Linguistic Mediation of Perceptual Adjustment in University Students

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Original Article

Abstract

Students from different areas of academic training (Psychology vs. Optometry) completed a task in which they had to locate a "lost moving target" in a simulated forest on a computer screen. The effects of three independent variables were assessed: a) the type of trajectory of the moving target (regular and irregular), b) the time elapsed since the loss of visual contact with the moving target (delays of 1, 4 and 6 seconds), and c) administration / non administration of verbal consequences for localization responses. Results indicated that accuracy in localization responses was higher on 1) regular trajectories, 2) shortest delays, 3) verbal consequences condition, and 4) Optometry students. Findings are discussed in terms of the parameters of the task. Contributions of the academic training of the participants are discussed as a linguistic scenario in which differential modes of the contact with the environment's mediation are learned.

Keywords:
perception, mobile trajectories, linguistic mediation, university students.

Resumen

Mediación lingüística del ajuste perceptual en estudiantes universitarios. En una tarea en la que estudiantes universitarios de diferentes áreas de capacitación académica (Psicología vs. Optometría) tuvieron que ubicar un "móvil perdido" en un bosque simulado en una pantalla de computadora, se evaluaron los efectos de tres variables independientes: a) el tipo de trayectoria del móvil (regulares e irregulares), b) el tiempo transcurrido desde la pérdida del contacto visual con el móvil (demoras de 1, 4 y 6 segundos), y c) administración/no administración de consecuencias verbales para la respuesta de localización. Los resultados muestran que la precisión de la respuesta de localización fue mayor en: 1) trayectorias regulares, 2) retrasos más cortos, 3) condición de consecuencias verbales y 4) estudiantes de Optometría. Se propone una explicación basada en los parámetros de la tarea y se discute la contribución del área de capacitación como escenario lingüístico en que se aprenden modos diferenciales de mediación del contacto con el medio.

Palabras clave:
percepción, trayectorias móviles, mediación lingüística, estudiantes universitarios.

Introduction

The behavioral adjustment of organisms (human and non-human) to a moving object based on the trajectory of its movement has been frequently described as trajectory perception or movement perception. One of the most representative examples of this adjustment in humans is the interception of a ball in sports such as football, volleyball, or baseball. Animals display this type of perception when hunting and catching moving prey (Bartley, 1969; Roca, 1995; Sillero, 2002). The present study was designed in order to evaluate the effects of three independent variables: a) the type of trajectory of the moving target (regular and irregular), b) the time elapsed since the loss of visual contact with the moving target (delays of 1, 4 and 6 seconds), and c)

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administration / non administration of verbal consequences for localization responses on university students, using a lost moving target task.

Some psychological theories have described this behavioral adjustment as a result of internal cognitive processes, such as perception, anticipation or reckoning. For instance, Barber and Legge (2017) said: "Perception is about receiving, selecting, acquiring, transforming and organizing the information supplied through our senses. It is about vision, hearing, smell, taste, touch and more" (p.7). Alternatively, other researchers have considered that these concepts merely describe the adjustment, but they didn't explain how (see Ribes, 1990a,1990b). Furthermore, they claim that the explanation must be sought in the circumstances in which the adjustment occurs, in addition to the biological and behavioral capabilities developed throughout each individual's experience (Roca, 1991, 2001).

Consistent with Roca's proposal (Roca, 1991, 1995, 2004), several studies have provided evidence about some factors influencing adjustment accuracy to moving objects (e.g., Ventura, 2004; Ventura & Roca, 1998). These factors can be classified into situational factors (e.g., moving object's speed, size, regularity of the trajectory, presence of other potentially distracting objects, contrast between object and background, distance between the organism and the object, etc.), organismic factors (e.g., the relevant senses involved in the situation, age, health status, drug effects, special conditions of feeding and sleeping deprivation), and historical factors (e.g., familiarity with the situation, previous training of the required interception skills, earlier exposure to similar situations, etc.). These factors concur in every interactive episode between an individual and a moving object, however, the preeminence each one has can be specific for each episode (Kantor & Smith, 1975; Ribes & López, 1985).

The aforementioned factors intervene in both, human and non-human animal's behavioral adjustment, however, in the former, an additional element can be identified: the availability of a conventional reaction system (i.e., language). Thus, human performance on perception tasks can be partially independent from situational parameters and can be based on elements that are linguistically introduced as functional modifiers of the situation (Baron & Galizio, 1983; Vygotsky, 1978, 1986). These linguistic elements can be introduced by other people (as instructions, warnings, threats, suggestions, feedback, etc.) or by the individual himself or herself (as speculations, assumptions, calculations, plans, etc.). They can be introduced either explicitly (if they are audible or visible), or implicitly (if they are invisible or inaudible to others). That´s why human situational perception, like any other type of human behavioral adjustment, can be regulated by extra-situational factors linguistically introduced by the person or by others when interacting with objects and events in every specific situation (see Kantor, 1977; Ribes & López, 1985).

Furthermore, linguistic reaction systems are not innate nor can their development in individuals be attributed to their mere biological constitution as human beings. These reaction systems must be developed through the daily contact with people in the groups in which individuals learn all forms of socially relevant behavior, that is, the social groups in which formal and informal educational processes are carried out (Vygotsky, 1978, 1986).

School, as an educational institution, represents an interactive circumstance where the learning of complex forms of linguistic interactions are planned. This is because schooling entails the use of highly specialized abstract and symbolic systems for the description and explanation of reality segments abstracted as an object of disciplinary study (Sánchez, 2014). At school, students learn to interact with objects and events through the *conceptual lenses* provided by the paradigmatic disciplinary structures, as a linguistic instrument (Fortes & Larissa, 1994; Hanson, 1977).

Hanson (1977) quoted Pierre Duhem´s work (1914) as clearly showing the regulatory role of language in adult´s perception, particularly the scientific language of a theory:

Enter a laboratory, approach the table crowded with an assortment of apparatus, an electric cell, silk-covered copper wire, small cups of mercury, spool, a mirror mounted on an iron bar; the experimenter is inserting into small openings the metal ends of ebony-handed pins; the iron oscillates, the mirror attached to it throws a luminous band upon a celluloid scale; the forward-back motion of this spot enables the physicist to observe the minute oscillations of the iron bar. But ask him

what he is doing. Will he answer: 'I am studying the oscillations of an iron bar which carries a mirror'? No, he will say that he is measuring the electric resistance of the spools. If you are astonished, if you ask him what his words mean, what relation they have with the phenomena he has been observing and which you have noted at the same time as he, he will answer that your question requires a long explanation and that you should take a course in electricity (p. 13).

Even though this quote illustrates that basic electricity knowledge is needed to "see" the resistance of the spools and to understand what the expression "minimum oscillations of an iron bar" means; the argument of linguistically mediated perception can easily be extended toother human scenarios, even those that seem to be simpler, such as *trajectory perception*. Thus, it is reasonable to suppose that with equal organismic and situational conditions, people with different linguistic mediation histories procured by the theoretical instruments acquired as part of their education in different disciplines, could have different adjustments to the same moving object. That would mean that performance should be better or worse depending on the "functional closeness" between the specific perceptual task and the academic background of participants.

The most common tasks in the study of trajectory perception in humans include procedures in which an object is thrown, usually a ball, and participants are asked to intercept it (i.e., intercept tasks), or to indicate its estimated point of arrival (i.e., anticipation tasks). Using these procedures, improvements in precision of perception and anticipation have been documented as a product of age (between 9 and 18 years), of practicing sports where balls are used (e.g., football, baseball), of larger objects being used, of profusely illuminating the testing room and of a higher contrast between background and the moving object (see Abernethy & Zawi, 2007; Dunham, 1977; Granda et al., 2006; Mann, Williams, Ward, & Janelle, 2007; Oudejans, Michaels, & Bakker, 1997; Savelsbergh, Van der Kamp, Williams, & Ward, 2005; Savelsbergh, Williams, Van der Kamp, & Ward, 2002; Sillero, 2002; Sillero & Rojo, 2001; Starkes, 1987; Vaeyens, Lenoir, Williams, Mazyl, & Philippaerts, 2007; Vaeyens, Lenoir, Williams, & Philippaerts,

2007). A relevant feature of these tasks is that participants always maintain visual contact with the object since it starts moving and until their response is emitted (either intercept or anticipation response). These tasks have, therefore, a "projective" or "anticipatory" quality because in both cases participants interact with the place where the object will be a moment later given its trajectory, but always with the present object serving as a sort of "auxiliary stimulus". Procedures in which the response must be emitted in the absence of visual contact with the moving object (e.g., finding a "lost moving target" tasks) represent a different situation because the participant must adjust to the situation in a "retrospective" way, without the aid provided by being able to see the moving target, that is, the response must be based on what happened before and not on what is happening now. Introducing a period of time during which the moving target cannot be seen would be a critical feature of such a task. This would force participants to establish an indirect contact with the object. Suppose that a target moves across the computer screen following a regular trajectory (i.e., straight line) in a single direction (i.e., left-to-right) and at a constant speed (i.e., 1cm/sec). Now suppose that halfway through its travel, the target becomes invisible, and 5 seconds later, a participant is asked to point in the screen where does she/he think the target should be. This participant cannot establish a direct contact with the target (she/he cannot see it), and this necessarily raises the question: What is the participant responding to?

Accordingly to Kantor (1977), the auxiliary stimulus function in interactions such as finding lost moving target is carried out by the linguistic components that the participant incorporates into the situation either explicitly (e.g., talking out loud or writing) or implicitly (e.g., thinking in silence); these linguistic components operate as mediators (i.e., modifiers or regulators) of present elements functions. These forms of linguistic behavior could be crucial for the response of our abovementioned hypothetical participant.

The linguistic components that people may incorporate into this kind of task depend on their specific personal experience and the degree in which they can be considered competent users of conventional communication systems, such as ordinary language or formal systems, such as the

technical languages (models, concepts, theories) that are learned in formal educational contexts. If the previous conjecture is correct, it could be supposed that people who have learned to "see" under different conceptual systems might perform differently in trajectory perception tasks, especially in those with no visual contact with the moving target, since the linguistic mediation provided by such systems would be different in each case. Another element that is usual in experimental situations are the consequences given to the participants, which are conceptualized frequently as "information", "feedback" or "reinforcement", whose effects are assumed independent of people's development and their linguistic abilities. This interpretation is opposite to the one derived from Kantor (1977) and Ribes and Lopez's (1985) approaches, who proposed that such consequences, in fact, interact with the particular history of each individual, producing different effects on each of them.

Assuming, along with other authors (Carpio & Irigoyen, 2005; Carpio, Pacheco, Flores, & Canales, 1999), that the learning of formal conceptual systems happens in a systematic and planned way during college education, the present study compared the performance of college students that were majoring in Optometry versus students without that kind of knowledge (Psychology major). With this aim, we designed a task in which participants saw an image of Little Red Riding Hood displacing into a forest and disappearing once having reached it; then, after a certain delay (1, 4 or 6 seconds) the participant was asked to use the computer mouse to click on the place in the forest where she/he thought Little Red Riding Hood should be. Different visible trajectories were used for each of the delay values. Half of the students were told whether their location response was correct or incorrect. Precision in the location response was measured as a variable of performance.

Therefore, if Carpio et al. (1999), and Carpio and Irigoyen's (2005) approaches are correct, one could expect greater precision in the optometry students' localization responses because of their conceptual and practical familiarity with mobile trajectories. Furthermore, one can expect that verbal consequences will favor precision, especially, in such students, independent of the mobile's particular trajectory.

Methods

Participants

36 students whose ages ranged from 20 to 24 participated voluntarily in the experiment. Eighteen of them were Psychology students (10 female and 8 male), while eighteen were Optometry students (11 female and 7 male). All participants were enrolled in the fourth semester of their respective majors at the School of Graduate Studies Iztacala of the National Autonomous University of Mexico. Psychology students were randomly assigned to one of two groups: 1) Presence of verbal consequences. 2) Absence of verbal consequences. The same procedure was followed for optometry students, thus yielding a total of four groups.

Apparatus

Two laptop computers (HP and TOSHIBA) and two pairs of headphones were used to run an HTML software developed in Java Script language, in which Little Red Riding Hood displaces into a nearby forest with different trajectories and disappearing from the screen when entering the forest. Text boxes were presented to ask questions to the participant (e.g., "click with the mouse over the place where Little Red Riding Hood is"). The software also indicated if the location response was correct or incorrect. The program automatically registered all location responses.

Experimental situation

Experimental sessions took place in two experimental evaluation rooms from the Laboratory for the Analysis of Higher Psychological Processes, each room consisted of a table (1 m long-50 cm wide), a chair, a laptop computer, and a pair of headphones.

Procedure

Participants completed a single 30 trial session, which began with Little Red Riding Hood placed in the upper left corner of the screen called "meadow area", and then moving towards the opposite corner called "the forest area" (see Figure 1). The following message appeared randomly 1, 4 or 6 seconds after Little Red Riding Hood disappeared into the forest (delay of response requirement): "Little Red Riding Hood has stopped right now, click on the place where you think she is".

Figure 1. Initial image in every trial

During each trial, Little Red Riding Hood could move according to one of five different trajectories: four were rectilinear with 0º, -90º, -30º, -40º degrees, the fifth was a vertical zigzag (see Figure 2). Each of these trajectories was randomly used for two trials with each of the delay values (1, 4 and 6 seconds); yielding a total of six trials for each trajectory.

Figure 2. Little red Riding Hood's possible trajectories into the forest

After the message was displayed, participants had to click on the point in the screen where they considered Little Red Riding Hood was. Sessions began when participants sat on a chair facing the computer. Immediately, both, the initial image of the trial and the following message, were displayed:

Thank you very much for participating!
The present task is about learning and is not a psychological test. You can ask to end the session whenever you wish, but if you do so, you will lose all the points you have earned. You will receive $2 (MXN) for each point you get. To start press "CONTINUE"

Once the participant pressed the continue button, the following instructions were displayed:

Little Red Riding Hood is going to visit her grandmother and decides to go through the forest, not knowing that the wolf is lurking there for her. Your job is to find Little Red Riding Hood and save her from the wolf. A message will appear on the screen stating that Little Red Riding Hood has stopped somewhere in the forest, so you must place the mouse cursor and click where you think she is. If you have any questions, this is the time for you to ask them because once the session has started, the researcher will not be able to talk to you. To start press "CONTINUE".

As soon as the participant pressed "continue", the screen shown in Figure 1 appeared. All participants assigned to the NC group did not receive consequences for their location responses (verbal or otherwise), while those assigned to the WC received the following message when their response was correct: "Very good! You have saved Little Red Riding Hood"

If the response was incorrect, the following message was displayed: "Very bad! The wolf has eaten Little Red Riding Hood"

After 30 trials, the following message was displayed: "Thanks for participating. Let the researcher know you have finished and then, you can leave"

The basic performance variable considered in this study was the location response precision, measured in Standardized Error Units (SEU) consisting of areas of the screen with the same size as that occupied by the moving target (Little Red Riding Hood's figure), so that the smaller the distance between the selected point and the actual location of Little Red Riding Hood, the greater the precision. For each participant and condition, a precision index was obtained by dividing the total SEU registered by the total possible maximum SEU, using the equation:

Precision Index=SEU_{to}/SEU_{po}

Where SEU_{to} is the total sum of SEU of all the tests of each condition, and SEU_{po} is the sum of maximum possible SEU in it. Thus, a value of 0.0 indicates total precision while a value of 1.0 indicates absolute imprecision.

Results

The main performance measured in this study was the accuracy index of the location response because it corresponds to the degree of behavioral adjustment of the participants to the trajectory of the moving target. To obtain it, the computer screen was divided into zones with the exact same area of Little Red Riding Hood (60 pixels high by 40 pixels wide), so that the smaller the distance between the selected point and the actual location of Little Red Riding Hood, the greater the accuracy. A correct response was defined as a click on the exact point in which Little Red Riding Hood was, based on her speed and trajectory (i.e., a response with zero SEU). Clicks on any other area were considered incorrect responses and precision in SEU terms was measured.

Figure 3 shows the precision index obtained by each individual participant on each trajectory. Optometry students are represented by continuous lines and psychology students are represented by dashed lines. Left panel shows the data for students who did not receive verbal consequences (NC). On the other hand, right panel shows the data for students who did receive verbal consequences (WC). Figure 4 shows the group average for the same data but averaged per group.
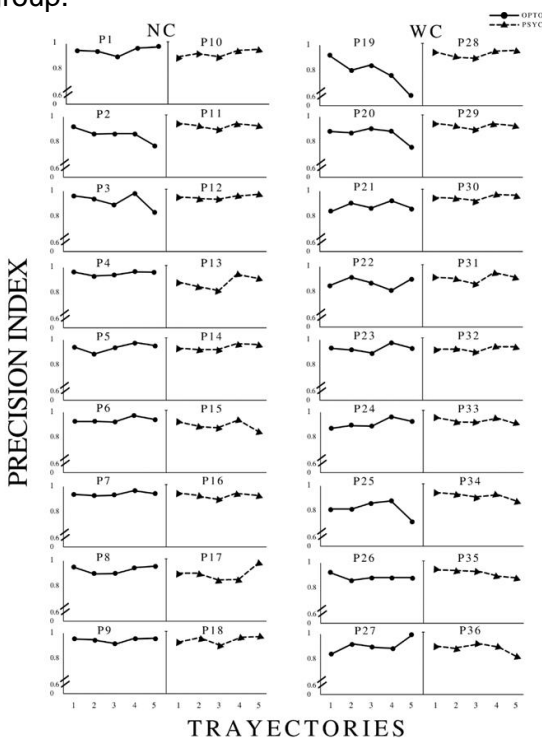

Figure 3. Precision index of each participant location response according to the moving target trajectory
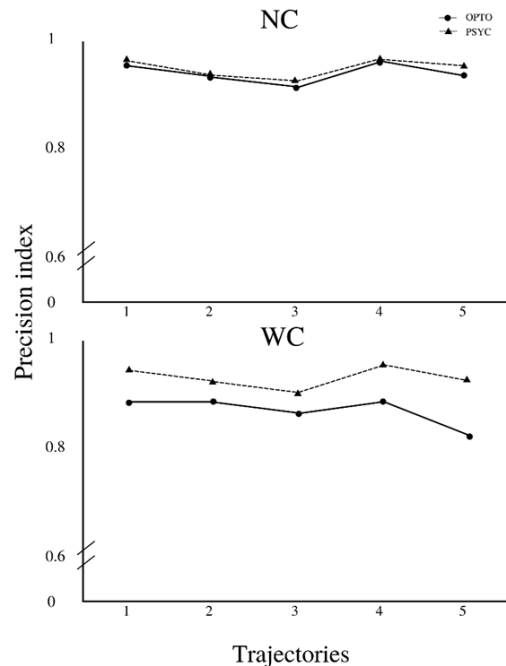

Figure 4. Average precision index of participants location responses according to the moving trajectory

Three findings can be appreciated in both figures: 1) The precision index was higher in trajectory 4 (zig zag) than any other trajectory for students from both majors with and without verbal consequences, which means that precision is lower for this trajectory; 2) This distribution was identical in both, the students who received verbal consequences for their location response and those who did not receive them; 3) Precision was significantly higher in Optometry students who received the verbal consequences in contrast with Psychology students who also received them.

Figure 5 presents the Precision Index as a function of delay since the disappearance of the moving target for both groups and for each trajectory. This plot clearly shows an interaction between the target's trajectory and the delay. Figure 5 shows that precision is systematically higher as the delay increases for trajectories 3 and 5. On the other hand, the same cannot be said about the remaining trajectories, for the effect of delay on precision for these trajectories is not as systematic. Two additional findings can be seen in this plot: 1) Distribution is very similar between the groups with and without verbal consequences; 2) Overall, Optometry students reached more precision when they received consequences in contrast with Psychology students who did not

receive them.

Figure 5. Precision index as a function of delay since the disappearing of the target for each group for each trajectory

Finally, figure 6 shows the average percent of correct responses (SUE = 0) for each group. This plot shows that percent correct responses was always higher for optometry students, and this difference was even bigger when students received verbal consequences.

Figure 6. Average percent correct responses for psychology and optometry students with and without verbal consequences

Discussion

The main purpose of this study was to compare performance of university students trained in different majors (Psychology and Optometry) in a task requiring them to find a "lost" moving target. The situational variables manipulated in the task were the target trajectory before it disappeared, the delay between the target disappearance and the moment in which the location response was required and the presence or absence of verbal consequences presented contingently upon the location response. The performance variable considered was the location response precision measured in Standardized Error Units (SEU) consisting of areas of the screen with the same size as that occupied by the moving target (Little Red Riding Hood's figure).

At the moment of designing the present study, it was hypothesized that each major provided undergraduate students with different skills and knowledge about moving trajectories. This knowledge was thought to be very extensive in case of Optometry students and scarce or null for Psychology students. This difference in training was expected to lead to different types of linguistic mediation of perceptual adjustments, making them more accurate in one case than in the other. Likewise, it was supposed that due to their extensive training in visual perception scenarios, linguistic mediation in Optometry students would reduce the potential negative effects of increasing the delay between the disappearance of the moving target and the opportunity to locate it, and finally, that verbal consequences contingent upon localization responses would have positive effects on the precision of such responses as it would allow to correct or adjust linguistic mediation in each trial, especially in Optometry students.

Our findings partially confirmed the initial expectations. The location response was, in fact, more accurate in Optometry students than in Psychology students, but only when verbal consequences were provided. This finding evidence that verbal consequences could have differential effects on performance depending on the history of linguistic mediation developed by students skilled in each different field. Several operant conditioning studies involving animal subjects have shown that reinforcing properties of any given stimulus are dependent on multiple circumstances, such as motivational states, the
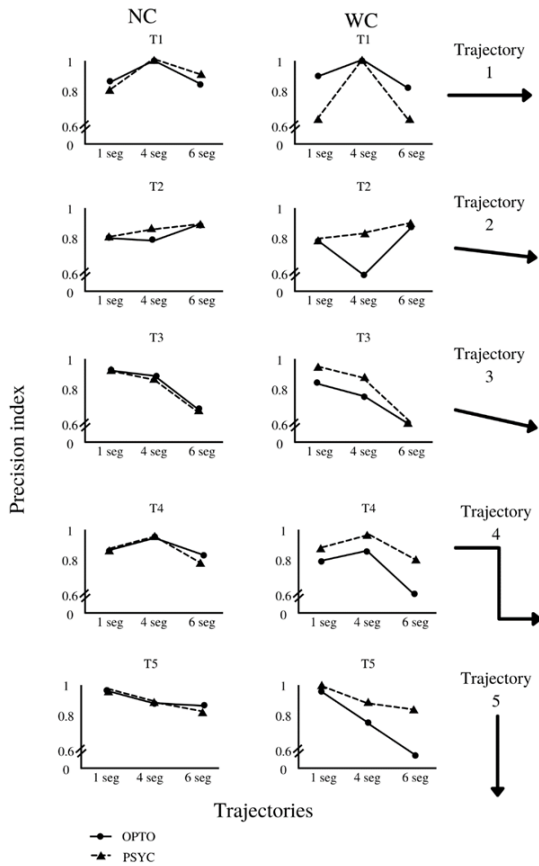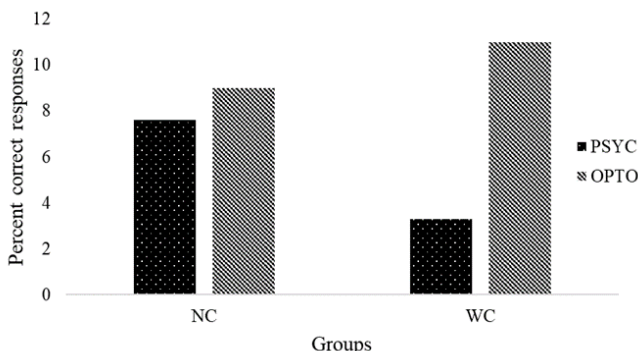
modality of the presented stimuli or the simultaneous availability of other stimuli (see Dunham, 1977; Morse & Kelleher, 1977). Taken together, these studies help preventing the mistake of assuming that stimuli are intrinsically reinforcing. In the same way, our results suggest that assuming that verbal consequences have, in an intrinsic way, "informative" properties, could be a serious mistake. Especially considering that the interactive history and the linguistics domains in which the person who receives verbal consequences is competent can have a modulating effect on the impact that these verbal consequences can have on their performance. In fact, observing that verbal consequences improved the precision of location responses exclusively in Optometry students is evidence that the function of these consequences depends, at least partially, on the mediation history developed in the respective areas of the student's academic education. That is, verbal consequences do not mean the same to each student; therefore, granting them a priori the status of "reinforcers", "informative", "confirmatory of expectations", and so on would be a big mistake. Instead, following Kantor and Smith (1975), Kantor (1977), and Ribes and López (1985), we propose to conceptualize them as setting factors whose function is to modify the subsequent contacts of the individual who receives the consequences with the elements of the task, insisting that the way in which such modification occurs is casuistic and dependent on the characteristics of said individual, such as linguistic domain of the conceptual structures developed during school learning.

On the other hand, precision was lower for all participants on the zig zag trajectory. This finding could be explained by the fact that students might experience an everyday exposure to rectilinear trajectories in urban environments, which could be seen as informal training in the anticipation, interception and location of moving targets in such trajectories. This would mean that performance under non rectilinear trajectories could be hindered due to a lack of experience with them in the student's environment. Shared experience with a geometrically similar environment could also explain why the functions in each plot were so similar between psychology and optometry students: It is reasonable to suppose that both groups have had wide experience with rectilinear trajectories in their urban environments. If this was

true, then it would suggest that differences in performance when "finding" an invisible moving target following different trajectories could be traced to the amount of exposure to similar trajectories and not to them entailing any an intrinsic difficulty; however, this remains a question for future research. This interpretation is consistent with the relevance that some authors like Ames (1951), Edney (1972), Bechtel (1997), Gibson (1979), Ittelson (1978) and Gifford (1987), granted to the history of environment perception, and with Vygotsky's proposal (1978, 1986) about the influence of the physical and social environment over the development of linguistic perception.

The present study lies on the assumption that linguistic mediation of the interaction with the task would hinder the negative effects of increasing the delay between the target disappearance and the opportunity to find it. Delay has a widely reported negative effect on many different operant conditioning tasks, for instance, in delayed matching to sample procedures, the non-human animal's performance progressively worsens as the delay between the sample and comparison stimuli increases (Cumming & Berryman, 1965; Geoffrey, 1985; White, 1985); however, if sample correlated stimuli are introduced during the delay, the detrimental effect is less powerful (Pacheco, Flores, González, Canales, & Carpio, 2005). A similar effect has been reported when the subjects engage in sample correlated behavioral patterns during the delay, which are usually called "mediating" behaviors (Blough, 1959; Santos & Miguel, 2015; Zentall, Hogan, Howard, & Moore, 1978). Unlike animals, humans usually engage in different forms of verbal behavior that seems to reduce the detrimental effects of delay in these tasks (Horne & Lowe, 1996). Phenomena such as "naming" or "self-instruction" are conspicuous examples in the experimental analysis of behavior literature that show that a participant's verbal behavior substantially modifies his/her global performance in this kind of procedures (Baron & Galizio, 1983; Randell & Remington, 2006; Sidman, 1994). Although no restriction was imposed to the possibility of participants adding verbal elements to their performance in this study, it was assumed that, if that occurred, these would be functionally more relevant in Optometry students, due to their education and knowledge about description and adjustment to trajectories. In other words, although linguistic mediation could

happen in all participants, it was assumed that the disruptive effect of delay would be less powerful in optometry students than in psychology students; moreover, our findings support the assumption that the potential effects of the linguistic mediation history acquired through academic education interact with the trajectory characteristics (remember that performance improved with increases in delay only on trajectories 3 and 5, which are geometrically different), and with the verbal consequences administered contingent upon the location response. These overall considerations highlight the fact that academic training does not have a direct and linear effect on performance, but rather interacts with all other variables assessed in this study.

Overall, the present study suggests that accurate performance on a task that requires following the route of a moving target that falls out of sight is not a simple function of the "complexity" of the route or the contingencies of the location response. A complex interaction in which the verbal history of each participant plays an important role was found. For the purposes of this study, we compared students whose academic training involves frequent exposure to visual perception tasks (Optometry) against students without such exposure (Psychology). As expected, our data revealed that the effects of the trajectory complexity, verbal consequences and delay, are not the same in each group of undergraduate students. Of course, more studies could yield further light into the question of whether verbal history can have an effect on human performance in visual perception tasks. More specifically, future studies should attempt to systematically control and assess the contribution of the degree of attention payed by the participants during the task, particularly under longer experimental sessions; studies like these could allow to ascertain whether a significant relation between attention, perception, and linguistic mediation exists. Definitely, comparing changes in attention and precision of the location response under verbal and non-verbal (e.g., sounds, gestures, etc.) consequences could be an important further step in the same direction. An additional variant of the present study could be asking the participants questions about their own performance during the task. Interacting verbally with their own performance could eventually reveal additional factors involved in the regulation of their behavior, such as verbal self-regulation of their

perceptual adjustments.

Finally, the present study did not contrast performance using verbal and nonverbal consequences. Since this fact poses constraints to the reach of our findings, comparing performance under verbal and nonverbal consequences should be added to the list of potential future studies with the aim of drawing stronger conclusions about the linguistic mediation of human perception.

Acknowledgements

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