The integration of learning paradigms by way of a non-causal analysis of behavioral events[1]

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Abstract

The main purpose of this paper is to show that all types of psychological interactions may be understood as matters of substitution of functions or function transfer. On the basis of this analysis, we argue that the distinction between Pavlovian and operant conditioning, as different types of learning processes, may be unnecessary. To do so we critically analyze the rationale for characterizing operant and classical conditioning as two types of learning processes, examine the similarities and differences between types of psychological events and identify which properties of substitution are particular to each type. We present the notion of function transfer as the main underlying process that accounts for all psychological interactions.

Key words: *pavlovian conditioning, reinforcement, S-S relations, stimulus equivalence, function transfer, human causal learning, complex human behavior*

Resumen

El propósito fundamental de este artículo es mostrar que todos los tipos de interacciones psicológicas pueden ser entendidas en términos de sustitución o transferencia de funciones. A partir de este análisis planteamos que la distinción entre condicionamiento Pavloviano y operante como tipos diferentes de procesos de aprendizaje puede ser innecesaria. Para justificar este argumento analizamos críticamente las razones para caracterizar el condicionamiento clásico y operante como dos tipos diferentes de procesos de aprendizaje, examinamos las similitudes y diferencias entre tipos de eventos psicológicos, e identificamos las propiedades de sustitución que son características de cada tipo de condicionamiento. A través de esta formulación presentamos la noción de transferencia de funciones como el elemento subyacente que da cuenta de todas las interacciones psicológicas.

Palabras Clave: *condicionamiento pavloviano, refuerzo, relaciones S-S, equivalencia de estímulos, transferencia de funciones, aprendizaje causal, conducta humana compleja.*

A review of the last decades of research in Pavlovian conditioning of complex human behavior shows that, the traditional conceptual framework of Pavlovian associations (in terms of the conditioning of reflexive responses) needs to be revisited. Our claim is that the developments in the field of Pavlovian learning invalidate some of the fundamental reasons for distinguishing between conditioning types. To demonstrate this, we will describe some of the findings from the most dominant research programs of

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Pavlovian learning focusing on complex human behavior. In particular we will review empirical findings that challenge definitional aspects of respondent relations; namely, the biological nature of the US, and the unidirectionality of CS-US associations. In support of our claims we will discuss data from respondent stimulus equivalence research and its interpretations in terms of Pavlovian processes. In addition, we contend that these findings may be taken as evidence that S-S relations are bidirectional as has been demonstrated by backward conditioning studies, often obscured by traditional theoretical models of Pavlovian conditioning. Finally we conclude by discussing the implications of re-conceptualizing S-S associations, on a science and philosophy of behavior. In contrast to views favoring operant-respondent interactions, we propose that behavior with respect to classes (and possibly all behavior-environment relations) may be understood in terms of transfer of functions, a basic process that accounts for both operant and respondent learning. We highlight the benefits of acknowledging and integrating operant and respondent research data for purposes of theory construction.

Re-conceptualizing S-S Relations: Implications for the Classical Conditioning Paradigm and the Philosophy of Behavior Science

The research literature in behavior science, both empirical and conceptual is divided in two main fields, which designate, according to most psychology textbooks, two clearly distinct types of learning processes, namely Pavlovian and operant learning. Since Skinner published his response to Konorski and Miller (1937a, 1937b) on the distinctions between conditioning types, behavior has been also dichotomized as either operant or Pavlovian/respondent. While the latter has been described as reflexive, controlled by antecedent stimuli and involuntary, the former is described as probabilistic, apparently voluntary, requiring of no antecedent stimuli, and it is said to encompass most of human behavior.

From the recognition of separate subject matters (i.e., types of behavior), different fields have developed rather independently of each other. In the 60's the cognitive neurosciences and other mediational approaches developed largely from classical conditioning research serving to widen the gap between operant and respondent literatures. As a result, irreconcilable differences at the level of their basic philosophical assumptions have been maintained. Today, each scientific community exists in isolation of the other. Each of them holds their own academic local and national conferences and their researchers publish in separate specialized journals. The two communities rarely interact and their scientific products remain largely unknown to one another.

This circumstance is astonishing because, as we see it, there are many more points of coincidence than reasons for divergence. First, both are concerned with the same subject matter, namely the behavior of organisms, many of the terms used to describe lawful environment-behavior relations are the same, and the relations to which these terms refer are also the same. To illustrate, both conditioning paradigms have systematically shown behavioral phenomena under the control of stimulation sources that have been defined as simple discrimination, generalization, higher order discrimination effects, habituation, acquisition, aversive control, extinction, spontaneous recovery, contextual control and function transfer.

Secondly, terms such as transitivity or emergent relations in operant conditioning, and second order conditioning in Pavlovian conditioning, have been used to study the same set of behavioral observations. Thirdly, phenomena that have been studied in operant conditioning are being accounted for in terms of the S-S relations involved in the operant contingency. For example, studies in equivalence and transformation of functions using respondent preparations suggest that it is the S-S associations and not the operant contingency, which accounts for successful derived relational responding (Delgado & Medina, 2011; Delgado, Medina & Soto, 2011; Leader & Barnes-Holmes, 2000; Leader & Barnes-Holmes, 2001; Leader, Barnes & Smeets, 1996; Smeets, Barnes-Holmes & Roche, 1997; Smeets, Leader & Barnes, 1997; Tonneau, Arreola & Martínez, 2006; Tonneau & González, 2004). Similarly, research in behavioral momentum has shown that resistance to change depends on Pavlovian S-S contingencies (Nevin, 2009; Nevin & Grace, 2000). Evidence of this is that greater resistance to change has been systematically observed in the presence of a stimulus that has been paired with the delivery of non-contingent reinforcers (Nevin, 2009; Nevin, Tota, Torquato & Shull, 1990).

On the other hand, Pavlovian research has evolved so much empirically, theoretically, and conceptually, that its descriptions in terms of the conditioned reflex fall short of its current scope (Rescorla, 1988). Because the differences between conditioning paradigms were formulated on the basis of the traditional definitions of classical conditioning, their validity needs reevaluation in terms of more current views.

In addition to the study of the conditioned reflex, researchers in classical conditioning have been focusing for a long time on the application of principles and procedures to the study of complex human behavior. Lines of research include transfer of value in the study of preferences (Beckers, de Vicq & Baeyens, 2009; Laane, Aru & Dickinson, 2010), the acquisition of social prejudices and attitudes (Olson & Fazio, 2002; Walther, 2002), causal reasoning in children and adults (Beckers, Van den Broeck, Renne, Vandorpe, De Houwer, & Eelen 2005; Delgado, 2013; Karazinov & Boakes, 2007; Livesey & Boakes, 2004; Vandorpe & De Houwer, 2006), the acquisition of reading repertoires (Didden, Prinsen & Sigafoos, 2000; Singh & Solman, 1990) and stimulus class acquisition (Delgado & Medina, in press; Rehfeldt, Dixon, Hayes & Steele, 1998). In examining the current literature, we find two fundamental aspects of the classical conditioning paradigm that require reconceptualization: a) the biological significance of the US; and b) the unidirectionality of the CS-US association. In the following sections we examine some of the research findings relevant to each of these aspects and their conceptual implications.

The biological significance of the US

Pavlovian conditioning research on complex human behavior involves examining the associations between one or more CSs and an outcome that is not a biological response but a verbally described stimulus event. In other words, associations are examined between two or more stimulus events that usually consist of conventional and arbitrary stimuli (as in the case of cue competition in human causal learning and evaluative conditioning), or arbitrary stimuli only (as in the case of respondent equivalence studies).

In the latter case the stimuli typically used are geometrical shapes, unfamiliar characters and symbols, or nonsense syllables; in the former, outcomes usually consist of stimulus events that are rated in a like/dislike scale, adjectives, or a description of an outcome. In causal reasoning research, outcomes usually consist of statements describing the presence/absence of an event such as a symptom, a disease, fluctuations in the stock market, the onset of a machine, or the spread of bacteria. These are presented in association with other stimuli (CSs) such as substances, medications, foods, unfamiliar brands, or objects or buttons on the computer screen (e.g., Beckers, De Houwer, Pineño & Miller, 2005; De Houwer & Beckers, 2003; De Houwer, Beckers & Glautier, 2002; Livesey & Boakes, 2004; Vandorpe & De Houwer, 2006).

However, several studies have suggested that the outcomes of applying classical conditioning procedures to study human behavior do not replicate those of studies with animal subjects. Evaluative conditioning research, for example, studies the transfer of value between a set of stimuli presented as outcomes (e.g., attitudes, adjectives, likes, dislikes) and another set of stimuli that have been rated as neutral in a pre-experimental phase. After exposure to stimulus pairs, transfer of functions between stimuli that have not been directly paired, as in the case of second order conditioning and sensory preconditioning, is examined. The authors of these studies suggest that unlike traditional Pavlovian conditioning with animals and humans, where the CS serves a signalizing function with respect to the US, these preparations reflect a type of learning where only transfer of value (and not prediction) is involved (Rozin, Wrzesniewski, & Byrnes, 1998; Walther, Nagengast & Trassselli, 2005). Some empirical evidence has supported the conclusion that evaluative conditioning constitutes a learning process different from Pavlovian learning. Successful conditioning in spite of the use of masking tasks or verbal interference tasks during training have shown that in contrast to some accounts of human causal learning, evaluative conditioning occurs in the absence of contingency awareness (Walther, 2002; Walther & Nagengast, 2006). In addition several studies have shown that greater resistance to extinction (Baeyens, Díaz & Ruíz, 2005) and possibly low sensitivity to the blocking effect may also characterize evaluative conditioning (Beckers, de Vicq & Baeyens, 2009; Delgado, 2013; Laane, Aru & Dickinson, 2010). To date however, the idea that evaluative conditioning should be regarded as a type of conditioning different from Pavlovian conditioning continues to be an important subject of debate among associative learning theorists (Field, 2000).

Within the area of human causal learning however, there has been a great deal of debate also as to whether or not the same principles observed in animal research apply to causal learning in humans (De Houwer, Beckers & Vandorpe, 2005; Shanks, 2010). For example, findings of studies on cue competition have shown that while experimental preparations that facilitate responding to the elements of a compound stimulus (elemental approach) predict the occurrence of the blocking effect, the procedures which facilitate configural responses to the compound produce conditioning of the target stimulus (Glautier, 2002; 2008). In a circumstance with two potential causes like the blocking procedure (A+, AX+, X?), elemental manipulations seem to resolve the ambiguity as to the causal role of the target stimulus X. This is particularly the case when these manipulations specify the individual contributions of A and X to the outcome, as in studies of ceiling effects and outcome maximality (Beckers, De Houwer, Pineño & Miller, 2005; Livesey & Boakes, 2004; Lovibond, Been, Mitchell, Bouton & Frohardt, 2003).

Other factors such as instructions, exposure to descriptions of the contingencies (as opposed to direct exposure), and stimulus configuration have also suggested that associative learning in humans may be characterized by behavioral patterns that differ from those established in animal learning. As in operant conditioning, this may be due to the participation of verbal behavior in behavior- environment relations. However, the idea that complex human behavior cannot be accounted for by the associative learning approach is still controversial. Conceptual and empirical data supporting the opposite view have also been reported. For example, Beckers, Miller, De Houwer & Urushihara (2006), conducted a cue competition experiment in rats specifying submaximal values for the US as in some of the human causal learning studies. Because their results were consistent with findings from human causal learning research, the authors argue in favor of the generality of Pavlovian models to account for human learning under circumstances of cue competition.

Denniston, Miller & Matute (1996) compared backward blocking measures in two groups of rats. One group was exposed to a biologically significant US, and the other was exposed to a low biological significance stimulus (moderate to low intensity auditory cue) in a conditioned suppression procedure. In order for the auditory cue to serve as a US for the second group, it was paired with a highly biologically significant stimulus using sensory preconditioning and second order conditioning procedures. Only the results from the low biological significance US group were consistent with those observed in causal judgment studies in humans. The authors suggest that the differences observed between animal Pavlovian studies and human Pavlovian studies are not due to biological or learning differences in species, but rather to the biological significance of the stimuli typically used in conditioning procedures in each species.

The authors suggest that biologically significant stimuli may be insensitive to cue competition effects. They argue that due to the biological relevance of those stimuli, both of the elements of a compound CS in a blocking procedure are likely to acquire associative value (Denniston, Miller & Matute, 1996; Oberling, Bristol, Matute & Miller, 2000). However, as we have noted, the blocking effect has been more consistently demonstrated in animals than in humans. Because non-biologically relevant stimulus events undergo function transfer more readily than biological ones, which is to say, they do not compete for transfer of stimulus functions from the US, it may also be argued that in the human case the occurrence of the blocking effect depends on a much higher number of conditions (Delgado, 2013).

It is possible that it is the biological significance of the stimulus participating in complex associations and not necessarily the verbal nature of those stimuli that produces behavioral outcomes which differ from those observed in traditional animal studies. However, more research is also needed to more specifically establish the role of verbal stimuli in learning processes.

The operant and respondent literatures have repeatedly shown that conditioning effects are unaltered by the inclusion of verbal interference tasks during training (Delgado, Medina & Soto, 2011; Olson & Fazio, 2002; Tonneau & González, 2004; Walther, 2002). An interpretation of these findings, common to both literatures, is that verbal behavior is not required for learning to occur. However, it has also been well established that when verbal behavior is involved behavioral outcomes of operant and respondent manipulations seem to differ from those observed in nonverbal individuals (Bentall, Lowe & Beasty, 1985; Delgado, Medina & Rozo, in press; Karazinov & Boakes, 2007; Vandorpe & De Houwer, 2006). Clearly, determining the role of verbal behavior in the acquisition of non-verbal behavior constitutes a pervasive challenge for comparative research in general, whether operant or respondent, and for the experimental analysis of human behavior in particular (Schlinger, 1993).

In reviewing some of the most current work in human classical conditioning research we hoped to highlight its contributions to the understanding of complex human behavior. Understanding Pavlovian relations as dependent upon associations between any two stimuli, regardless of their biological significance, broadens the scope of events that can be studied using a Pavlovian conditioning paradigm. While the traditional definitions restrict Pavlovian conditioning to reflexive responses, the current view permits complex human phenomena to be approached in terms of classical conditioning processes.

Just like mainstream operant conditioning views of language and cognition, Pavlovian researchers are focusing on the study of verbal relations, the conditions under which they are acquired, and their effect on non-verbal behavior. In both cases, these studies involve understanding the conditions that facilitate or impede function transfer among classes of stimulus events.

We now turn to examine some evidence suggesting that S-S relations may be bidirectional or symmetrical. Overall, the findings in respondent equivalence seem to indicate that the phenomenon of stimulus equivalence can be explained sufficiently in terms of the S-S associations between stimulus pairs. If this is so, it follows that S-S relations must be bi-directional. In the following section we expand further on this topic.

The bi-directionality of CS-US associations

A bidirectional or symmetrical relation is observed when after learning to respond to B in the presence of A, an organism also responds to A in the presence of B. To illustrate with a familiar example, given that the dog salivates in the presence of the bell (CS), we could say that bell (CS) and food (US) functions are symmetrical if the dog also responds to the bell - as in hearing the bell in its absence - in the presence of the food.

In current research of Pavlovian processes with human subjects the US and CS are often verbal or arbitrary stimuli (e.g., Olson & Fazio, 2002). However, one of them is usually experimentally defined as the conditioned stimulus and the other as the unconditioned stimulus, whereby only conditioning of the response to the designated unconditioned stimulus is examined. The resulting assumption of causality where the CS is predictive of the US and the US is the cause of the response has been extended to all sorts of relations among psychological events.

Research has shown robust evidence of the critical role of stimulus-stimulus relations --characterized as non-causal, symmetrical, and acquired without the use of a biologically relevant unconditioned stimulus--in the acquisition of stimulus classes. Specifically, the study of equivalence using respondent procedures has fostered the development of both research and theory that has: a) extended the methods and processes available to study complex human behavior, and b) provided the respondent paradigm with a much wider scope in accounting for psychological events (Delgado & Medina, 2011; Delgado, Medina & Soto, 2011).

The term "respondent-type," was coined by Leader, Barnes and Smeets (1996) to refer to the use of Pavlovian preparations in studies with humans. They introduced this term to make a distinction between the stimulus-stimulus relations studied in humans and traditional CS-US respondent associations. In our view, however, this distinction seems unnecessary. The current end point of an evolving paradigm should not be construed as a new paradigm. The basic processes are essentially the same; what has changed is the range of phenomena that can be accounted for by such processes.

Several studies comparing the efficacy of the respondent and operant MTS (matching to sample) procedures have shown equal or higher performances in symmetry, transitivity and equivalence tests when the respondent procedure was used (Leader & Barnes-Holmes, 2001; Tonneau & González, 2004). Because equivalence was at times observed only after repeated exposures to training and testing sessions (see Augustson & Dougher, 1997), some have argued that the test trials may have produced a concealed training effect or that reinforcement may have occurred in an unapparent manner (Clayton & Hayes, 2004). For example, factors such as self-generated rules may involve a reinforcing effect. However, reports of respondent equivalence after disrupting self-rule generation (Tonneau & González, 2004) show that reinforcement control by way of rules is unlikely. In addition, other studies report high performances in tests for derived relations without exposing participants to a high number of training and testing trials. For example, Delgado, Medina & Rozo (in press) showed respondent equivalence using an MTS preparation including blocks of 18 trials per trained relation and 9 trials only for each equivalence test. In another study examining the blocking effect in the formation of equivalence classes, Delgado & Medina (in press) showed evidence of derived relations in a respondent MTS preparation with compound samples, including blocks of only 10 trials for each relation trained and tested.

Rehfeldt, Dixon, Hayes & Steele (1998) provide additional evidence supporting the involvement of respondent conditioning in the acquisition of equivalence classes. These authors examined the extent to which equivalence class formation is sensitive to the blocking effect. In their study, training consisted of A-B trials followed by AX-B trials; and B-C trials followed by BX-C trials. The target stimulus was the X element added to the sample (A or B) to form the compound (AX or BX). Tests for blocking consisted of testing acquisition of stimulus class A-B-C versus X-B-C, for example. As the authors discuss, possibly because the position (left or right) of the elements in the compound was varied on every trial, a blocking effect was observed in only half of the participants. An interesting finding was that the subjects who showed blocking performed poorly in tests for A-X and X-A relations. The implication is that if respondent learning is responsible for transfer of function in equivalence, Pavlovian processes such as forward blocking, backward blocking and overshadowing should also be observed.

In order to test this hypothesis Delgado & Medina (in press) replicated the study conducted by Rehfeldt, Dixon, Hayes & Steele (1998) with a few modifications. First, they used a respondent rather than an operant MTS procedure to train acquisition of classes. Second, they did not vary the position of the elements of the compound sample across trials. Third, they compared the data of participants in three groups: one group was exposed to a forward blocking procedure, a second group was exposed to a backward blocking procedure, and a control group was exposed to the compound sample without additional exposure to A-US training trials. Results were similar to those of Rehfeldt, Dixon, Hayes & Steele (1998); that is, the blocking effect was found in about half of the participants in the backward blocking and control groups. Although the blocking effect was not observed in most of the participants of the forward blocking group, statistical significant differences between groups were not obtained.

The failure to find blocking effects in the formation of equivalence classes does not indicate that equivalence relations are not acquired via S-S associations though. Current studies on the blocking effect in humans show that inconsistent findings as to the occurrence of the blocking effect are not infrequent, especially when types of perceptual responding to compound stimuli are not controlled, as it has been widely discussed (García-Retamero Ramos & Catena, 2008; Glautier, 2002; 2008; Melchers, Shanks & Lachnit, 2008).

Overall, it may be affirmed that the findings in respondent equivalence (Delgado & Medina, 2011; Delgado, Soto & Medina, 2011; Rehfeldt & Hayes, 1998; Tonneau & Sokolowski, 1997) challenge explanations of stimulus equivalence in particular and of the acquisition of stimulus classes in general, in terms of operant contingencies. It could be said that the role of reinforcers in operant equivalence preparations is to increase the subject's behavior of initiating an action with respect to the correct pairs. In other words, reinforcement induces participants to self-create a history in which repeated exposures to certain stimulus pairs allow for stimulus substitution processes. By contrast, the respondent procedure resembles a situation where in such a history is provided by the environment. In the experimental situation such a history, is arranged by the experimenter.

The implication of these arguments is that a history of exposure to stimulus pairs may constitute the necessary and sufficient conditions to produce transfer of functions (Tonneau, 2002). A fair test for the effect of reinforcers on the acquisition of equivalence classes would entail altering only the presence or absence of reinforcers while holding all other variables constant. It could be argued that clicking on the comparison stimuli to make a selection may enhance differential observing in the operant MTS procedure. However, Delgado, Medina and Rozo (in press) reported evidence of equivalence relations using a respondent MTS procedure in which participants were required to click on the correct comparison, signaled on the screen. No differences were found between a group of participants exposed to this procedure and a group of participants exposed to an MTS respondent procedure. However, further studies comparing operant and respondent procedures are needed to show if such observing responses are associated with higher performances in equivalence tests.

While some authors have suggested that both operant and respondent contingencies operate in the formation of equivalence classes (Clayton & Hayes, 2004; Rehfeldt & Hayes, 1998), others contend that function transfer is a component of equivalence that arises from operant reinforcement contingencies (Sidman, 2000). Similarly, Relational Frame Theory (RFT) (Hayes, Barnes-Holmes & Roche, 2001) suggests that function transfer occurs because of a history of reinforced exposures to stimulus-stimulus pairs and that this history generalizes to other situations involving other stimulus classes (Smeets, Barnes

& Roche, 1997). However, as Tonneau & González (2004) remind us, the effect of reinforcement is an increase in response rate, not a change in behavior. Hence, the first occurrences of untrained substitutive responding must be the result of some process different from reinforcement, that is present also in S-S associations (Tonneau, 2002).

Not surprisingly, transfer of functions arranged through operant preparations posed an important challenge for operant researchers. Because emergent relations were observed in verbal individuals only, they were attributed to the complexity of human behavior (Devany, Hayes & Nelson, 1986; Sidman, 2000). Such untrained relations have been construed as the basis of verbal behavior and human cognition (Hayes, Barnes& Roche, 2001).

Some authors have agreed that the failure to observe equivalence in animals may be merely a procedural issue (Hayes, 1992; Rehfeldt & Hayes, 1998). In fact, studies a variation of procedures have demonstrated equivalence in non-human animals (Kastak, Schusterman & Kastak, 2001). Consider the following: a) the Pavlovian literature has systematically reported that animals show function transfer (e.g., Holland, 1981), b) rats acquire conditioned responding when training includes a non-biologically significant stimulus as a US (Denniston, Miller & Matute, 1996), and c) research with humans has shown that equivalence classes may be acquired through Pavlovian preparations. In our view, these data strongly suggest that the phenomenon of derived relations is not exclusive to humans.

From these considerations it may be affirmed that operant experiments which result in emergent relations are successful because of the stimulus-stimulus pairing contingency and not because of its operant component (Augustson & Dougher, 1997; Delgado & Medina, 2011; Tonneau, 2002; Tonneau & González, 2004; Tonneau & Sokolowski, 1997). Transitivity has been demonstrated in Pavlovian conditioning (e.g., second order conditioning and sensory preconditioning) before the operant conditioning literature tried to explain the observation of relations that had not been directly trained (Tonneau & Sokolowski, 1997). Still, a fair amount of disagreement on this issue still remains. Equivalence research using respondent procedures seems to suggest that symmetry is indeed a property of S-S relations. However, more research is needed to determine if symmetrical relations are also observed using other types of respondent preparations, or if such a property is characteristic of some S-S relations only. In the latter case it is important to identify the stimulus conditions under which S-S contingencies result in bidirectional function transfer.

Pavlovian relations have been symbolically depicted with a one-way arrow (S→R), implying that such relations are predictive and causal. However, this model is based on early research in conditioned reflexes in which the only response measured was the response to the US. Because the response to the conditioned stimulus was often inconspicuous, the possibility that it also underwent conditioning remained unexamined.

As Hayes (1992) points out, a demonstration of symmetry in the simplest case of classical conditioning, namely, in the example of conditioned salivation, would entail testing for the perceptual response of hearing the bell, which would presumably occur in the presence of the food alone. Notice that this analysis is taking into account that for each of the stimuli involved in the conditioning procedure (CS and US), there are two corresponding responses; in this case, hearing or seeing the bell, and salivating to the food. Typically, only the response to the US is examined.

The CS-US relation could be said to be symmetrical if given CS→US training, organisms responded to the US in the presence of the CS alone and if they also responded to the CS in the presence of the US alone; the latter test corresponds to the demonstration of a US→CS relation (see Hayes, 1992).

That is to say, given that both stimuli (CS and US) produce a corresponding response, presentation of either stimulus during test trials will presumably produce responses to the other stimulus in the pair.

A strong demonstration of bidirectionality of transfer of stimulus functions in Pavlovian associations of this sort is provided by studies of backward conditioning. Generally, backward conditioning is not predicted by any of the predominant theories of classical conditioning (e.g., Mackintosh, 1975; Pearce & Hall, 1980; Rescorla & Wagner, 1972), and some of the most common findings show that US-CS trainings result in inhibitory rather than excitatory conditioning (see LoLordo & Fairless, 1985, for a review).

However, a large body of empirical evidence has shown excitatory conditioning of the CS in backward conditioning procedures (e.g., Chang, Blaisdel & Miller, 2003; Cole & Miller, 1999; Hall, 1984; Spetch, Wilkie & Pinel, 1981). Some of these studies have found that while inhibition occurs only with a large number of training trials, exposure to a small number of trials usually predicts excitation (Cole & Miller, 1999; Chang, Blaisdel & Miller, 2003). In these studies, the authors suggest that with a large number of backward pairings, inhibition may result from cue competition between the CS and contextual stimuli. However, a few other studies have reported excitatory conditioning even with a large number of training trials (Hearst, 1989; Hemmes, Brown & Cabeza de Vaca, 1994).

This variety of findings suggests that the conditions controlling bidirectional transfer require further study. As is usually the case, the general acceptance that backward training produces insignificant conditioning effects may result from methodological and traditional theoretical biases; in this case, regarding the predictive nature of the CS and the reflexive nature of the US and the UR (Hall, 1984; Spetch, Wilkie & Pinel, 1981).

These findings suggest that assumptions of unidirectionality between stimulus events may be but an interpretation induced by the availability of our methods of observation. Because some responses elicited by neutral stimuli are often inconspicuous (e.g., hearing or seeing the stimulus), this symmetrical relation has been largely ignored. Findings from research in backward conditioning need to be taken into account in order to further explore the conditions that describe bidirectional transfer in S-S contingencies.

Conclusion: Implications of the respondent-operant dichotomy for the notion of function transfer

For the most part, classical conditioning research has been neglected within the behavior analytic literature (Rehfeldt & Hayes, 1998; Rescorla, 1988). Failing to acknowledge the role of respondent processes in what are considered to be exclusively operant ones, may be due to a tradition of understanding operant and Pavlovian processes as relevant to different types of phenomena. Although only a few behavior analysts seem especially interested in Pavlovian processes, more and more acknowledge that the latter are often embedded in operant processes.

In our view there are more points of convergence between operant and classical conditioning than reasons for maintaining the dichotomy between conditioning types. Upon considering some of the more recent developments in Pavlovian research of complex human behavior, we propose that a re-conceptualization of Pavlovian learning, so as to abolish the distinction between the two conditioning types, is called for. More specifically, when S-S associations are construed as not being limited to the conditioned reflex, as not requiring a biologically significant US, and as being bidirectional, the traditionally cited distinctions between operant and Pavlovian contingencies appear obsolete and unwarranted. In our view, behavior with respect to stimulus classes is neither operant nor respondent. Neither is it the result of complex operant-respondent interactions. In place of these distinctions, we propose that behavior with respect to stimulus classes may be understood simply in terms of processes of function transfer or stimulus substitution.

In a functional analysis events are correlated and co-vary with one another; which is to say, changes in one event are accompanied by changes in the other (Fryling & Hayes, 2011). Due to the contingent relation between the stimuli, some of the functions of each come to be present in the other. Evidence of this process is that after exposure to an S-S contingency, participants behave with respect to the absent stimulus when in the presence of the other stimulus in the pair. This is to say, the organism is responding to the functional properties of the absent stimulus that inhere in the presently available stimulus.

A non-causal analysis of behavior-environment relations, as herein proposed, would resolve the early debate between Konorski and Miller (1937a, 1937b) and Skinner (1937) regarding conditioning types. Although Skinner presented what appeared to be a non-causal treatment of operant conditioning, his descriptions of this process have led to a variety of incompatible interpretations. For example, while Chiesa (1994) emphasizes the historical, non-causal nature of operant conditioning as presented by Skinner (1974), Fryling & Hayes (2011) point out how readily operant researchers and practitioners use the notion of function to mean cause or purpose. Describing events as causes or consequences may thereby limit our understanding of the conditions under which substitution of functions occur; that is to say, it may limit our understanding of psychological events.

The lack of interaction between operant and respondent researchers has prevented both groups from acknowledging their points of convergence. Part of the reason for this is that most of the human research examining S-S associations is strongly influenced by a cognitive mediational approach that is unpalatable to behavior analysts of the operant group. For example, in the classical conditioning literature the process of conditioning is often described in terms of a representation of the US activated by the presence of the CS. Despite the fact that "to represent" means to present again, this description is rejected out of hand as "cognitive" in nature. Nonetheless, when an organism behaves with respect to an absent stimulus object it does not behave in the absence of sources of stimulation. It behaves with respect to the functions of the US that are now *present* in a stimulus, which, at least partially, serves as its substitute (Kantor, 1958; see also Delgado & Hayes, 2007). If Skinner's terms are preferred, when something is *re-presented*, it simply means that the organism may "see again in the absence of the thing seen" (Skinner, 1974). Even if "seeing in the absence of the thing seen" is not the cognitive psychologist's intended meaning for the concept of representation, the disagreement may be irrelevant, at least in so far as it impacts the empirical researcher. In focusing more on the phenomena of interest than on the constructs used to describe them, interaction and cooperation between branches of behavior science and perhaps, between scientific disciplines may be facilitated. We expect that as a likely result of such interaction, integrative models of conditioning will come to replace the so far divorced ones.

In a recent article by De Houwer (2011), the author contends that concentrating on the differences between the traditional associationistic approach and the cognitive approach to human learning may be impeding scientific development. He suggests that while the cognitive approach could benefit from the functional analytic view that characterizes behavioral traditions, behaviorists could benefit from cognitive researchers by contacting other possible environmental causes of behavior. Whether or not one accepts mediational constructs or mental entities, processes and procedures accounting for behavioral phenomena may be investigated and described by both approaches. If an interaction of this sort is possible for disciplines that differ in their basic philosophical assumptions, it should also be the case for traditional operant and respondent researchers.

Behavioral sciences could also benefit from emphasizing simplicity and generality above conceptual division. Integration and unity should always follow fragmentation and analysis. When respondent equivalence was observed, it was suggested that the name "respondent type" be used to differentiate this procedure from the procedure used in early animal studies on the conditioned reflex. When classical conditioning of preferences and attitudes was observed, the term evaluative conditioning was proposed also to differentiate it from traditional studies on Pavlovian learning. Using new concepts to describe variations of traditional procedures, the use of different types of stimuli, or the application of the same procedures to other populations, suggests that the laws, as construed by the scientific community, lack in generality and scope.

In mature scientific systems, laws describe invariances notwithstanding a number of unessential transformations (Marr, 2013). As Marr (2013) accurately explains: "In the most sophisticated of sciences a minimum of distinctions yield a maximum of explanatory power" (Marr, 2013, p. 17). With the aim of achieving theoretical cohesion and solidity one of our goals as behavior scientists is to find points of conceptual convergence and unity rather than reasons for disintegration; ultimately, to strive for an integrative theory of behavior.

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