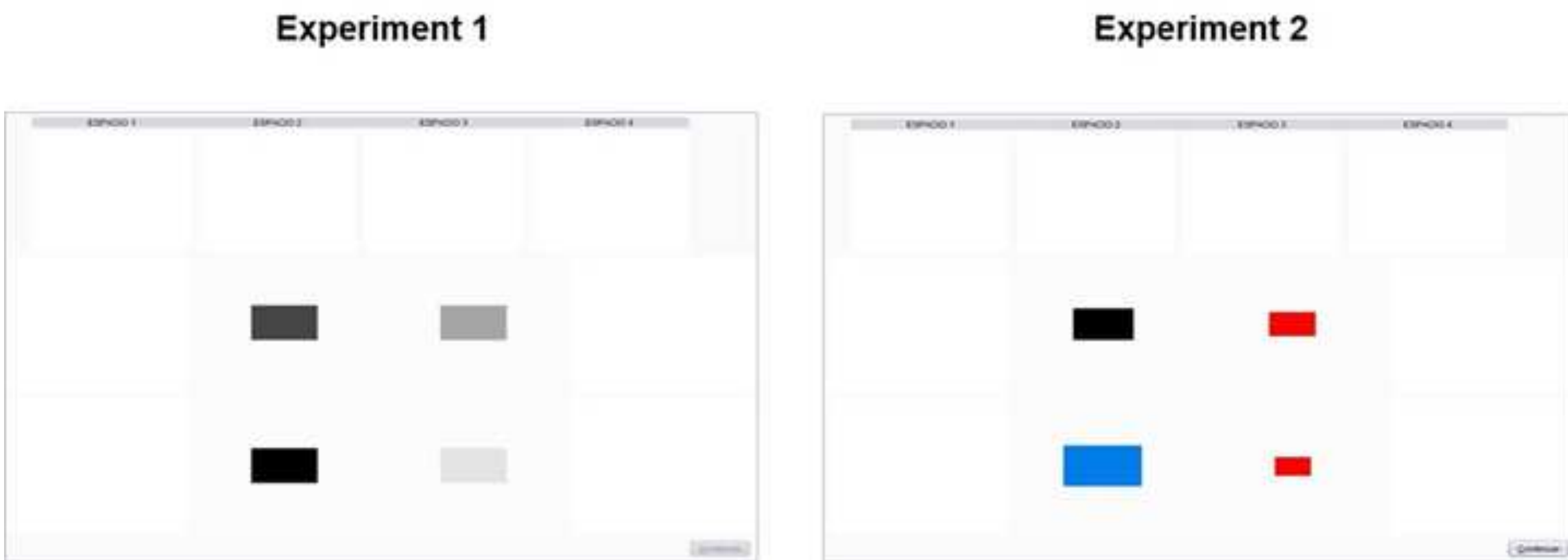
Examples of screens of each relationship criteria in the three phases of the Experiment 1.

Click here to access/download;Figure;Figure 3.jpg



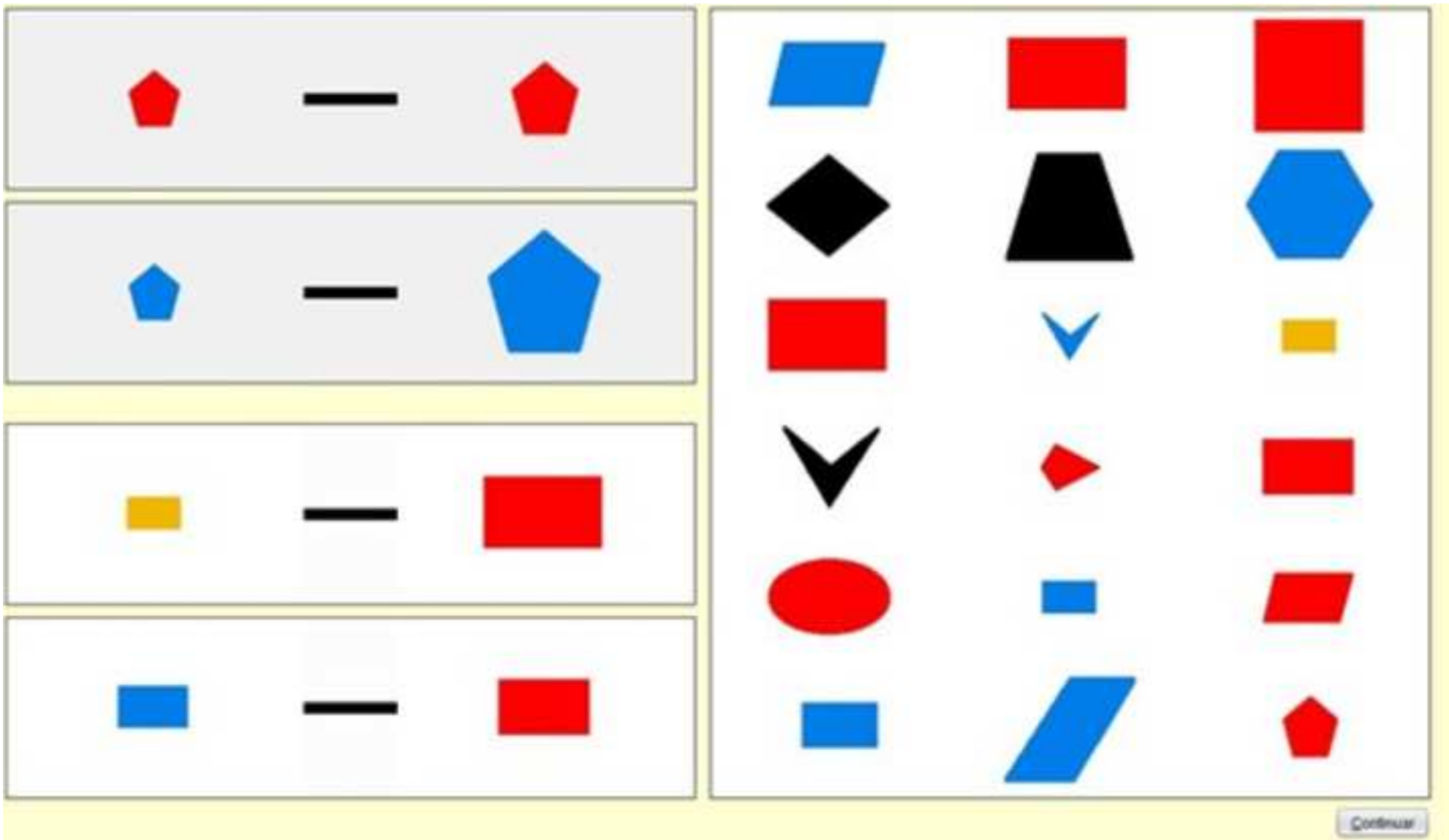
Examples of screen in ordering task in Experiment 1 and 2. In the upper zone are the empty spaces to order the figures shown in the lower zone.

Click here to access/download;Figure;Figure 4.jpg



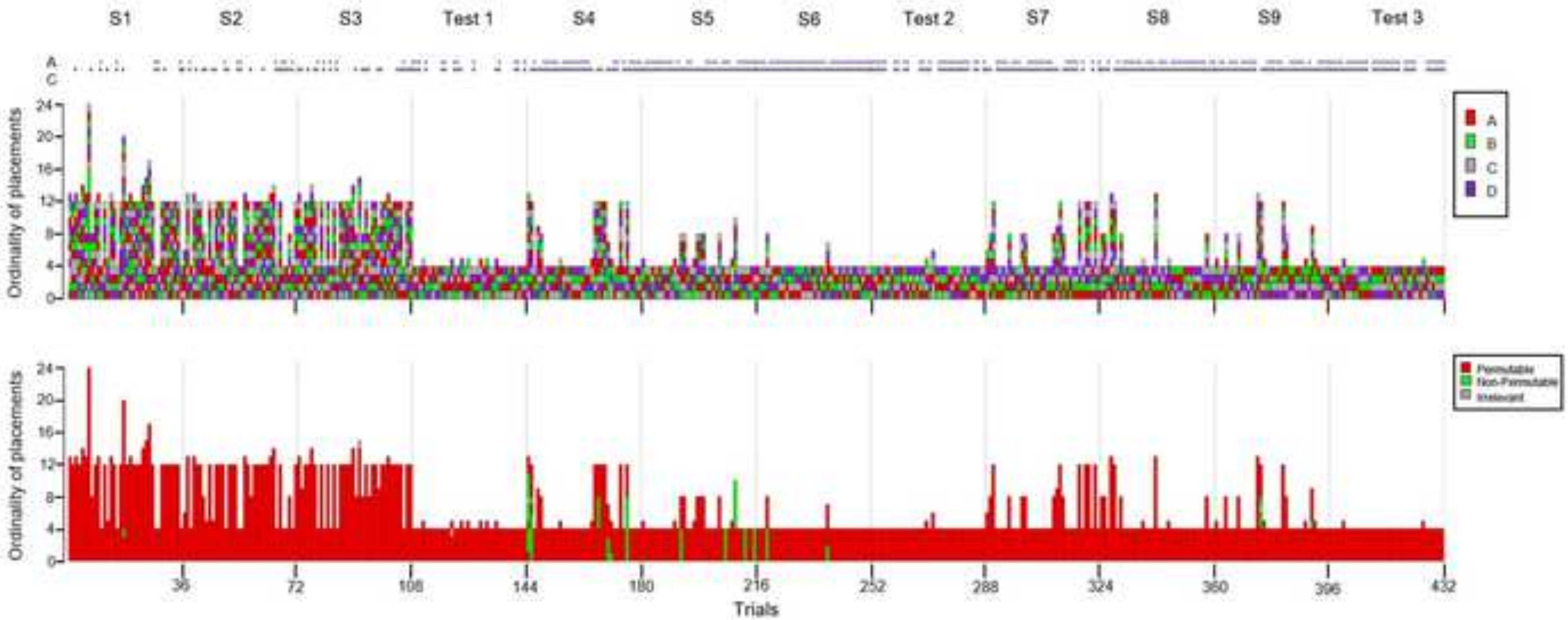
Example of a screen of relationship criteria in the four sessions of the Experiment 2.

Click here to access/download;Figure;Figure 5.jpg



Behavioral continuum of Participant 1 (P1) of Experiment 1. First panel shows sequences of placement in the CRCs, each color represents one position in the four

Click here to access/download;Figure;Figure 6.jpg



Behavioral continuum of Participant 2 (P2) of Experiment 1. First panel shows sequences of placement in the CRCs, each color represents one position in the four

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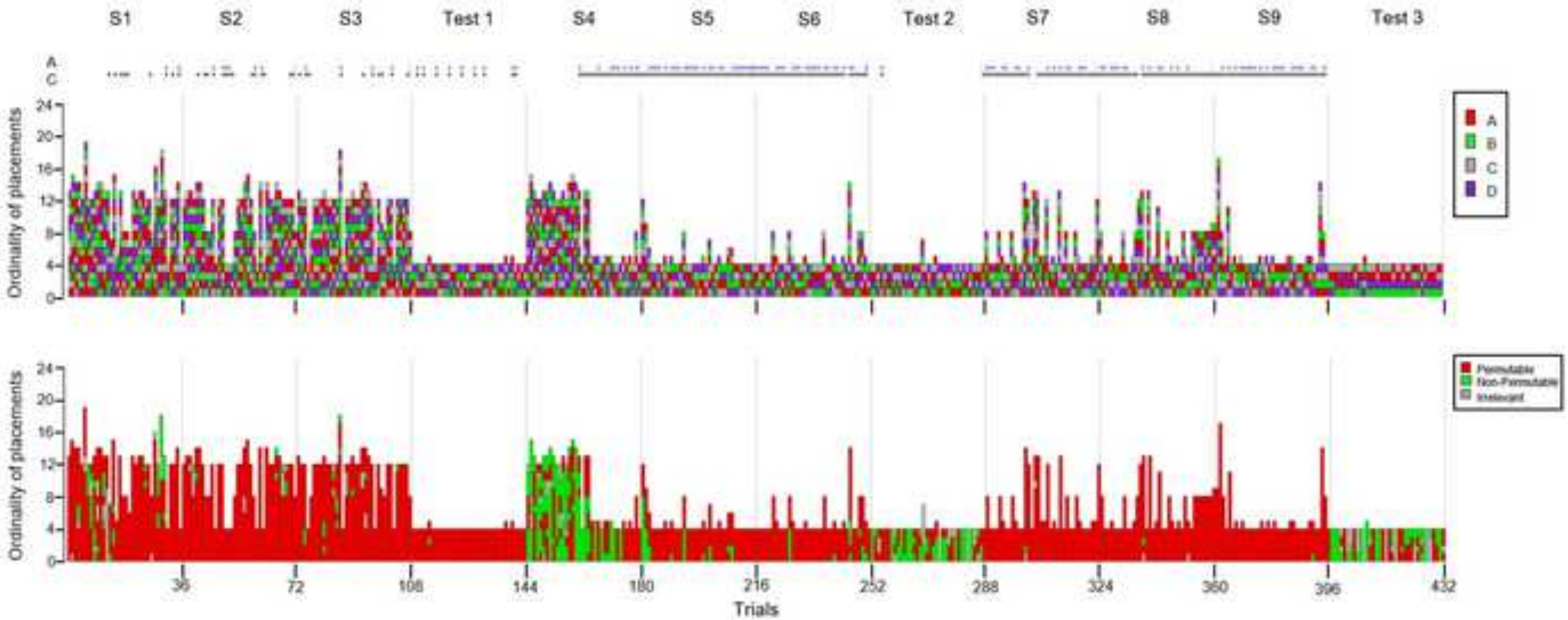
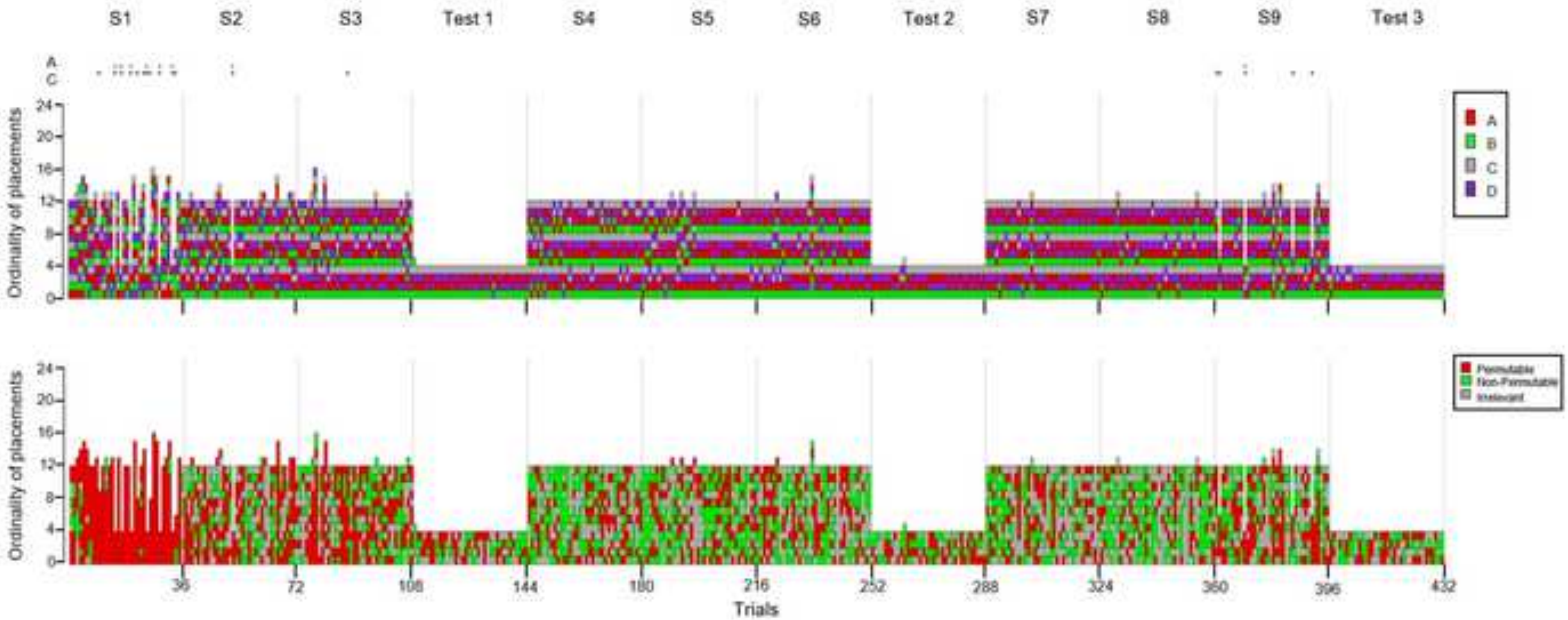
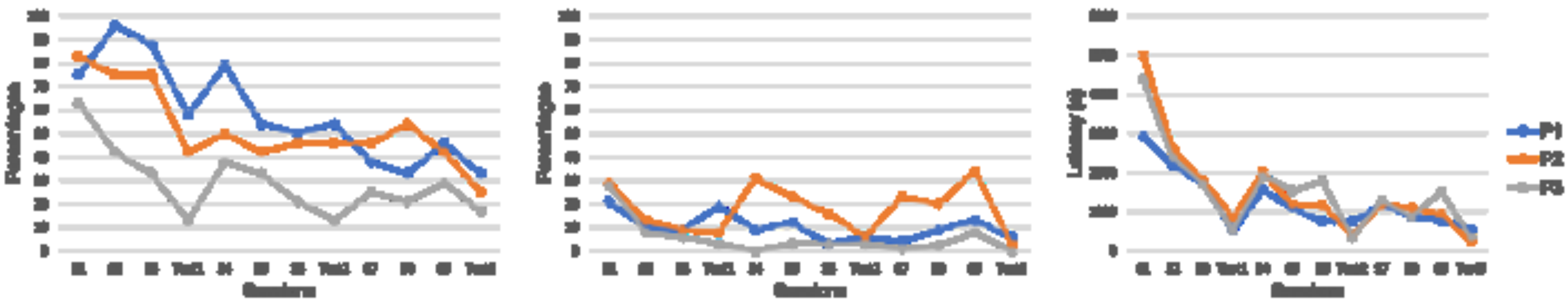


Behavioral continuum of Participant 3 (P3) of Experiment 1. First panel shows sequences of placement in the CRCs, each color represents one position in the four



Left panel shows percentages of variety of sequences involving only four placements.
Middle panel shows percentages of exceeding placements. Right panel shows latency



Behavioral continuum of Participant 1 (P1) of Experiment 2. First panel shows sequences of placement in the CRCs, each color represents one position in the four

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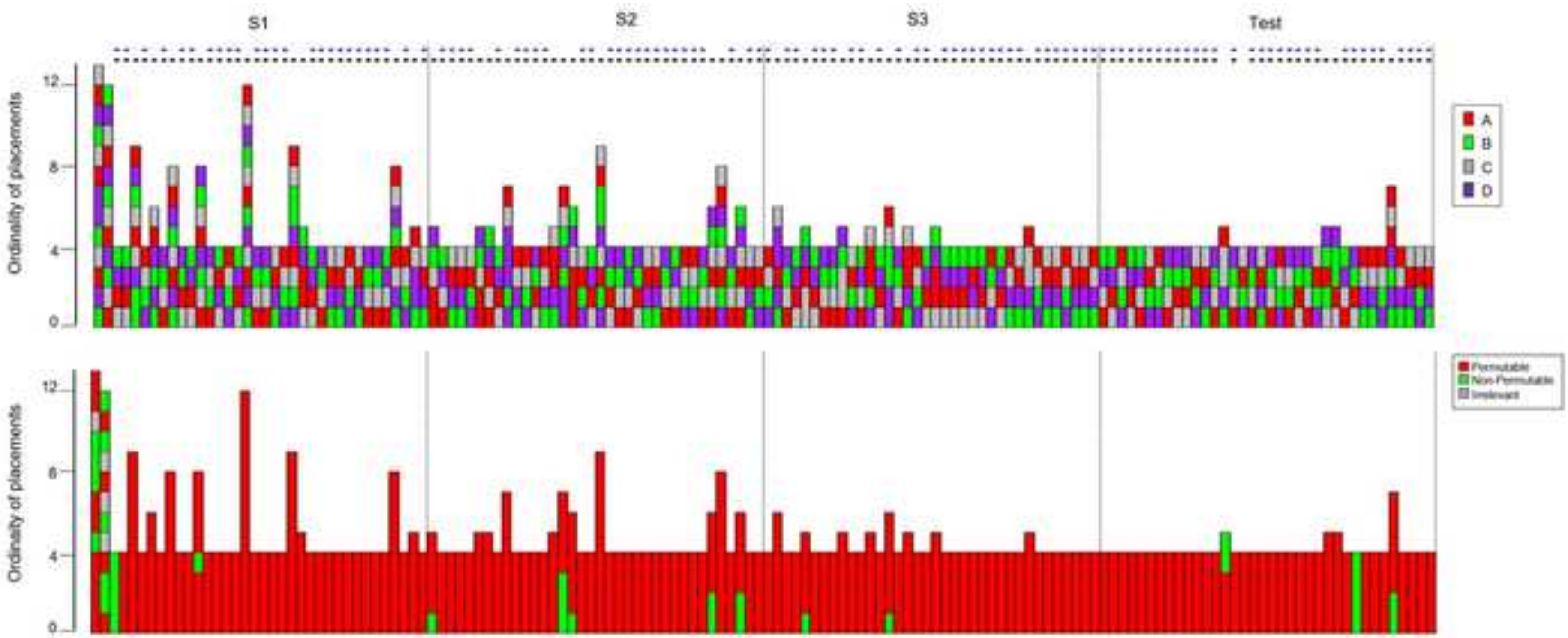

Behavioral continuum of Participant 2 (P2) of Experiment 2. First panel shows sequences of placement in the CRCs, each color represents one position in the four

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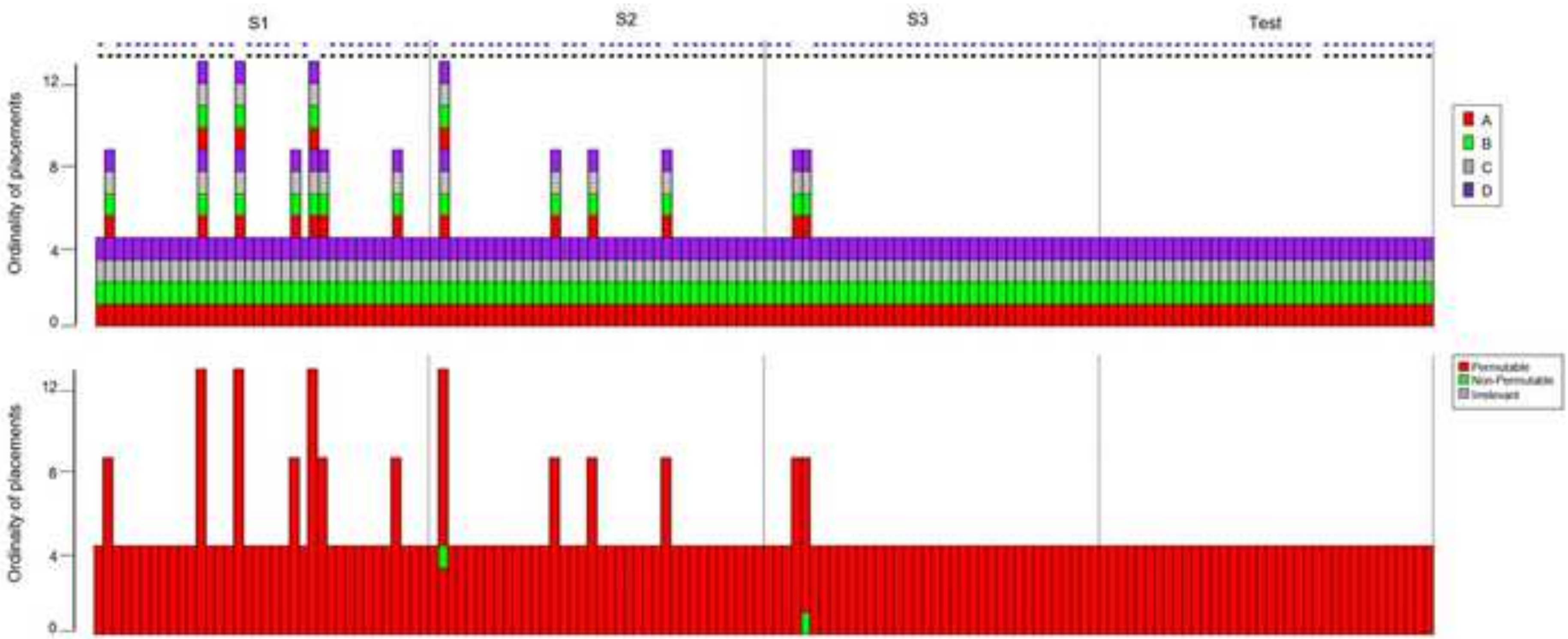
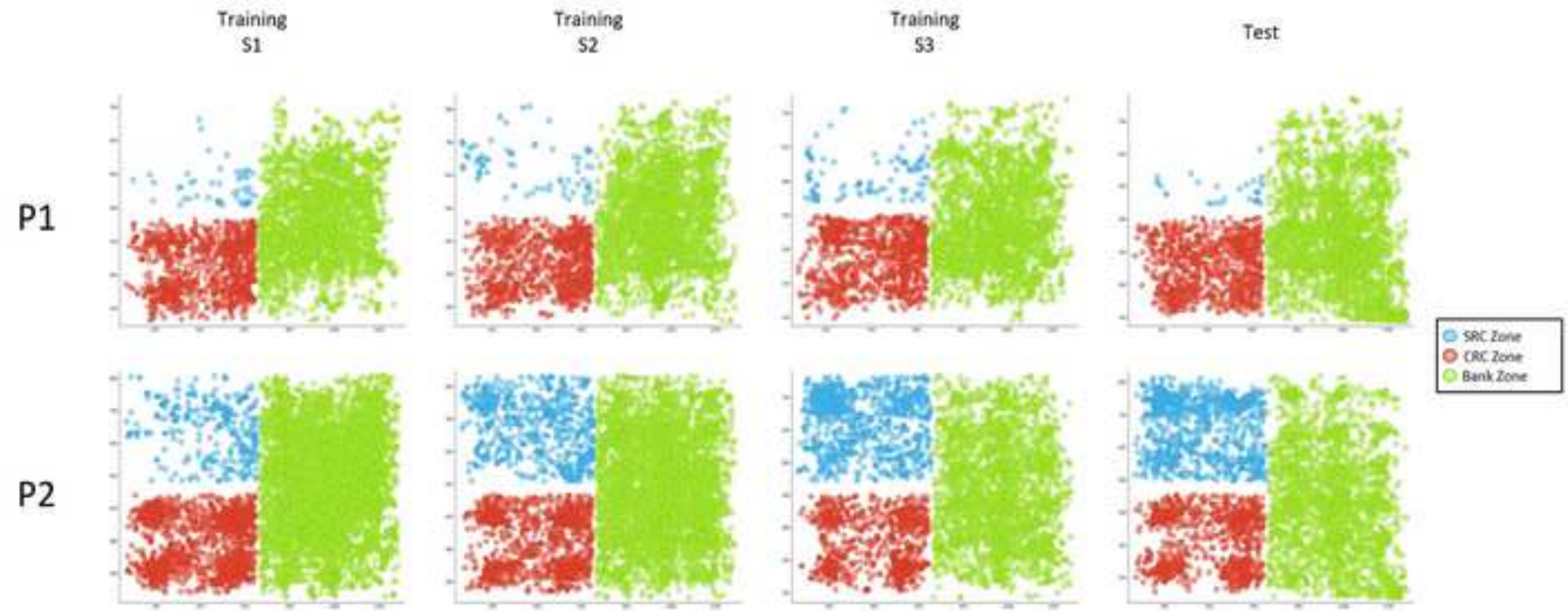
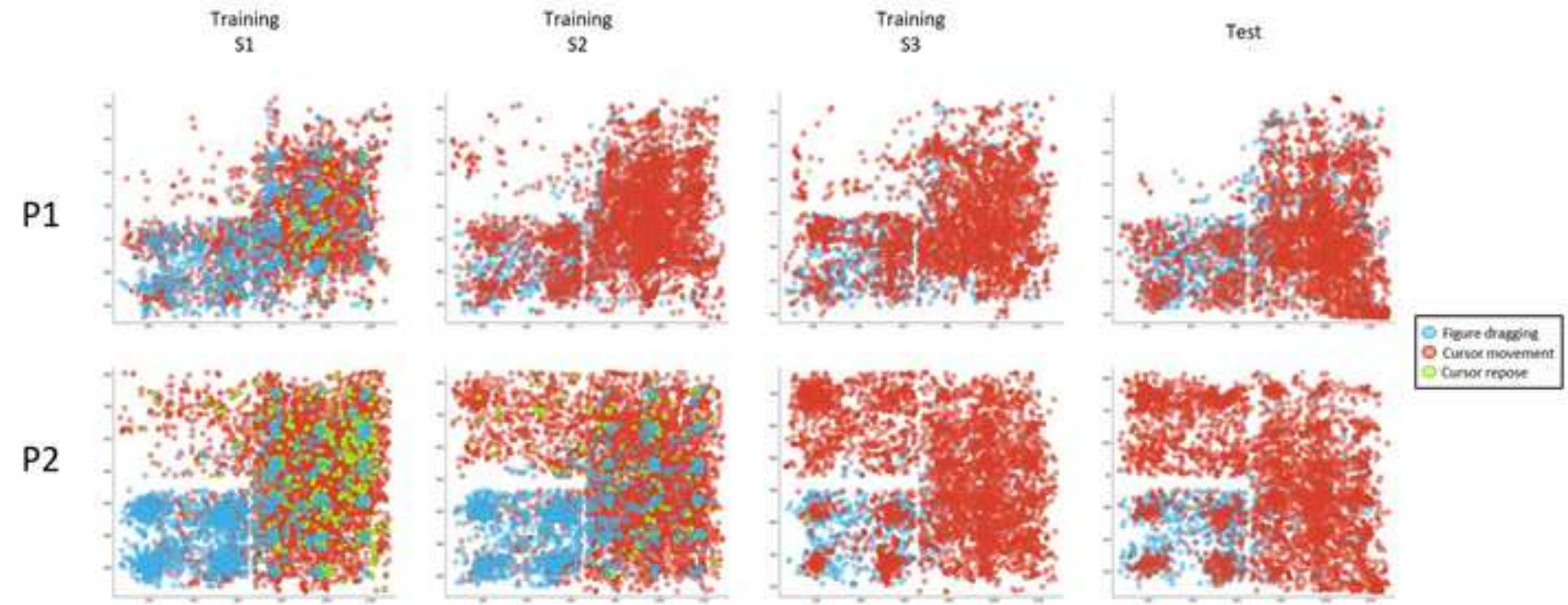


Shows the position of cursor in the screen throughout the Experiment 2. Each row corresponds to each participant (P1 in unrestricted condition, and P2 in restricted

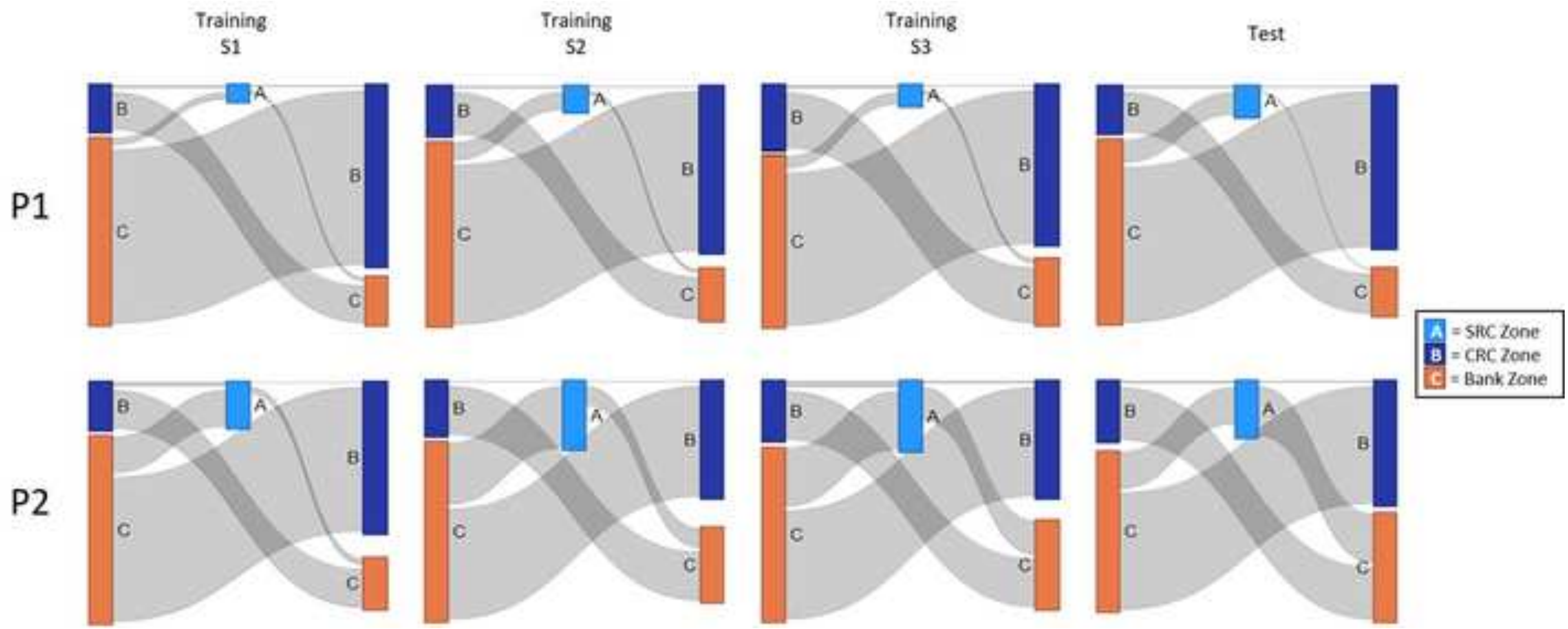


Shows the patterns of figure dragging, cursor movement and repose throughout the Experiment 2. Each row corresponds to each participant (P1 in unrestricted condition,



Shows the transitions between zones in the Experiment 2. Each row corresponds to each participant (P1 in unrestricted condition, and P2 in restricted condition), each

Click here to access/download;Figure;Figure 14.jpg



Latency in seconds between placements of two participants of Experiment 2. Training (S1 to S9) and test (1 to 3) sessions are shown on the horizontal axis and seconds on

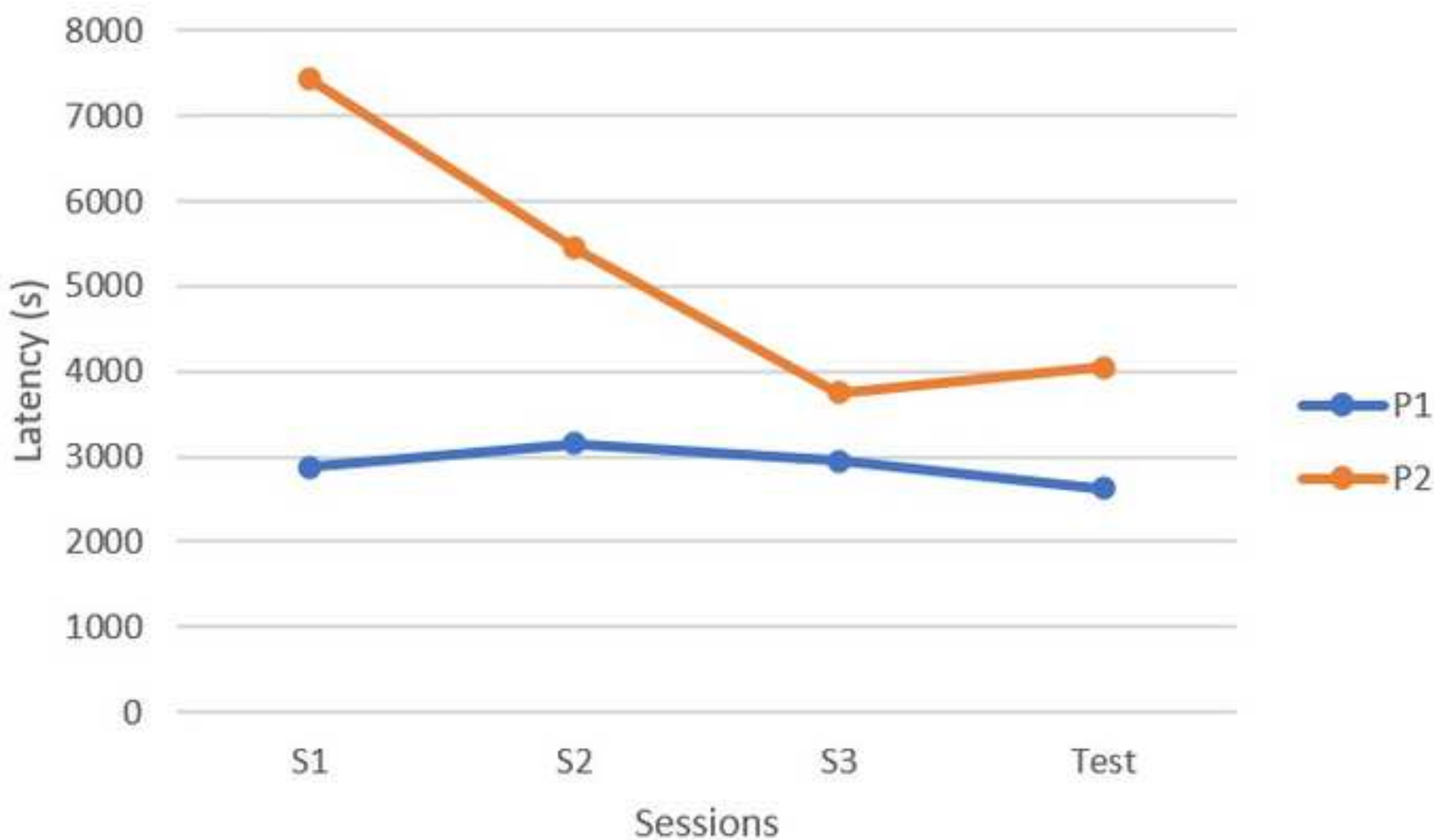


Table 1. Design of Experiment 1.

Table 1. Design of Experiment 1				
Phase 1		Phase 2		Pha
S1 to S3	Test 1	S4 to S6	Test 2	S7 to S9
Similar stimulus objects		Different stimulus objects		Different stimulus (

se 3
Test 3
objects in each CRC

Table 2. Design of Experiment 2.

Table 2. Design of Experiment 2

Sub-Experiments		
P1 No restriction of placement sequences and excessive placements P2 Restriction of placements sequences and restriction of excessive placements	Training	Test

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Table of Materials
JoVE_Table_of_Materials.xlsx

Universidad Veracruzana

Centro de Estudios e Investigaciones en Conocimiento y Aprendizaje Humano

May 19, 2021.

Dear Dr. Kyle Jewhurst

Science Editor

Journal of Visualized Experiments

Dear Dr. Nam Nguyen

Manager of Review

Journal of Visualized Experiments

Thank you for reviewing our manuscript “RBDT: A computerized task system based in transposition for the continuous analysis of relational behavior dynamics in humans”. We have carefully read your suggestions. We tried to attend all the suggestions and made changes based on them. Without a doubt, the editorial comments allowed us to improve the quality of our manuscript. We attached a file with the relation of adjustments, changes, and responses to the comments.

Again, we thank you for your appreciated comments and kindness.

Sincerely,

Alejandro León, Diana Andrade, Varsovia Hernández, Daniel Hernández, Juan Gutiérrez, Fernando Rechy, & Nancy Domínguez.

Editorial comments:

Written Manuscript

1. Some text in the written manuscript must be revised to avoid text overlap with previous publications. Please see the comments in the attached manuscript.

R: We revised to avoid text overlap.

2. Please provide the figure legends as text in the written manuscript after the representative results.

R: We provide the figure legends as text after the representative results.