

Translational research: The ontological relation between adjunctive and stereotyped behavior case

Investigación traslacional: El caso de la relación ontológica entre conducta adjuntiva y conducta estereotipada

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Abstract

Translational research has reported several benefits as a heuristic strategy of knowledge expansion. Given that some authors have found similarities between adjunctive behavior and stereotyped behavior, the present paper analyze if these two kinds of behavior could be raw material for translational research. As elements of the analytical work adjunctive and stereotyped behaviors were described in their relationship with timing and Autism Spectrum Disorder, respectively. Then, a morphological and a functional assessment between both types of behavior were carried out. Main results showed morphological similarities and functional differences between types of behavior which were discussed in terms of suitability for translational research and in terms of the analytical tools utilized.

Key words: Translational research, Adjunctive behavior, Stereotyped behavior.

Resumen

La investigación traslacional, como estrategia heurística, ha demostrado diversos beneficios para el desarrollo del conocimiento. Dado que algunos autores han encontrado similitudes entre la conducta adjuntiva y la conducta estereotipada, en el presente estudio se lleva a cabo un análisis para determinar si estos dos tipos de conducta pueden ser empleados en investigación traslacional. Entre lo elementos que constituyen el análisis se encuentra una descripción tanto de la conducta adjuntiva como de la conducta estereotipada, así como su relación con la estimación temporal y con el Trastorno del Espectro Autista, respectivamente. Posteriormente, se llevaron a cabo tanto un análisis morfológico como uno funcional entre los dos tipos de conducta. Algunos de los principales resultados, arrojaron semejanzas morfológicas y diferencias funcionales. Tales resultados se discuten en términos de qué tan adecuadas son la conducta estereotipada y adjuntiva para llevar a cabo investigación traslacional y en términos de los recursos analíticos empleados.

Palabras clave: Investigación traslacional, Conducta adjuntiva, Conducta estereotipada.

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Introduction

Many authors have related adjunctive and stereotyped behavior, even to the point of declaring them as the same phenomenon (e.g., Goodman, et al., 1983; Lejeune, et al., 1998; Muñoz-Yunta, et al., 2005; Palya & Zacny, 1980; Powell, et al., 2000; Wayner, 1970). This article aims to analyze if any relation between these two kinds of behavior indeed exists either in a morphological or in a functional basis. The main consequence of adjunctive and stereotyped behavior being functionally related, from the present standpoint, is that they could be used as raw material for translational research. Obviously using them for translational research without existing a functional relation between them would be a great

mistake with very serious consequences that will be addressed later. Having this in consideration, even a functional relation absence detection would be an important and useful outcome.

Thus, at first, a translational research characterization is provided in which some of its benefits are stand out. Then, starting from a stereotyped behavior description with its morphological characteristics and the same for adjunctive behavior, a functional analysis between the two classes of behavior would be stressed out. Finally, the importance of analyses of this sort in the translational research context is discussed.

Translational research: the double-edged sword

A simple way of disciplinary classification, which naturally is not the only one, identifies in one hand basic science disciplines like biology, chemistry, physics, amongst others, devoted no more no less to knowledge progress; in the other hand, applied ones are acknowledged, whose efforts have been directed towards instrumental and technical development in favor of endowing services, which is the case of all the engineering for example, and, at least some years ago, medicine. In addition to these two kinds of discipline, exist another kind of discipline that has both endeavors, in other words, in these disciplines, knowledge is built, and, from that same knowledge, technology is produced. An example of this final kind of discipline is psychology.

Doesn't matter if basic and applied knowledge is developed in the same discipline or in more than one, the existence of this dichotomic classification of knowledge can be sustained. Even more, it is common to find applied developments based on basic knowledge. For example, it is well known by most of people that a secure building or a strong bridge can't be accomplished if is not built based on physics information like resistance of the soil, the force of gravity exerted in function of the height and weight of the construction, among many others physics basic knowledge. Examples of the relation between the two kinds of knowledge in the opposite direction are also available. For instance, it was not until sildenafil (Viagra) started to be being used for man's erection that these compound effects started to be studied in females (e.g., Basson, 2002).

When basic research, developed by a scientist, scientific group or laboratory, is the basis for new questions in applied research, and this new evidence turns again with new questions for basic research, and so on, this scientific process is called translational research (Mace, 2018; Mace & Critchfield, 2010). Is important to say that doesn't matter if the process starts with basic or applied investigation, if the described come and forth between basic and applied inquiry is guaranteed.

Many times, basic research has been criticized for not having application to a specific social problem or for not making easier people's life directly, *ergo* some basic studies seem to be useless. Is for this matter that translation-

al research have had great acceptance in some scientific communities including, obviously, grant evaluators. With translational research, knowledge development continues, and it comes with direct applications to social problems. Furthermore, translational research has had the great advantage of empowering scientific production, very important fact in the present days in which it is constantly inspected, and scientists' contractual stability depends on production volume. In this logic, when good results are obtained they come with three advantages: a) they could be applied directly and resolve social problems; b) they could be published; c) they generate new research in the applied field which will have the same b and c advantages to the other side.

In many occasions, relation between basic and applied knowledge is very direct, is very simple, pitifully, in many occasions it don't, an in many occasions seems to be direct and simple and it is not. That is why analyses like the one in this paper are, in several occasions, necessary. If the analysis was needed to be done and it was not made, some of the advantages of translational research become disadvantages in the form of wasted time and resources. Translational research can be a double-edged sword.

As stated above, an analysis between structural and functional relation between stereotyped and adjunctive behavior will be thru. In this case, stereotyped behavior has been typically addressed from applied research, specifically Applied Behavior Analysis area; while adjunctive behavior has been studied from basic research, specifically Experimental Analysis of Behavior area.

Stereotyped behavior: a trait of Autism Spectrum Disorder

Autism Spectrum Disorder (ASD) has been defined as a neurodevelopmental disorder consisting of difficulty with social communication and interaction in general, restricted interests and *stereotyped behavior*, and some symptoms which make difficult appropriate person's school, work and other areas functioning (National Institute of Mental Health, 2019).

Muñoz-Yunta, et al., (2005), defined stereotypy as a persistent, automatic and unconscious repetition of gestures, words, or as organized motor activity, repetitive, morphologically identical and not purposeful. This kind of behavior has been understood from several disciplines as functionless vocal and motor responses (Ahearn, et al., 2007; Kennedy, et al., 2000; Rapp, et al., 2004; Verdugo & Gutiérrez, 2011). It may be concluded that stereotyped behavior could be identified by three main features: identical morphological pattern, is constantly repeated and is not directed towards any purpose. This last trait may sound odd, that is to say, how could a specific behavior be directed towards any purpose, moreover if is repetitive? Well, if we take some other examples of repetitive activity, we can identify a target or goal to achieve, like when: we chop

an onion, lift weight in a gym or when we practice singing scales. Once the onion is chopped, we stop chopping onion and start eating; with weight lifting is common to determine, before workout, a specific number of repetitions once they are completed exercise is over; in singing scales practicing there's a specific time or performance criteria that signal when practicing have finished. In stereotyped behavior there are not this kind of goals or targets and is not easily identified the behavior's causes, in part, because they are no sustained by other's behavior.

Stereotypes have been classified attending to quite a few criteria, two that have been used more often are etiology and morphology. Regarding etiology three stereotyped behavior general types could be recognized: The first one befalls as a Central Nervous System (CNS) improvement and maturation, because they are behavioral consequences of neurodevelopment which with time allow later developmental functions. Some of them are balance, that prevailing as part of a neurodevelopmental process gives way to seating; suction, which far ahead enables breastfeeding (Aguilar, et al., 2019; Muñoz-Yunta, et al., 2005).

The second stereotyped behavior type is due to a CNS failure. Some examples of the second stereotypy type are "washing hands" behavior, present as one of Rett Syndrome symptoms (Aguilar, et al., 2019), rocking, taking hands to mouth, ear covering, hand biting, amongst others (Muñoz-Yunta, et al., 2005).

The third type of stereotyped behavior is that originated by environmental influence, for example as response to aversive stimuli or behavior restriction (Aguilar, 2019; Muñoz-Yunta, et al., 2005).

Considering morphology, stereotyped behavior could be classified as gestural, of movement, of action, and of vocalization. Gestural behaviors are referred to as focal stereotypies from a specific limb, movement behaviors consist of whole-body movement patterns, action behaviors are focal movements without displacement and vocalization behaviors are those linked with sounds (Muñoz-Yunta, et al., 2005).

Even though stereotyped behaviors have been related to neural substrates which have favored their manifestation decrease via neuroleptic drugs as risperidone (Barra-Carmona & Gutiérrez-Moctezuma, 2004), some strategies have been developed in order to reduce them via behavioral methods (Cronin, et al., 1985).

Not only has been demonstrated that stereotyped behavior difficult other academic, social and familiar activities acquisition, but also because some authors have suggested stereotyped behaviors as predictors of self-injurious behavior development (Barnard-Brak, 2015).

Adjunctive behavior in temporal- based schedules

In operant conditioning paradigm, a response is maintained by its consequences. Thus, if there are no specified consequences for a particular response, it should not be in

the organism repertoire (Skinner, 1938). This was a very powerful paradigm for many evidences supported it (e.g., Ferster & Skinner, 1957). Around 60's and 70's decades, anomalous data in the operant conditioning paradigm started to proliferate, one of them adjunctive behavior.

As a result of schedules of reinforcement as methodological tools for behavior study, time-based schedules, such as Fixed Interval (FI), Fixed Time (FT), Differential Low Rate (DLR), behavior started to be explored thoroughly. Staddon and Simmelhag (1971) showed that between operant or terminal responses, both followed by a reinforcer stimulus, many other responses were presented by organisms. Those other responses were morphologically different between each other and were different between organisms. Markedly, that was an unexpected and incomprehensible finding for the operant conditioning paradigm. Furthermore, these previously unidentified, unregistered and unanalyzed behavioral patterns seemed to be partially organized and very similar trial to trial.

Staddon and Simmelhag (1971) made a classification based on the part of the interval in which the adjunctive behavior was presented. They called responses in the first part of the interval, interim responses; those presented around half of the interval, adjunctive responses; finally, responses at the end of the interval were called terminal responses. Adjunctive behavior has been called, also, collateral behavior because they are presented with or aside operant responses. Another kind of adjunctive behavior is the one so called polydipsia or schedule induced drinking (see Falk, 1966). Schedule induced drinking has the characteristic that is presented when no water deprived organisms are brought under a temporal-based schedule in which reinforcer stimulus is food, but water is available and the most presented adjunctive response is a great amount of water intake between reinforcer deliveries.

Taking into consideration that adjunctive behavior has been found in temporal-based contingency arrangements, is not weird to think that this kind of behavior is the basis or at least a critical component in the *how an organism estimates time* explanation. In fact, two of the most accepted theories of timing, Behavioral Timing theory (BeT, Killeen & Fetterman, 1988) and Learning to Time model (LeT, Machado, 1997), recognize adjunctive behavior as an essential trait for timing explanation due to its regular and idiosyncratic properties.

Stereotyped and adjunctive behavior relation analysis

At first, should be underlined that stereotyped behavior being in narrow relation with ASD as one of its three principal traits is clearly subject matter of the applied research area. In fact, stereotyped behavior has no received importance by itself but as an ASD peculiarity that needs to be controlled or diminished in favor of people's presenting ASD learning sake, that is to say, stereotyped behav-

ior study has everything to do with an educational applied goal. In counterpart, adjunctive behavior has been related with how a specific behavioral development takes place, which is one of the main purposes of basic research in behavior analysis area. If that is the way it is, the first step is accomplished for stereotyped and adjunctive behavior to be raw material for translational research, because stereotyped behavior is a phenomenon from an applied area of research, while adjunctive behavior is a basic research area phenomenon.

Now, the justification for some authors to relate them, even though both types of behavior belong to different research areas, could be found, first, attending to a morphological standard and, second, to a pattern of behavioral display standard. Stereotyped behavior has a morphological identical pattern or model (Muñoz-Yunta, et al., 2005), while adjunctive behavior has a very similar pattern from trial to trial (Staddon & Simmelhag, 1971). In other words, for both types of behavior, displayed patterns are very similar through time. The second standard is related with the constant repetition of stereotyped behavior and the repetitiveness of adjunctive behavior in every trial. With both standards' integration, stereotyped and adjunctive behavior look very similar to each other.

Staddon & Simmelhag (1971) and Muñoz-Yunta, et al., (2005) as part of the description that they offered over their respective type of behavior, included an aspect that could be consider a functional one, and it seems that here is the first great difference. As said before, stereotyped behavior, it is presumed, is not directed toward any objective or does not fulfill a specific function. In the other hand, adjunctive behavior, does fulfill a specific function in timing. At least from BeT and LeT theoretical views, timing cannot be carried out without adjunctive behavior development.

In the face of the first difference between the referred behaviors, two consequences stand out. The first one is that this functional difference could be anticipated given that the relation of stereotyped and adjunctive behavior with a certain phenomenon, ASD and timing respectively, could lead to the idea that they are totally unrelated even though some shared characteristics since ASD and timing are totally different phenomena. Although it is true that ASD and timing are not even by close similar, in translational research it is not the important argument with which phenomenon some kind of behavior is related, but the functional similarities between the analyzed behaviors. Functional relation between types of behavior is like functional relation between a drug and different kind of ailments. Hypertension and fever have very different symptoms, but the effect of acetylsalicylic acid in the body, or the functional relation between acetylsalicylic acid with the body, aids in both cases.

The second consequence, then, is that a functional analysis is needed in order to know if stereotyped and adjunctive behavior may be used for translational research. For this quite complicated task, a taxonomy based on functional properties is needed. Ribes and Lopez (1985)

developed a taxonomy of behavior precisely by the logic required based on a synchronic interaction behavioral field model developed by Kantor and Smith (1958). Ribes and Lopez taxonomy is composed of five levels of functional structuration, which are ascendingly more complex, and every one of them include the previous one. Two are the criteria for functional differentiation of the five levels: functional detachment and functional mediation. Functional detachment is the level in which organism's responses depends less on physic and chemical properties of the environment. The higher functional detachment, higher the level. Functional mediation has to do with the element that gives structure to the interaction in each level. So, the in ascending order of complexity, the levels are: contextual, supplementary, selector, referential substitutive and no referential substitutive.

Contextual level is that in which the organism responds differentially to stimuli relations like in classical conditioning. Supplementary is the level in which some of the stimuli present in the environment are produced by the organism's behavior, as it happens in operant conditioning. In selector level organism behavior must adjust to stimulation variability in order to produce a reinforcer stimulus, as it occurs in conditional discrimination. Substitutive levels are linguistic ones and interactions have elements totally detached from the present situation.

When this simplified characterization of the Ribes and Lopez taxonomy it is possible to identify if stereotyped and adjunctive behavior are structured in the same or in different functional levels. Some authors that work with stereotyped behavior sustain that it is automatically reinforced by sensorial consequences produced by the same behavior; that is controlled by multiple reinforcement sources; and it is not controlled by social reinforcement (Ahearn, et al., 2007; Anderson, et al., 2010; Rapp & Volmer, 2005). From these assertions is very clear that stereotyped behavior needs reinforcement to be maintained, and in many occasions the main source of that reinforcement is the same person that present stereotypy. This kind of interaction lead us to a supplementary level of functional structuration.

Regarding adjunctive behavior, some authors say that it is developed under reinforcement programs temporally based, defined by periodic presentation of food or water (Falk, 1966; Ruiz & Bruner, 2005; Staddon & Simmelhag, 1971; Wilson & Keller, 1953). Based on that sentence, food and water are presented apart from adjunctive behavior occurrence. In consequence adjunctive behavior belongs to a contextual level of functional structuration.

Until now, functional aspects and functional analysis show that adjunctive behavior is different from stereotyped behavior. But what happen if adjunctive and stereotyped behavior are to be augmented or reduced in frequency? Commonly, stereotyped behavior is not to be augmented, it is rather decremented by not contingent reinforcement, differential reinforcement, punishment, multiple contingencies and physical exercise (Doughty, et al., 2007; Hanley, et

al., 2000; Lanovaz, et al., 2013). Again, evidence is in favor of treating stereotyped behavior at a supplementary level because all the reducing strategies entail some sort of consequence. When adjunctive behavior is to be augmented or decremented is by objects, dispensers and operand disposition or retirement (Barnes & Keenan, 1993; Bruner & Revusky, 1961; Falk, 1966; Laties, et al., 1965; Ruiz & Bruner, 2005). Also interrupting behavior mechanically or via substance administration (Frank & Staddon, 1974; Glazer & Singh, 1971; Hodos, et al., 1962). As can be seen, neither strategy involve consequences to behavior, presumably because adjunctive behavior is not controlled by contingent consequences due to a contextual functional level.

Discussion

As said before, the main intention of the present paper was to identify any relation between stereotyped and adjunctive types of behavior, because that analysis may shade light concerning the possibility or impossibility of translational research through these two kinds of behavior. The results from the analysis carried out here, emphasize the importance of not reaching only a morphological based analysis in order to make decisions about possible basic and applied concepts relation, because a morphological level of analysis could take the lead to misleading outcomes. From a morphological standing point adjunctive and stereotyped behavior looked quite similar, but from a functional analysis it comes clear that they belong to different functional levels of contingency arrangements.

Stereotyped and adjunctive behavior being functionally different is an important and valuable outcome in two ways. The first one is demystifying the former functional relation and moreover, the former conception of these two kinds of behavior being the same behavior. The second one is that the present analysis prevent future attempts of using these behaviors for translational research, that is a great possibility regarding the importance of ASD study in the applied scientific field in one hand, and regarding how important is timing research these days in the basic research area in the other hand.

It is important to say that the functional analysis outcomes are directly bound to the ontological view of behavior. The present analysis was made from the molecular analysis segmentation of behavior of operant conditioning and from the interbehavioral taxonomy of Ribes & Lopez which rests in the same molecular analytic level. It is possible that if the analysis is made from a molar frame like Baum's (2012), outcomes may come different.

Another possible value of the present paper is showing how convenient, powerful and heuristic translational research may be, but at the same time, how inconvenient and tortuous may also be, depending on an inaccurate identification of related phenomena from basic and applied research. That accuracy necessarily is a result of a deep analysis of the elements that potentially be the raw material

for translational research. Therefore, more analysis should be made with the probability of finding the phenomena that could produce translational research and, as a natural consequence, a great amount of quality knowledge for basic and applied research fields.

Finally, it is important to address that translational research not only has de advantages mentioned above of being heuristic in one hand, and that of agile and powerful application properties in the other, which are very important by the themselves, but also settle opportunities of conceptual and theoretical clarification as in the present case, which always brings in benefits for the discipline in which translational research takes place.

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