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Learning to be a psychostimulants addict with self-regulation therapy

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***Abstract*— This article presents the results of a single-case experiment of alternative treatments in which a participant applied the Self-Regulation Therapy (SRT) to reproduce the effects of a stimulant drug, methylphenidate, and a sedative, alcohol. The SRT is a learning procedure based on classic conditioning and suggestion that reproduces the effect of drugs by remembering the effects they have. The participant reproduced the effects of both drugs during ten sessions held on 5 consecutive days. To record effects, adjective scales were used that measured Drug effect, High, Rush, Energy, Tension and the General Factor of Personality (GFP). The results indicated that the participant was capable of independently reproducing the effects of both the above-cited drugs, and that most of these effects were graphically represented as an inverted U-shape. This inverted U can be interpreted as a process in which effects of drugs become progressively more marked (sensitization) to become progressively less marked (tolerance). In this way, the inverted U represents the equivalent to a complete process of becoming addicted to a drug. The participant "learnt to be an addict" without using drugs. The theoretical implications and therapeutic potential of this procedure are discussed.**

Keywords- Addiction; Self-Regulation Therapy; sensitization drug; tolerance drug; General Factor of Personality; methylphenidate; alcohol.

1. Introduction

Different addiction models can explain the process by which drug use becomes abuse and compulsive drug use [1,2]. Among the most outstanding addiction models we find those based on the opponent process theory of addiction [3,4,5], the incentive-sensitization of addiction [6,7], and neurobiological addiction models [8,9].

Despite their differences, these models share some characteristics, like the importance attached to non-associative processes such as pharmacological sensitization and tolerance, and learning processes (classic and operant conditioning) when explaining the origin and development of addiction, and also of relapses.

Learning models of addiction underline the importance of environmental stimuli in addiction developing. Drugs classic conditioning has been amply demonstrated in experiments done with animals and humans by conditioning positive effects, as well as sensitization, tolerance and drug withdrawal [10,11,12].

In studies into learning addictive behavior through classic conditioning, emphasis has been placed on the CS-US (Conditioned Stimulus - Unconditioned

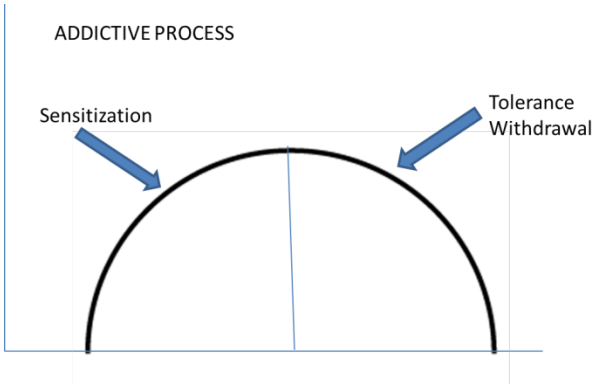
Stimulus) association to explain the learning of positive drug effects. However, very little attention has been paid to the nature of the Conditioned Response (*CR*) and its relevance in the addiction process or therapeutic intervention. Therefore in those treatments administered to lessen the conduct learnt by classic conditioning, the extinction procedure is designed to handle the *CS-US* association while waiting for the *CR* to be easily eliminated [13].

One learning process has been designed specially to reinforce the *CS-CR* association. This procedure is known as the Self-Regulation Therapy (*SRT*) [14,15], which is based on applying classic conditioning and suggestion from the cognitive-behavioral perspective of hypnosis [16]. The main objective of its design was to help reproduce the positive effects of drugs; that is, to reinforce the CR.

A detailed description of the *SRT* procedure is found in [15], along with a broad and complete experimental basis of the procedure. A summary of some studies and procedures is found in [17].

Most studies conducted with the *SRT* have demonstrated that it is possible to reproduce drug effects during a single session, but a few studies have been conducted with more sessions [18,19], and it was impossible to know if reproducing drug effects with time and during different sessions can produce a similar effects curve to that of addition; in other words, a progressively increasing intensity of the effect (sensitization), followed by a progressive drop in effects (tolerance, drug withdrawal). If this intensity curve of drug effects took place, it would be inverted U-shaped. Figure 1 is a simple schematic representation of an inverted U-shaped addictive process with the first stage of sensitization and a second tolerance/withdrawal phase.

Figure 1. Schematic representation of the drug addictive process with a first sensitization phase and a second tolerance/abstinence phase.



This article presents the results of a first experiment that intends to shed some light on this matter. It is a single-case experimental design of alternative treatments in which the subject, by applying the *SRT*, reproduced the effects of a psychostimulant, methylphenidate, and alcohol on 5 consecutive days.

The classic conditioning of the effects of psychostimulants, like cocaine, has been well demonstrated [20-22], as it has the classic conditioning of alcohol effects [23-28]. The *SRT* has proven efficient to reproduce stimulant effects of certain drugs like cocaine, speed and methylphenidate [29-34], although it has still not been used to date to reproduce the effect of alcohol.

If during different *SRT* sessions some indication of sensitization and tolerance is noted, we can state that we are about to demonstrate the possibility of creating a "drugless" addictive drug process which, as discussed later, may have important consequences for research and treating addictions and other psychological disorders.

2. Methodology

Participant

The participant was a 50-year-old male, and an old patient of the author of this article. He voluntarily accepted to form part of the study and signed the informed consent.

Instruments

1. The Five-Adjective Scale of the General Factor of Personality (*GFP-FAS*) [35]. The five adjectives are: adventurous, daring, enthusiastic, merry and bored. The *GFP-FAS* is related positively with Extraversion, Agreeableness and Openness, and negatively with Neuroticism and Conscientiousness. However, it can integrate all basic traits of personality [35]. Two versions of the *GFP-FAS* were used: trait-format version and state-format version ("Are you like this at this moment?" or "do you feel so at this moment?"). The participant filled out the state-format version form every 15 minutes to obtain a situational measure of the *GFP*. Each adjective is self-rated on a 10-point continuum.

2. *Effects of drugs.* It comprises two adjectives, High and Rush, and an expression: Drug Effect. The scale scores go from 0 (no effect) to 10 (maximum effect). These adjectives have been used in a large number of studies on subjective drug effects, quite often in the Visual Analogue Scales (*VAS*) format.

3. A short form of the Activation-Deactivation Adjective Check List (*AD ACL*) [36]. This is a multidimensional test of various transitory arousal states. There are five adjectives on each subscale, and each adjective is self-rated on a 10-point continuum. Two subscales were chosen for this experiment: Energy and Tension. The adjectives included in these two subscales were: energetic, lively, active, vigorous, and full of pep, and tense, clutched-up, fearful, jittery, and intense.

Experimental design and procedure

This is a single-case experimental design of alternative treatments. The patient usually consumes alcohol, sometimes in large quantities, and even remembers the psychostimulant effects of methylphenidate, which he took for the last time 6 months earlier. He was taught to apply the *SRT*, a procedure which he was already familiar with, to specifically reproduce the effects of methylphenidate and alcohol. The participant had to reproduce the effects of both drugs alternatively and randomly on 5 consecutive days. During each session, he had to complete adjective scales (Drug Effects, High, Rush, Energy, Tension, *GFP-FAS*) on a Likert scale from 0 to 10 points. We call each occasion on which the participant had to reproduce the stimulant effect the "Stimulant Condition", and each occasion on which he had to reproduce the alcohol effect the "Alcohol Condition".

For both experimental conditions, the participant had to complete all the scales before applying the *SRT* so that the Baseline was recorded. After applying the *SRT* to reproduce stimulant effects, he had to complete the scales again while experiencing the maximum euphoric effect, and yet another time when the euphoric effect had substantially reduced and the participant felt relaxed. So we can distinguish three Stimulant Condition phases:

1. Baseline
2. Maximum euphoric effect experienced
3. Relaxing effect experienced

We distinguished two phases for the Alcohol Condition:

1. Baseline
2. Maximum effect experienced that is similar to alcohol

With this design it is possible to compare the reproduced effects of both the stimulant and alcohol in relation to the baseline, and with each other. With the three Stimulant Condition phases, the intention was to compare the two effect types that the stimulant produced until this effect had completely disappeared: euphoria followed by serenity, which we describe herein as "relaxation".

Next the results obtained in the experiment are presented as both statistical and graphical results. The statistics used was non-parametric as the sample (number of sessions) was small (five sessions for each drug). So, N was considered the number of sessions when adapting inferential statistics to the single-case experimental designs [37].

The graphical results offer the unique chance to visually observe how the points on the different scales evolve on 5 consecutive days. This is a good way of checking whether sensitization and tolerance processes occurred as this would indicate the possible development of drug addiction by the *SRT*; that is, "drugless".

3. Results

Table 1 offers the means and standard deviations of the scores on the different scales used in this study.

(The section Appendix, placed after the section References, is devoted to present figures and tables).

Friedman's test was used to compare the reproduction of the stimulant effects of methylphenidate in the three phases. The variables "drug effects", "high" and "rush" were not compared as they scored 0 at the baseline. To make the table simpler, 0 was not included, but a dash (-) was used instead.

Table 2 presents the result of the Friedman's test.

Table 2. Results of Friedman's chi-squared test for the Stimulant Condition. (Df.= degrees of freedom; Sig.= asymptotic significance).

	Chi-squared	Df.	Sig.
Energy	8,316	2	.016
Tension	7,600	2	.022
GFP-FAS	8,400	2	.015

We can see how for Energy, Tension and *GFG-FAS*, Friedman's test gave significant results; that is, significant differences appeared among the three scales for the different experiment phases: baseline, reproducing euphoric effects and reproducing relaxing effects.

For the pair-wise comparisons, the Wilcoxon test was used for the Energy, Tension and *GFP-FAS* scales of the ranges with signs for the related samples. The results are found in Table 3.

For the Stimulant Condition, reproducing the

euphoric effects significantly increased Energy and *GFP-FAS* compared to the baseline and the relaxing effects. The relaxing effect of the stimulant reduced Tension compared to the baseline and the euphoric effect (Z=-2.04 and Z=-2.02, respectively, with p<.05). Reproducing alcohol with *SRT* significantly reduced the score for Energy (Z=.-2.02; p<.05).

The Wilcoxon test gave significant results at the 0.05 significance level on the scales Drug effects, High and Rush for the Stimulant Condition when comparing Phase 1 (stimulation) with Phase 2 (relaxation). The results are found in Table 4.

Table 4. Comparison of Phase 1 and 2 on the scales Drug effects, High and Rush for the Stimulant Condition. (Sig.= asymptotic significance).

	Wilcoxon Z	Sig.
Drug effect	-1.84	.066
High	-2.32	.042
Rush	-2.06	.039

When we compared the scores of all the scales between reproducing the effects of both the Stimulant and Alcohol Conditions, and for both the baseline and phase 1 using the Kolmogorov-Smirnov test for independent samples, we found no differences in the baseline, whereas reproducing the stimulant significantly increased the scores for Energy and Tension in the comparison made with reproducing alcohol effects. The results are found in Table 5.

Table 5. Comparison of the scores obtained with the scales for the Stimulant and Alcohol Conditions, for both the baseline and first phase. (Sig.= asymptotic significance).

		Z	Sig.
BASELINE	Energy	.632	.819
	Tension	.316	1
	GFP-FAS	.632	.819
REPRODUCING THE EUPHORIC EFFECT	Drug effect	.949	.329
	High	.632	.819
	Rush	.949	.329
	Energy	1.581	.013
	Tension	.632	.819
	GFP-FAS	1.581	.013

We now show the graphs to illustrate the variation in the scores of the different scales for all the conditions.

In Figure 2 we can see the scores on scales Drug effects, High and Rush for the Stimulant (two phases) and Alcohol Conditions.

We observe how the higher scores correspond to phase 1 of the Stimulant Condition (euphoric effects) and the lowest ones correspond to phase 2 of the same condition (relaxing effects).

Figure 3 offers the scores of scales Energy, Tension and *GFP-FAS* for both the Stimulant and Alcohol Conditions and for all the phases.

For the Stimulant Condition we can see that the euphoric effects considerably increase Energy and *GFP-FAS*, while the relaxing effects lower them to the baseline, and also reduce Tension.

Whereas Tension remains at baseline levels with the Alcohol Condition, reproducing alcohol effects reduces Energy and *GFP-FAS* and goes below the baseline.

We can see that most of the curves in the two figures are inverted U-shaped. This may represent the characteristic curve of addiction, with scores increasing at the beginning (sensitization) and then progressively lowering during the next sessions (tolerance).

It is worth stressing some U-shaped curves, especially those for the Tension variable in the Alcohol Condition, and also for the Energy variable in the reproduction phase, which might indicate some adaptation to the depressor alcohol effect when reproduction sessions are repeated.

4. Discussion

This article presents the results of a single-case experiment on reproducing drug effects during 10 sessions (five reproduction sessions for each drug) on 5 consecutive days. The participant used the *SRT* alternatively and randomly to reproduce the effects of a psychostimulant (methylphenidate) and alcohol.

The statistical results reveal that the participant was capable of discriminating the effects of both drugs, and was able to clearly distinguish when their effects were reproduced with the *SRT*. This article also demonstrates that Drug Effect, High and Rush clearly increased when the participant was experiencing the maximum (euphoric) effects of both drugs compared to the baseline. It was also possible to distinguish two phases in the stimulant effects: a peak for euphoria, followed by a calm and relaxing phase.

Where the results of this experiment are clearly illustrated is in the two graphs, where we can see how

Drug Effect, High and Rush tend to form an inverted U over the 5 days that the experiment lasts, particularly for the first two scales and for phase 1 (peak of euphoria) for the Stimulant Condition.

Energy and *GFP-FAS* also tend to form an inverted U, especially in the two Stimulant Condition phases. For the Alcohol Condition, *GFP-FAS* forms an inverted U, while Energy forms a U.

An inverted U can be interpreted as proof of the addictive process, with an enhanced effect during the first sessions (sensitization) and a lessened effect during the following sessions (tolerance). For the Alcohol Condition, the Energy U can be interpreted as a process of tolerance to the depressor effects of alcohol. In another experiment, where the subject reproduced the effects of another psychostimulant, ephedrine, over 5 consecutive days, a sensitization effect was also observed, but there was no tolerance effect [18].

The participant's subjective feelings about the potential addictive process were learnt during the next interview held with him. He revealed that during the week, he felt he wanted to experience the effects that he had managed to reproduce, but only to reproduce the psychostimulant effects. He felt a strong dislike to the Alcohol Condition as he was unable to reproduce the effect of feeling slightly drunk, but managed to reproduce the feeling very drunk effect. This aversive feeling (feeling sick, dizzy and generally unwell) made him reject this experience. Conversely, he found that reproducing the effects of methylphenidate was gratifying, especially in phase 2 (relaxation). He felt he wished to once again experience the feelings reproduced by the stimulant, but never felt the need to use the drug.

What all this allows us to understand is that it is possible to reproduce an addictive process of a drug with the *SRT* without using the drug and that this type of addiction does not lead subjects to seek the real drug. This, in turn, allows us to deduce that the *SRT* procedure can be used to treat drug addictions, especially after verifying this by the *SRT*, as heroin and cocaine addict patients who underwent rehabilitation were capable of reducing their drug craving during a test session [31,38]. Moreover, the *SRT* can be used to improve emotional disorders in psychology and psychiatry because by knowing the "addictive process" that the *SRT* produces. When employed during several sessions, it is possible to intervene in any process phase in order to favor therapy. This has already been performed to enhance the sensitization to reproduced drug effects and to avoid tolerance [18,19].

The limitations of this study are obvious since it is a single-case experimental design that includes only a few sessions. In order to continue making progress with the many suggestions made in this article about the advantages of using the *SRT*, it is necessary to work with much larger groups in the experiments, with both number of subjects and number of sessions. It is also necessary to work with a clinical sample so that the obtained results can be applied to this population. It is important to point out that apart from increasing the number of sessions in future studies, it would be most interesting to apply another type of quantitative analysis to better reflect the significance of the evolution of the scores. Our research team has already published dynamic mathematical models of differential equations to simulate the acute effect of a stimulant dose [39] and the complete addictive process of cocaine [40]. These findings must be applied to future research designs that follow the guidelines presented herein.

Despite all these limitations, this study is the first step to demonstrate that it is possible to "acquire an addiction" without drugs, which is beneficial for clinical and general populations. Besides that considered herein, the approach of this article, along with its title, offers a new look at addictions, which may suggest exploring new research routes and intervening in the broad psychology, psychiatry and neurology fields.

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Appendix

Table 1. Means ($\overline{X}$) and standard deviations (SD) of the scores obtained with the different scales for the three phases in this study.

PHASE	SCALES	STIMULANT		ALCOHOL	
		$\overline{X}$	SD	$\overline{X}$	SD
BASELINE	Drug effect	-	-	-	-
	High	-	-	-	-
	Rush	-	-	-	
	Energy	10.60	2.07	14.60	4.98
	Tension	30.60	3.28	29.40	4.50
	GFP-FAS	3.60	4.15	17	4.74
REPRODUCING EUPHORIC EFFECTS	Drug effect	7	1.73	5.40	1.81
	High	7.40	1.81	6.40	1.51
	Rush	9	1.73	7.20	1.64
	Energy	34.20	2.58	7.60	2.19
	Tension	29.80	5.97	28.40	4.72
	GFP-FAS	36.20	5.89	11.80	2.58
REPRODUCING RELAXING EFFECTS	Drug effect	4.40	.54		
	High	4.20	2.09		
	Rush	0	0		
	Energy	13	4.84		
	Tension	15.20	5.16		
	GFP-FAS	18	6.40		

Table 3. Pair-wise comparisons made of the different scales that measured the effect of reproducing stimulants in the three phases (information on positive and negative ranges has been left out).

	SCALES	Phase1-LB		Phase2-LB		Phase2-Phase1	
		Z	Sig	Z	Sig	Z	Sig
STIMULANT	Energy	-2.03	.042	-1.46	.14	-2.03	.042
	Tension	-.54	.58	-2.04	.041	-2.02	.043
	GFP-FAS	-2.02	.043	-1.76	.078	-2.03	.042
ALCOHOL	Energy	-2.02	.043				
	Tension	-.55	.58				
	GFP-FAS	-1.82	.068				

Figure 2. Scores of the scales Drug effects, High and Rush for the Stimulant (phases ST1-stimulant and ST2-relaxing) and Alcohol Conditions.

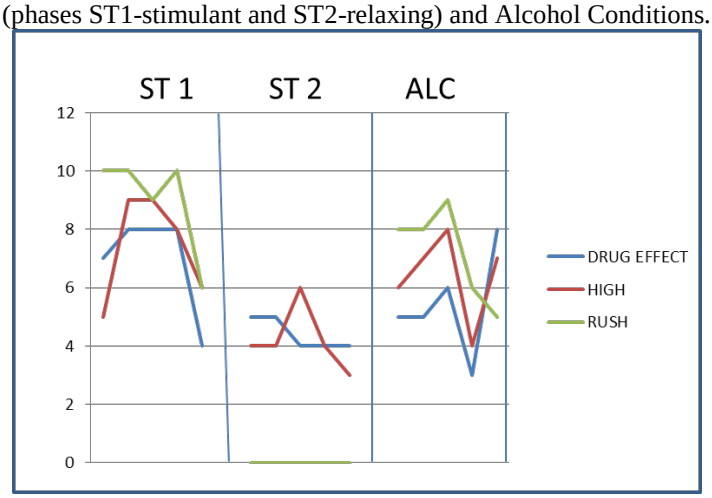

Figure 3. Scores on scales Energy, Tension and *GFP-FAS* for both the Stimulant and Alcohol Conditions and for all the phases.