REVISTA MEXICANA DE ANÁLISIS DE LA CONDUCTA 2009 MONO (SEP)
MEXICAN JOURNAL OF BEHAVIOR ANALYSIS **35**, 31-43 MONO (SEP)

THE CONTINGENCY CONTRAST MODEL: AN EXPLANATORY ALTERNATIVE

EL MODELO DE CONSTRASTE CONTINGENCIAL: UNA ALTERNATIVA ORGANIZATIVA

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ABSTRACT

The present paper is a theoretic proposal in the field of experimental psychology. Its objective is to present the contingency contrast model (CCM) as an explanatory alternative for the study of conditional discrimination learning. The general notion of a model is discussed as well as the epistemic properties which a model must have in order to be a candidate in the set of explanatory models in the field of conditional discrimination. The epistemic properties discussed here are: a) empirical inclusiveness; b) predictability; and c) heuristic capacity, all of which are proven given procedures, effects, and empirical exploration possibilities in the study of conditional discrimination learning. Finally, given this demonstration of the epistemic properties of the CCM it is presented as an explanatory alternative in the field of conditional discrimination.

Key words: *Contingency contrast, conditional discrimination, model, epistemic properties.*

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Recibido: 30 de marzo de 2009. Revisado: 20 de julio de 2009. Aceptado: 27 de julio de 2009

RESUMEN

El presente trabajo constituye una propuesta teórica en el dominio de la psicología experimental. Su objetivo es presentar el Modelo de Contraste Contingencial (MCC) como una alternativa explicativa para el estudio del aprendizaje en discriminación condicional. Se discuten los aspectos genéricos de un modelo teórico, así como algunas de las propiedades epistémicas que un modelo debe poseer para ser un candidato en el conjunto de modelos explicativos en el campo de la discriminación condicional. Las propiedades epistémicas discutidas son: a) inclusividad empírica; b) predictibilidad; y c) capacidad heurística, cada una de las cuales es demostrada a partir de los procedimientos, los efectos y las posibilidades de exploración empírica en el estudio del aprendizaje en discriminación condicional. Finalmente, se concluye con la propuesta de que el MCC es una alternativa explicativa en el área de la discriminación condicional.

Palabras clave: *contraste contingencial, discriminación condicional, modelo, propiedades epistémicos*.

Conditional discrimination learning, as a field of experimental study has generated a vast quantity of evidence accumulated over the last 40 years since Cumming & Berryman (1965) first described the matching-to-sample procedure to study complex learning. Different variables have been used to study such learning phenomenon, some of the most commonly used have been temporal ones such as the duration of the stimuli or the intervals that separate them (Blough, 1959; Grant, 1975; Holt & Shafer, 1973; Jones & White, 1994; Mazur, 2000; Nelson & Wasserman, 1978; Urcuioli, DeMarse & Lionello, 1999; Wilkie & Spetch, 1978). Another type of variables studied are those relative to the physical (Alsop & Porritt, 2006; Miyashita, Nakajima & Imada, 2000; Trapold, 1970) or probabilistic properties of the stimuli (DeLong & Wasserman, 1981).

Studies like the ones mentioned before have generated an enormous amount of data accumulated over the last four decades that seems necessary to organize and interpret within a single and homogeneous theoretical frame, that is, to formulate explanatory and organizational models. Ribes (1990) has stated that one of the main enterprises in the advancement of psychology, given an enormous amount of evidence, is conceptual analysis. In the present paper such a view is accepted but the specific way of doing such an analysis is different form the one favored by Ribes. This author showed that by means of a logical classification of the particular terms used in research a new understanding of the true nature of the phenomenon will be apparent. This type of analysis is typical of the syntactic view of science in which theories are understood as a set of theoretical terms which are either given meaning due to their connection to other terms or by their use as part of a linguistic practice.

This type of analysis isn't the only or the best one in the quest for the advance of a particular field of research (da Costa, 2000). Other philosophers of science have stated that a better understanding of science, and therefore a better way to create tools of organization of data and concepts, will come from the notion that theories are a set of models (Giere, 1990; Van Fraassen, 1980). This has been called the semantic view of science (see Echeveria 1999 for a review) and its main notion, model, will be used in the rest of this paper as a guideline for the organization and interpretation of evidence, procedures and new possibilities of exploration for the advancement of psychology in the field of conditional discrimination learning.

MODELS

The word model can be employed in several ways. Estany (1993) showed that there are two main ways in which model is used: a) as that which is represented; and b) as that which represents. In the present paper the second way is adopted and a specific formulation is given: a model is a set of postulates about objects-events and their relations, with limited descriptive-predictive functions which are established by a specific theory. Such a meaning of model is very similar to the one given by Cartwright (1999). The author used the expression "representational model" to capture the way in which a theory is specified by representing: "*The real arrangements and affairs that take place in the world*" (p. 180). Commenting on the relation between theory and model, Cartwright stated that "*This way of using the term model allows the epistemic passage from the more abstract role of a theory to a more specific one of the model, although, this does not imply* […] *any kind of reductionism of abstract concepts to more specific ones*" (p. 40).

Also, in the present paper the term *explanatory* is used in the form of a set of propositions which answer to a specific set of questions in the form of "why…?" For example: Why is performance enhanced when there are differential consequences in the task? Such a meaning of the term explanatory is in accordance with De Gortari's (1988) use: "*In relation to anything, to give the why so of its existence or behavior*" (p. 191). The acceptance of a particular model as an explanatory alternative in a specific field of research, given that there are more than one available, is do to the proof that it posses certain specific epistemic properties. The ones that will be discussed here are: a) empirical inclusiveness; b) predictability; and c) heuristic capacity. Each one will be briefly outlined.

EPISTEMIC PROPERTIES

Empirical inclusiveness. This is the epistemic property of a model by which it can incorporate previous designs and research activities and by doing so it makes the phenomenon workable under given a theory.

Predictability. This epistemic property has been considered a main virtue of models and theories alike. Skinner (1938) stated that one of his objectives was to "*establish laws in virtue of which behavior can be predicted*" (p.23). In a philosophical context De Gortari (1982) has said that "*all which is done with a model are predictions. In a sense, a system serves as a model because it allows the formulation of predictions. In general, to predict it is necessary to establish models […] the fulfillment of the predictions constructed upon a model, is the criteria that allows a decision on the validity of the model*" (p.132).

Heuristic capacity. The expression "heuristic" has enjoyed a special popularity in recent years, even though a single and clear definition has yet to be proposed (Pérez-Ransanz, 2000). It has been used as a personality trait of the researcher (Polanyi, 1958) or as a type of problem solution algorithm (Simon, 1977), among others. In the present paper this property will be considered as the capacity of a model to generate new ways of studying already known variables and to produce new evidence. This notion of heuristic is in line with a statement made by Peréz-Ransanz (2000) referring to that term: "*the continue development of new conceptions, more adequate, mean while the discovery and interpretation of facts moves on*" (p.27)

AN EXPLANATORY ALTERNATIVE

In the field of conditional discrimination learning several models have been presented. Eckerman (1970) presented a model that had a specific emphasis in the mediational responding to sample stimuli. Wixted (1989) also presented a model in which the main explanatory parameter was the reinforcement reduction delay. Also Delong & Wasserman (1981) explained the effects of differential consequences by way of functional expectancies of reinforcement for each sample stimulus. Most recently, Sidman (2000) has stated a model for the emergence equivalence relations and conditional discrimination responding which takes as its main concern the particular reinforcement contingencies. A problem with these models has been described as the "micro-theory problem" (Cabrer, Daza & Ribes, 1975). It implies that the model cannot be placed within a theory and therefore impedes the development of a parametric continuum in which the effects of different variables can be identified given the generic theoretical abstractions.

The contingency contrast model (CCM) was presented as response to such micro-theories in conditional discrimination (Camacho, Serrano & Carpio, 2008). These authors have stated that the CCM represents the empirical conditionality in a matching to sample task in terms of contingency structures (CONSTS). These CONSTS represent specific sets of conditionality between sample, comparison, responses, reinforcements and intervals in the task. Such conditionality, and not the effect of a specific element or event, is the main focus of the CCM and the root of its separation from micro-theories building, given that since conditionality is common to all tasks it can form a parametric continuum and can be placed within a specific theoretic frame that assumes conditionality as its main source of explanation.

Two types of distinctions can be made given a standard successive matching task: Between CONSTS and within a single CONST. For the first type, the possible outcome is either a difference or similarity between CONSTS. For the second type, the possible outcome is also a difference or a similarity but now within each CONST. This type of analysis has been previously reported in the form of "trial-specific factors" and "between trial factors" (Hartl, Dougherty & Wixted, 1996) with the implicit danger that these expressions have of omitting the theoretical (conceptual) relevance of conditionality between stimuli and response events by reducing the analysis to matters of design and procedure. The two main assumptions of the CCM are: a) Each CONST is analytically distinguishable and unified; and b) the differentially or similarity between or within CONSTS are conditions which have specific effects on the development of conditional control (Camacho, Serrano & Carpio, 2008). The second assumption has been mapped out in a 2X2 matrix format and can be seen as exhaustive in terms of the procedure possibilities given a standard two sample successive task.

Research concerning the CCM has evolved over the course of several years, changing and adapting the terminology according to data and theory. In the first study Serrano, Camacho and Carpio (2006) described a procedure in which two groups of pigeons learned under a successive delayed matching-to-sample task. For the first group each of two sample stimulus were correlated with a specific inter-trial-interval, either a 30s or a 5s interval. For group two the same inter trial interval (17.5s) was correlated with both samples. Results showed that as delay value increased precision index dropped faster for group two. Also, pigeons in group one were the only ones to show different sample responding. Even though this study did not recognize the CCM, the procedure was build upon the main assumptions of the CCM, that is, that the difference between CONSTS is a condition that affects conditional control.

In a follow-up study Camacho, Aguilar and Carpio (2008) manipulated another interval as the parameter to differentiate CONSTS. In their study, pigeons were exposed to a matching-to-sample task in which reinforcement delay was varied. Three groups were used, for one group a sample specific reinforcement delay procedure was used, for a second group no sample specific delay and finally, for a third group no delay at all. Data showed that performance was equal for pigeons that were exposed to the sample specific delay and the cero delay procedure, and that both groups had a higher precision index that the group that was exposed to the no sample specific delay.

Even though it wasn't until the Camacho et al. (2008 a) study that the CCM was properly presented, both previous studies can be placed as direct evidence of this model. Additionally, as new research is conducted some changes can be made which might improve the clarity of presentation of the CCM. Some of these are the ones that concern the inclusion of other responses and stimuli (negative contingency specifically) to the bare bone representation of the CONSTS in the CCM and the use a single expression to denote the conditional relationships between responses and stimuli in a matching-to -sample task since in Camacho et al. (2008 b) study the term "structural sequences" was employed to refer just that. Future research should be open to such changes.

EPISTEMIC PROPERTIES OF THE CCM

The CCM was formulated as an explanatory alternative in the field of conditional discrimination learning (Camacho et al. 2008 a). But to date no attempt has been made to make explicit the epistemic properties that, seen as virtues, could make this model an explanatory alternative in the field of conditional discrimination. This is precisely the task that is immediately presented.

Empirical inclusiveness of the CCM

Due to the generic nature of the CCM any specific parameter can be used to establish the difference or similarity between/within CONSTS and therefore it is possible to incorporate into the body of evidence in favor of the model any data that was reported under the procedures outlined in the contingency contrast matrix. What follows are some examples of how the procedures of previous research can be incorporated to the CCM in a case by case bases.

Case 1: Similarity between and within CONSTS

In a recent study Hayashi and Vaidya (2008) used adult humans as participants in an arbitrary matching-to-sample task. Their study investigated the discriminability of sample and comparison stimuli. They used four simple (one element) or four complex (two elements) stimuli in four conditional discriminations: a) simple sample –simple comparison; b) simple sample -complex comparison; c) complex sample-simple comparison; or d) complex sample

-complex comparison, which give a total of 16 conditional relations. Results showed that acquisition of conditional control is a function of the discriminability of the sample and comparison stimuli and that the former plays a more important role in the rate of acquisition. In this experiment the conditional discrimination formed by simple sample-simple comparison is an example of the type of procedure in which there is similarity between samples given that all four samples were of only one element and these were similar to comparisons which were also of one element and therefore similar within each particular CONSTS.

Case 2: Difference between and similarity within CONSTS

Alling, Nickel and Polling (1991) presented a study in which pigeons were exposed to a delayed matching-to-sample task in which two outcomes were scheduled after correct responses (sample-comparison identity): food or feeder light. Both outcomes were either correlated with a specific sample stimulus (red or green) or not correlated. Results showed that under sample-outcomes correlation accuracy was significantly higher than when sample-outcome correlation was not in effect. Also responding to sample stimuli was greatly differentiated in the sample-outcome correlation condition. This study exemplifies the case when there is a difference between CONSTS given that in the sample-outcome correlated condition the CONSTS were different in terms of the outcomes and also, as an effect, the sample response rate. Given that the task was of identity matching, both sample and comparisons were similar in terms of their physical properties and therefore there was similarity within CONSTS.

Case 3: Difference within and similarity between CONSTS

Again, the study of Hayashi and Vaidya (2008) presents the experimental conditions to show an example of the possible differences or similarities described in the contingency contrast matrix. The procedure that they used to program the simple sample- complex comparison conditional discrimination exemplifies a condition in which the elements of a particular CONSTS are different but are similar between all the CONSTS. This is because all the sample stimuli in their study consisted of one element while all of the comparisons were a two element stimuli.

Case 4: Difference between and within CONSTS

An example of this case is a recent study by Lionello-Denolf & Urcuioli (2003) that tested a procedure to establish differential sample responding with no different exteroceptive stimuli. In Experiment 1 of their study, four pigeons were exposed to a pre matching-to-sample training in which two reinforcement schedules were in effect during the presence of a white light: DRL 3 and FR 10. After this mixed DRL-FR training a matching-to-sample procedure began. In the matching to sample task each one of the previously trained response patterns served as sample for either a triangle or a dot comparison stimuli. Results showed that this “unsignaled response” procedure was effective in establishing the baseline conditional discriminations. In other words, the difference between CONSTS was established by the different responding as sample (DRL3-FR10) in the presence of the same stimulus while the difference within each CONST was done by the fact that a specific response pattern served as sample while a specific figure served as a comparison.

This analysis shows that procedures employed in the field of conditional discrimination learning may be included in the CCM but a special point must be made: that such analysis only considers the CONSTS as previously defined. The analysis of the functional role of the negative elements (negative comparisons or intervals during negative trials) of the task such as the one made in the studies of the stimulus control topography coherence theory (McIlvane & Dube, 1992; McIlvane, Kledaras, Callahan, & Dube, 2002) is a pending job that must be attended.

Predictability of the CCM

This property of the CCM can be showed by the fact that the effects of different manipulations can be described in advance and already reported data can be easily interpreted. In this way the CCM can establish a clear empirical test to its validity as an explanatory alternative in conditional discrimination learning. Some of the general facts that can be predicted have been previously outlined by Camacho et al. (2008).

First, the condition of difference between and similarity within CONSTS is the one that can produce a better acquisition rate and a better overall performance of the subjects. This effect is consistent with the data of Jones (2003). In his study, pixel density was employed as stimulus dimension. Density varied between samples and comparisons or between the samples and the comparisons stimulus in three conditions. Condition 1 had the highest difference (disparity in his terms) between sample and comparisons. Condition 2 had a lower degree of difference between comparisons and Condition 3 also a lower degree of difference but now between samples. The results showed, just as the CCM predicts, that matching accuracy of pigeons during the condition that had a sharp difference between CONSTS and a similarity within CONST (condition 1) was higher. Another example of the predictive property of the CCM comes from differential outcomes effect experiments (Goeters, Blakely & Poling, 1992), in which each sample (usually of the same dimension as the comparisons) is correlated with a specific consequence and therefore there is a condition of difference between CONSTS and similarity within CONST.

Second, the condition of difference within and similarity between CONSTS is the least effective in the development of conditional control. This prediction is confirmed by the negative results on performance (slower acquisition rate, lower terminal accuracy, less resistance to sample-comparison delay, etc.) that the absence of difference between CONSTS can generate. The effect is especially clear with non-differential sample responding (Cohen, Looney, Brady & Aucella, 1976; Urcuioli & Honig, 1980), inter-trial interval (Serrano at al. 2006), reinforcement delay (Camacho et al. 2008 b) or outcomes (Goeters, Blakely & Poling, 1992)

Finally, the extreme conditions of similarity or difference between or within CONSTS have intermediate effects. This last prediction is very important to the CCM given that it presents the occasion for an evaluation of the combinations of the difference or similarity between CONSTS and the difference or similarity within each CONST. For instance, when there are differences between CONSTS positive effects appear, as in differential sample responding, but to the contrary, when there are differences within each CONST, as in the line sample-hue comparison (Carter & Eckerman, 1975) or complex sample-simple comparison (Hayashi &Vaidya, 2008) a negative effect appears, and therefore an intermediate general effect is present. Yet this prediction must be postponed given that to this date no single experimental procedure has addressed this issue.

Heuristic capacity of the CCM

Of special importance is the epistemic property of a model to provide the means to design the type of procedures that can raise new questions and produce new data which can open a scientific field to further research. This property can be shown in the CCM, given that it produced the first design to use reinforcement delay in a matching-to-sample task which had been reported as having a negative effect on performance and report a positive effect (Camacho et al. 2008 b). Another parameter that has been reported as having a negative effect is the sample-comparison delay (Blough, 1959). Its manipulation is a possibility easily addressed given the CCM.

Another proof of this property for the CCM is that a *novel* contingency contrast scale that can measure the relative or independent role of a specific element (the sample, the comparison, the reinforcement, the delay interval, etc.), in a similarity or a difference between CONSTS or within CONST, in the development of conditional control may be constructed and experimentally studied. The construction of this scale also presents the opportunity to test different characteristics of the matching to sample task, such as the use of compound stimuli, subject's own behavior as stimulus, or even internal state discriminations.

Finally, in a typical conditional discrimination learning study, the subjects receive a number of sessions in response establishment and are experimentally naïve to the procedures and stimuli involved in the task. But if subjects were to be trained to respond to a stimulus in an avoidance program and then that same stimulus becomes a part of a compound stimulus and served as one of the samples in the matching-to-sample task ¿Will this be enough to observe an effect on subject's performance? ¿Can there be differences between CONSTS given previously formed functional properties of the stimuli involved? These questions are novel in the field given that they address the experimental constitution of special stimulus functions and its involvement in the development of a new functional property, namely, conditional control. Also, these questions about the functional difference between CONSTS may direct research activities to the basic point that: "a structural (and physical) measure does not necessarily correspond to stimulus discriminability as a functional (and psychological) measure" (Hayashi &Vaidya, 2008, p. 181).

CONCLUSION

The main purpose of the present paper was to present the CCM as an explanatory alternative in the field of conditional discrimination. This was done by presenting the CCM and the epistemic properties which make it an alternative model for the field. The epistemic properties that were described were: a) empirical inclusiveness; b) predictability; and c) heuristic capacity, all of which were proven given procedures, effects and possibilities, respectively, in the study of conditional discrimination learning. Given this and the small, but consistent, amount of evidence directly produced by the model (Camacho, et al. 2008 b; Camacho et al. 2008 a; Serrano et al. 2006) it can be said that the CCM is an explanatory alternative with significant epistemic properties in the field of conditional discrimination learning.

Ribes (1990) and the present paper employ different ways of working but with the same objective: the advancement of experimental psychology. Having this objective this paper might serve as the basis for more theoretical inquiry. Other properties (e.g., theoretical embedding, application, etc.) must be proven to further enhance the importance and relevance of the CCM. Finally, theoretical analysis must be directed toward the comparison of the CCM to classic and current models in conditional discrimination learning.

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