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The general factor of personality: History of an interdisciplinary venture

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1. Introduction

The General Factor of Personality (GFP) is a new psychological approach of the study of the human personality that is based on the idea that, as in the case of General Intelligence, there is a personality super-factor that agglutinates and represents all the other aspects of personality. Therefore, it can be considered as a system of personality subsystems, or a global and integrated system of all the different components from the personality.

Thus, the GFP also can be studied from Psychology and from General Systems Theory. As far as psychology, the theoretical and empirical boarding of the GFP has been limited the structural study, that is to say, to the correlational and structural study of the main factors of personality and the GFP. Between the personality models that have been used to make these studies, it raises the model of Big Five (Extraversion, Neuroticism, Opening to Experience, Amiableness and Responsibility) and the model of Eysenck (Extraversion, Neuroticism, Psychoticism). But nothing is known about the dynamic relations among these factors at the time of explaining the personality super-factor that represents the GFP.

The main aim of our research group has consisted of the study of the dynamics of the GFP and the factors that compose it. To do so, it has been started from the single trait theory of personality [1] and the theory of systems, in order to advance on the study and understanding of the GFP and to design a mathematical model that explains its dynamics. The stimulant drugs have been considered as a stimulus that initiates the body's response and, therefore, that of the GFP.

At the present time, we have been able to state and to describe the dynamics of the super-factor of personality of the human being; simultaneously we have entered into other related areas such as the study of the change of the GFP with the Therapy of Auto-Regulation (TAR), the personality of societies, or the relation body-mind.

Next the evolution of the work of the team through something more than one decade is explained with a little more detail and chronological form.

2. The beginnings: the Unique Trait Personality Theory and the Theory of Systems

In year 2005 Salvador Amigó publishes the book "La Teoría del Rasgo Único de Personalidad" (The Unique Trait Personality Theory). This trait is identified for the first time with Extraversion, and this theory sets up the scientific bases of the existence of a supra-system of personality, of a single factor that agglutinates all the other systems of personality, besides to present, in this scope of study, the TAR for the change of the unique trait, from the mental reproduction of the drug effects. Therefore, it was assumed that drugs can change the unique trait, i.e. the global personality in the short term (while the effect of the drug lasts), and that it is possible to learn to mentally reproduce the effect of drugs with the TAR and, therefore, to change temporarily the global personality voluntarily.

That same year we agreed and showed the interest to collaborate in a project to elaborate a dynamic mathematical model to study the dynamics of the unique trait from its reaction to the stimulating drugs consumption. Antonio Caselles and Joan C. Micó had a wide and extensive educational and research experience in the theory of systems. In addition, Caselles had developed some mathematical tools: SIGEM [2], for the automatic programming of complex mathematical models, REGINT [3], for searching and fitting functions of several variables to a data set and PARDOSU [4] with which to fit systems of differential equations to a data set or to calibrate systems.

The first months served to bring our knowledge and scientific experience to the group, what always is complex when it is to carry out an authentic interdisciplinary collaboration from very diverse fields, and to organize the work agenda. From the beginning it already turned out to be a bet of high level of difficulty, simultaneously that productive and exciting.

3. First publications: Dynamics of short and long term for Extraversion

In the first international publication the mathematical model of Extraversion appeared, showing how the Unique Trait or Extraversion reacted to a single stimulating drug dose [5]. If Extraversion is a bipolar dimension that extends from the pole of extreme Extraversion to the one of the Introversion, we saw that we could classify people throughout this line based on its reaction to a drug dose.

Also we elaborated a dynamic mathematical model to predict the evolution of Extraversion throughout two years of continued cocaine consumption [6]. Therefore, our model was able to describe the effect of a drug not only of a single dose but of a sequence of repeated consumptions along time.

4. The General Factor Personality appears in scene

We published a study in which we demonstrate that Extraversion, like Unique Trait, is the super-system that integrates the main factors of personality of the more influential models of personality, like the one of the Big Five and the one of Eysenck. [7]. From the different revisions of the article we became aware that the concept of Unique Trait was already becoming a powerful international research line, but that the name with which it was known was General Factor of Personality. Although we continued maintaining the concept of Unique Trait and the same action mechanisms that explained it, we chose to assume the name with which it was internationally known, and began to accept the term General Factor of Personality in the next publications.

5. Experimental studies with the General Factor of Personality (GFP): validation of the theoretical and mathematical model

We obtained a brief scale of only 5 items in state-format to evaluate the change of GFP [8]. With this scale it was possible to measure the evolution of the GFP like reaction to a unique dose of drug. We performed experiments in which the participants took a dose of coffee and evaluated their reaction on the GFP and on the Big Five [9,10]. The results supported what the theoretical-mathematical model already announced: that it is possible to predict the short term response of the subjects to a dose of a drug (its effects). We were in the way to validate a general dynamic model of personality, which to our to understand was the first demonstration made on the matter in the scientific community.

6. The biological bases of the General Factor of Personality dynamics: experimental studies with methylphenidate

Inside the process of validation of an integral and dynamic model of the GFP we set out to study its biological foundation. In an experimental study of an only case we could verify that the methylphenidate, a stimulating drug used in psychiatry, produced a change in the levels of glutamate in blood in the line of the established thing in the original model, what designates glutamate like the par excellence neurotransmitter of GFP [11].

On the other hand, in studies of an only case we could validate our model from the changes that methylphenidate produced in two regulating genes: DRD3 and c-fos [12,13]. DRD3 is a gene that regulates the cellular inhibiting mechanisms and the opposite is true for c-fos. In these studies we could state that, indeed, the inhibiting and activator genetic mechanisms that we observed were coherent with our theoretical-mathematical model.

7. The Therapy of Auto-Regulation to mentally reproduce the effects of drugs appears

In the biological studies above mentioned [11-13] a suggestion procedure designed by Salvador Amigó, named Therapy of Auto-Regulation (TAR) was used, that teaches "to imitate" or to reproduce mentally the effects of drugs [14]. It was verified that the TAR modifies the biological parameters (glutamate, DRD3 and c-fos) in the same way that the own drug does, besides to reproduce the same subjective effects and also the same dynamics of the personality. Therefore, we had a procedure that in future studies can replace the drug taking.

In the Mathematical Modelling in Engineering & Human Behavior 2017 Conference, celebrated in 2017 July, we presented a communication in which it was confirmed that the same parameters of the dynamic model that explain the effect of methylphenidate on personality were applicable when TAR is used instead of the drug [15].

8. We considered to deepen into the body-mind relation

The previously mentioned experiments looking for to investigate in the biological substrate of the GFP and its dynamics generated a new line of work: the study of the body-mind relation. This old problem of the humanity was treated dynamically, involving the biological bases of personality (concretely the c-fos gene and the glutamate neurotransmitter) and the GFP, through partial differential equations, when the stimulus is methylphenidate [16].

9. Beyond the individual: the General Factor of Personality in societies

The idea that the same mechanisms explain the dynamics of individuals, groups and wide associations are essential in the theory of complex living systems [17]. This is why we have initiated the way to validate our theoretical-mathematical model in societies. At a first moment we proposed a theoretical model, based on the theory of systems, to validate the theory of the survival of societies of Salvador Amigó [18]. This theory suggests a dynamics of the evolution of societies like a reaction to crises and in a publication we outlined a first approach of a theoretical-mathematical model [19].

More ahead, in a scientific meeting in the "Universidad Complutense de Madrid" a model based on a wider theory of global personality appeared [20], partly inspired by the theory of personality of Carl Jung and re-elaborated by Amigó [21], with the pretension that it were extrapolative to societies. Therefore, the possibility that our theoretical-mathematical model of personality were also applicable to societies of any place and time was opened.

10. To the search of a unifying model of psychology and physics. Quantum mechanics, personality and brain

Until certain moment of our research the developed models had time as the only variable of reference of the change. But the reality that we considered is that the brain, like fundamental part of the stress system, physiological substrate of the GFP, is located in a limited space zone. Therefore, we set out to

generalize our mathematical model of response to a single dose of a drug, including the space variation in addition to time variation. The research took us to a mathematical model of space-time response given by a parabolic partial differential equation. The boundary conditions of the brain provide a surprising newness: an infinitely numerable set of results of quantisized functions that correspond with an infinitely numerable set of self-values also quantisized, and that depend on integers [22].

This new space-time approach provides results similar to the quantum-mechanic ones for the hydrogen atom or the black body of Planck. At the present time we try to deepen into this approach, on the one hand, experimentally introducing the tonic level in the model like a space function, concept not yet present in [22], and on the other hand, looking for experimental data for its validation. Therefore, a validated space-time development like that we propose would be equivalent to an interdisciplinary approach that would include physics, brain and personality.

11. The method like the main target of our work

We have based all our work on the scientific method, the complex mathematics and the inferential statistics. We have proposed theoretical models and we have performed empirical studies with group experimental designs and designs of only one case. But from the first moment, and especially at present, our interest to improve the work method has been a constant.

In fact, the evolution of our theory has been an auto-exigency when we face new challenges. For example, the mathematical model of response to a stimulating drug was conceived in [5,9] like a finite differences equation with a discreet delay. Nevertheless, face to the challenge of looking at the body-mind problem, the model became a continuous delay differential equation [13,15,16], well-known in mathematics as an integro-differential equation. In addition we have to add to the obtained equations, the partial differential equation with which to study the body-mind problem [16] and the dynamic relations among the GFP and the Big Five [10]. And to complete the set of equations that are a generalization of the previous ones, we have the space-time model of the brain [22] that could throw mathematical light on the basic frequencies of the electroencephalogram.

12. Conclusion

In this article we have summarized the evolution of our interdisciplinary work along more than one decade. We had begun saying that the serious interdisciplinary work is complicated, and thus it was at first. Little by little we went adapting to a system of organized and fruitful work that has been gradually improving the joint work supported by the group synergy.

The result, until the moment, is that we have a theoretical-mathematical model, able to describe and to explain the dynamics of the complete personality and its more important components, from the environmental stimuli, especially drugs, since the reaction to drugs provides a privileged information, detectable and registrable by the intensity of the same one.

Besides to know in greater depth the dynamics of the global personality of the human beings, we entered into the study of the relation mind-body, and into the analysis of the voluntary and fast change of personality using the Therapy of Auto-Regulation, also created by one of us.

In addition, we have carried out the first proposals to validate our dynamic model beyond the individuals, for societies, and have made a concerted effort in improving the method of interdisciplinary work, approaching the complex mathematics and the inferential statistics, looking for methodologic bridges of encounter between disciplines so apparently distant as mathematics and psychology and, in fact, between physical sciences and human sciences.

But the way is still being crossed; there is much task to be made. That is why we have wanted with this special number of the RIS, on the one hand, to expose our trajectory until the present and, on the other hand, to offer some of our more recent research.

In this issue we present new confirmation

about the structure and dynamics of the GFP, as well as about the effectiveness of the TAR to change the global personality in the short and mid-term, what opens a new field of important applications in psychology, psychiatry and neurosciences. On the other hand, we offer a developed theoretical model for the General Factor of Personality of societies, as well as some suggestions for its mathematical development. On the other hand, we offer the new methodologic contributions in which we surpassed the "old model of response" and we replaced it by a more effective and sensible model, in the above pointed line, of our firm intention to continuously improve the work methodology.

Really, this special issue about the General Factor of Personality and the theory of systems tries to be not only a presentation of the made things until now but, mainly, a proposal of future to continue deepening in the knowledge of the human nature and in the development of an integrating model of the different fields of knowledge, from physics to psychology, as well as of the individual and the society to which it belongs.

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Factor General de personalidad: historia de una aventura interdisciplinar

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1. Presentación

El Factor General de Personalidad (FGP) es un nuevo enfoque psicológico del estudio de la personalidad humana que se basa en la idea de que, como en el caso de la Inteligencia General, hay un súper-factor de personalidad que aglutina y representa a todos los demás aspectos de la personalidad. Por tanto, puede considerarse un sistema de subsistemas de personalidad, un sistema global e integrado de todos los diferentes componentes de la personalidad.

Así, el FGP puede ser estudiado desde la psicología y también desde la teoría de sistemas. En cuanto a la psicología, el abordaje teórico y empírico del FGP se ha limitado al estudio estructural, es decir, al estudio correlacional y estructural de los principales factores de personalidad y el FGP. Entre los modelos de personalidad que se han utilizado para realizar estos estudios destaca el modelo de los Cinco Grandes (Extraversión, Neuroticismo, Apertura a la Experiencia, Amabilidad y Responsabilidad) y el modelo de Eysenck (Extraversión, Neuroticismo, Psicoticismo). Pero nada se sabe de la relación dinámica de esos factores a la hora de explicar el súper-factor de personalidad que representa el FGP.

El principal objetivo de nuestro grupo de investigación ha consistido en el estudio de la dinámica del FGP y de los factores que lo componen. Para ello, se ha partido de la Teoría del Rasgo Único de Personalidad [1] y de la teoría de sistemas, para avanzar en el estudio y la comprensión del FGP y diseñar un modelo matemático que explique su dinámica. Se han incluido en el modelo las drogas estimulantes como el estímulo que inicia la respuesta del organismo y, por tanto, del FGP.

En la actualidad, hemos podido constatar y describir la dinámica del súper-factor de personalidad del ser humano, a la vez que nos hemos adentrado en otras aéreas relacionadas, como es el estudio del cambio del FGP con Terapia de Auto-Regulación (TAR), la personalidad de las sociedades, o el dilema cuerpo-mente.

A continuación se explica con un poco más de detalle y de forma cronológica la evolución del trabajo del equipo a través de algo más de una década.

2. Los comienzos: la Teoría del Rasgo Único de Personalidad y de la teoría de sistemas

En el año 2005 Salvador Amigó publica el libro La Teoría del Rasgo Único de Personalidad, que se identifica con la Extraversión, en la que se sientan las bases científicas de la existencia de un suprasistema de personalidad, de un solo factor que aglutina a todos los demás sistemas de personalidad, además de presentar, por primera vez en este ámbito de estudio, la TAR para el cambio del rasgo único, a partir de la reproducción mental de los efectos de drogas. Por tanto, se admitía el supuesto de que las drogas pueden cambiar el rasgo único, es decir, la personalidad global en el corto plazo (mientras dura el efecto de la droga) y que se puede aprender a reproducir mentalmente el efecto de las drogas con TAR y, por tanto, cambiar temporalmente la personalidad global a voluntad.

Ese mismo año coincidimos los tres y mostramos el interés de colaborar en el proyecto de elaborar un modelo matemático dinámico para estudiar la dinámica del rasgo único a partir de la reacción de este rasgo ante el consumo de drogas estimulantes. Antonio Caselles y Joan C. Micó contaban con una amplia y extensa experiencia docente e investigadora en teoría de sistemas. Además, Caselles había desarrollado unos instrumentos matemáticos: SIGEM [2], para la programación automática de los modelos matemáticos complejos, REGINT [3], con el que buscar funciones de varias variables ajustadas a un conjunto de datos y PARDOSU [4] con el que ajustar sistemas de ecuaciones diferenciales a un conjunto de datos.

Los primeros meses sirvieron para aportar al grupo nuestros conocimientos y experiencia científica, que siempre es complejo cuando se trata de llevar a cabo una auténtica colaboración interdisciplinar desde campos muy diversos, y para organizar la agenda de trabajo. Ya desde el principio resultó ser una apuesta de alto nivel de dificultad, a la vez que productiva y apasionante.

3. Primeras publicaciones: Dinámicas a corto y a largo plazo de la Extraversión

En la primera publicación internacional se presentó el modelo matemático de Extraversión, en la que se mostró cómo el Rasgo Único o Extraversión reaccionaba a una dosis única de estimulante [5]. Si la Extraversión es una dimensión bipolar que se extiende desde el polo de la Extraversión extrema hasta el de la Introversión, vimos que podíamos clasificar a las personas a lo largo de ese polo en función de su reacción a una dosis de droga.

También elaboramos un modelo matemático dinámico para predecir la evolución de la Extraversión a lo largo de dos años con un consumo continuado de cocaína [6]. Por tanto, nuestro modelo era capaz de describir el efecto de una droga no solo de una dosis única sino de una secuencia en el tiempo de consumos repetidos.

4. Sale en escena el Factor General de Personalidad

Publicamos un estudio en el que se demuestra que la Extraversión, como Rasgo Único, es el súper-sistema que integra los principales factores de personalidad de los modelos de personalidad más influyentes, como el de los Cinco Grandes y el de Eysenck. [7]. En las diferentes revisiones del artículo tomamos conciencia de que el concepto de rasgo único estaba ya convirtiéndose en una poderosa línea de investigación internacional, pero que el nombre con el que se conocía este rasgo era el de Factor General de Personalidad. Si bien nosotros seguíamos manteniendo el mismo concepto de rasgo único y los mismos mecanismos de acción que lo explicaban, optamos por asumir el nombre con el que se le conocía internacionalmente, y empezamos a aceptar el término de Factor General de Personalidad en las siguientes publicaciones.

5. Estudios experimentales con el Factor General de Personalidad (FGP): validación del modelo teórico y matemático

Obtuvimos una escala breve de solo 5 ítems en formato-estado para evaluar el cambio del FGP [8]. De esta manera era posible medir la evolución del FGP como reacción a una dosis única de droga.

Realizamos experimentos en los que los participantes tomaban una dosis de café y evaluamos tanto la reacción del FGP como de los Cinco Grandes [9,10]. Los resultados avalaron lo que ya el modelo teórico-matemático anunciaba, y es que es posible predecir la respuesta de los sujetos a los efectos a corto plazo de una droga. Estábamos en el camino de validar un modelo general de personalidad dinámico, lo que a nuestro entender era la primera demostración que se realizaba al respecto en la comunidad científica.

6. Las bases biológicas de la dinámica del Factor General de Personalidad: estudios experimentales con metilfenidato

En el proceso de validación de un modelo integral y dinámico del FGP nos propusimos estudiar el fundamento biológico. En un estudio experimental de caso único pudimos comprobar que el metilfenidato, una droga estimulante de uso en psiquiatría, producía un cambio en los niveles de glutamato en sangre en la línea de lo establecido en el modelo original, que designa al glutamato como el neurotransmisor por excelencia del FGP [11].

Por otra parte, en estudios de caso único pudimos validar nuestro modelo a partir de los cambios que el metilfenidato producía en dos genes reguladores: el DRD3 y el c-fos [12,13]. El DRD3 es un gen que regula los mecanismos inhibitorios celulares y lo contrario es cierto para el c-fos. En estos estudios pudimos constatar que, efectivamente, los mecanismos activadores e inhibitorios genéticos que observamos eran coherentes con nuestro modelo teórico-matemático.

7. Aparece la Terapia de Auto-Regulación para reproducir mentalmente los efectos de las drogas

En los estudios biológicos que se acaban de señalar [11-13] se empleó un procedimiento de sugestión diseñado por Salvador Amigó, llamado Terapia de Auto-Regulación (TAR), que enseña a "imitar" o reproducir los efectos de las drogas [14]. Se comprobó que la TAR modifica los parámetros biológicos (glutamato, DRD3 y c-fos) de la misma manera que lo hace la propia droga, además de reproducir los mismos efectos subjetivos y también la misma dinámica de la personalidad. Por tanto, contamos con un procedimiento que en futuros estudios puede sustituir a la toma de drogas.

En el Congreso Mathematical Modelling in Engineering & Human Behaviour 2017 Conference, celebrado en julio de 2017, se presentó una comunicación en la que se confirmó que los mismos parámetros del modelo matemático dinámico que explican el efecto del metilfenidato en la personalidad eran aplicables cuando en lugar de la droga se utilizaba la TAR [15].

8. Nos planteamos ahondar en la relación cuerpo-mente

Los experimentos citados anteriormente que buscaban indagar en el sustrato biológico del FGP y su dinámica generaron una nueva línea de trabajo: el estudio de la relación cuerpo-mente. Este antiguo problema de la humanidad se trató dinámicamente, involucrando las bases biológicas de la personalidad, (en particular el gen c-fos y neurotransmisor glutamato) y el FGP, a través de ecuaciones en derivadas parciales, cuando el estímulo es el metilfenidato [16].

9. Más allá del individuo: el Factor General de Personalidad en las sociedades

La idea de que los mismos mecanismos subyacen en la dinámica de los individuos, grupos y amplios colectivos es consustancial a la teoría de los sistemas vivientes complejos [17]. Es por eso que hemos iniciado el camino para validar nuestro modelo teórico-matemático en las sociedades. En un primer momento propusimos un modelo teórico, basado en la teoría de sistemas, para validar la teoría de las supervivencia de las sociedades de Salvador Amigó [18]. Esta teoría sugiere una dinámica de la evolución de las sociedades como reacción a las crisis que atraviesan y en una publicación esbozamos una primera aproximación de un modelo teórico-matemático [19].

Más adelante, en una reunión científica en la Universidad Complutense de Madrid se presentó un modelo basado en una teoría más amplia de la personalidad global [20], inspirada en parte por la teoría de personalidad de Carl Jung y reelaborada por Amigó [21], con la pretensión de que fuera extrapolable a las sociedades. Se abría así la

posibilidad de que nuestro modelo teórico-matemático de personalidad fuera también aplicable a las sociedades de cualquier lugar y época.

10. A la búsqueda de un modelo unificador de la psicología y la física. Mecánica cuántica, personalidad y cerebro

Hasta cierto momento de nuestra investigación los modelos desarrollados tenían al tiempo como única variable de referencia del cambio. Pero la realidad que nos planteamos es que el cerebro, como parte fundamental del sistema de estrés, sustrato fisiológico del FGP, está localizado en una zona espacial limitada. Por tanto, nos propusimos generalizar nuestro modelo matemático de respuesta de dosis única, incluyendo la variación espacial además de la temporal. Las investigaciones nos llevaron a un modelo matemático de respuesta espacio-temporal dado por una ecuación parabólica en derivadas parciales. Las condiciones de contorno del cerebro proporcionan una novedad sorprendente: un conjunto de resultados infinito numerable de funciones cuantizadas que se corresponden con un conjunto infinito numerable de valores propios también cuantizados, y que dependen de unos números enteros [22].

Este nuevo enfoque espacio-temporal proporciona unos resultados similares a los mecano-cuánticos para el átomo de hidrógeno o para el cuerpo negro de Planck. En la actualidad intentamos profundizar en el mismo, por una parte, introduciendo experimentalmente el nivel tónico en el modelo como una función espacial, concepto aún no presente en [22], y por otra parte, buscando datos experimentales para su validación. Por tanto, un desarrollo espacio-temporal validado como el que proponemos equivaldría a un enfoque interdisciplinar que incluiría la física, el cerebro y la personalidad.

11. El método como objetivo fundamental de nuestro trabajo

En todo nuestro trabajo nos hemos basado en el método científico, la matemática compleja y la estadística inferencial. Hemos propuesto modelos teóricos y hemos realizado estudios empíricos con diseños experimentales de grupo y diseños de caso único. Pero desde el primer momento, y especialmente en el presente, nuestro interés por mejorar el método de trabajo ha sido una constante.

De hecho, la evolución de nuestra teoría ha sido una auto-exigencia conforme nos proponíamos enfrentarnos a nuevos retos. Por ejemplo, el modelo matemático de respuesta a una droga estimulante fue concebido en [5,9] como una ecuación diferencial de retraso discreto, más conocida en matemáticas como una ecuación en diferencias finitas. Sin embargo, ante el reto de enfocar el problema cuerpo-mente, el modelo pasó a ser una ecuación diferencial de retraso continuo en [13,15,16], conocida en matemáticas como ecuación integro-diferencial. Además hemos de añadir a las ecuaciones obtenidas, la ecuación en derivadas parciales con la que se puede estudiar tanto el problema del cuerpo-mente [16] como la relación dinámica del FGP y los 5 Grandes [10]. Y para contemplar el conjunto del catálogo de ecuaciones, que son una generalización de las anteriores, tenemos el modelo espacio-temporal del cerebro [22], que podría arrojar luz matemática sobre les frecuencias fundamentales del electroencefalograma.

12. Conclusión

Hemos resumido en este artículo la evolución de nuestro trabajo interdisciplinar de más de una década. Habíamos empezado diciendo que el trabajo interdisciplinar serio es complicado, y así lo fue en un principio. Poco a poco nos fuimos adaptando a un sistema de trabajo organizado y fructífero que ha ido mejorando paulatinamente el trabajo conjunto auspiciado por una sinergia de grupo.

El resultado, hasta el momento, es que contamos con un modelo teórico-matemático, capaz de describir y explicar la dinámica de la personalidad completa y de sus más importantes componentes, a partir de los estímulos ambientales, especialmente las drogas, ya que la reacción a las mismas proporciona una información privilegiada, detectable y registrable, por la intensidad de la misma.

Además de conocer en mayor profundidad la dinámica de la personalidad global de los seres humanos, nos hemos adentrado en el estudio del dilema mente-cuerpo, y en el análisis del cambio voluntario y rápido de la personalidad utilizando la Terapia de Auto-Regulación, creada también por uno

de nosotros.

Además, hemos llevado a cabo las primeras propuestas de validar nuestro modelo dinámico más allá de los individuos, para las sociedades, y hemos realizado un gran esfuerzo en mejorar el método de trabajo interdisciplinar, acercando la matemática compleja y la estadística inferencial, buscando puentes metodológicos de encuentro entre disciplinas tan aparentemente alejadas como la matemática y la psicología y, en definitiva, las llamadas ciencias físicas y la ciencias humanas.

Pero el camino se está todavía recorriendo, hay mucha tarea que realizar. Es por esto, que hemos querido con este número especial de la RIS, por una parte exponer nuestra trayectoria hasta el presente y, por otra parte, ofrecer algunas de nuestras investigaciones más recientes.

En este número presentamos nueva confirmación sobre la estructura y dinámica del FGP, así como de la eficacia de la TAR para cambiar a corto y medio plazo la personalidad global, lo que abre un campo nuevo de importantes aplicaciones en psicología, psiquiatría y neurociencias. Por otra parte, también ofrecemos un modelo teórico desarrollado del Factor General de Personalidad de las sociedades, así como algunas sugerencias para su desarrollo matemático. También ofrecemos las nuevas aportaciones metodológicas en las que superamos el "viejo modelo de respuesta" y lo sustituimos por un modelo más eficaz y sensible, en la línea apuntada más arriba de nuestra firme intención de mejorar continuamente la metodología de trabajo.

En definitiva, este número especial sobre el Factor General de Personalidad y teoría de sistemas pretende ser no solo una presentación de lo realizado hasta ahora sino, sobre todo, una propuesta de futuro para seguir profundizando en el conocimiento de la naturaleza humana y en el desarrollo de un modelo integrador de los distintos campos del conocimiento, desde la física hasta la psicología, así como del individuo y la sociedad a la que pertenece.

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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

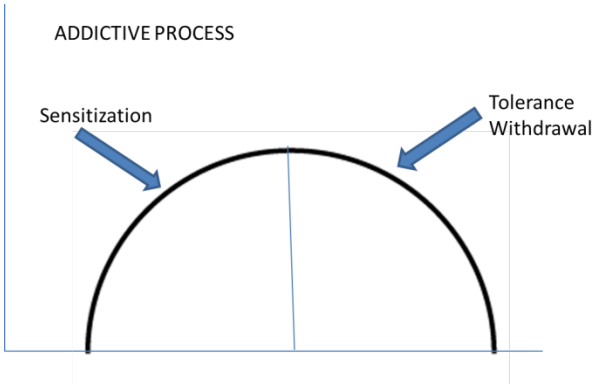
Stimulus) association to explain the learning of positive drug effects. However, very little attention has been paid to the nature of the Conditioned Response (*CR*) and its relevance in the addiction process or therapeutic intervention. Therefore in those treatments administered to lessen the conduct 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.

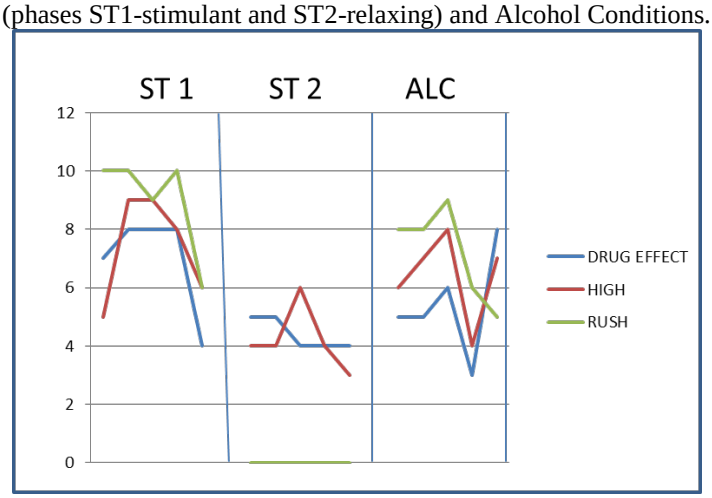
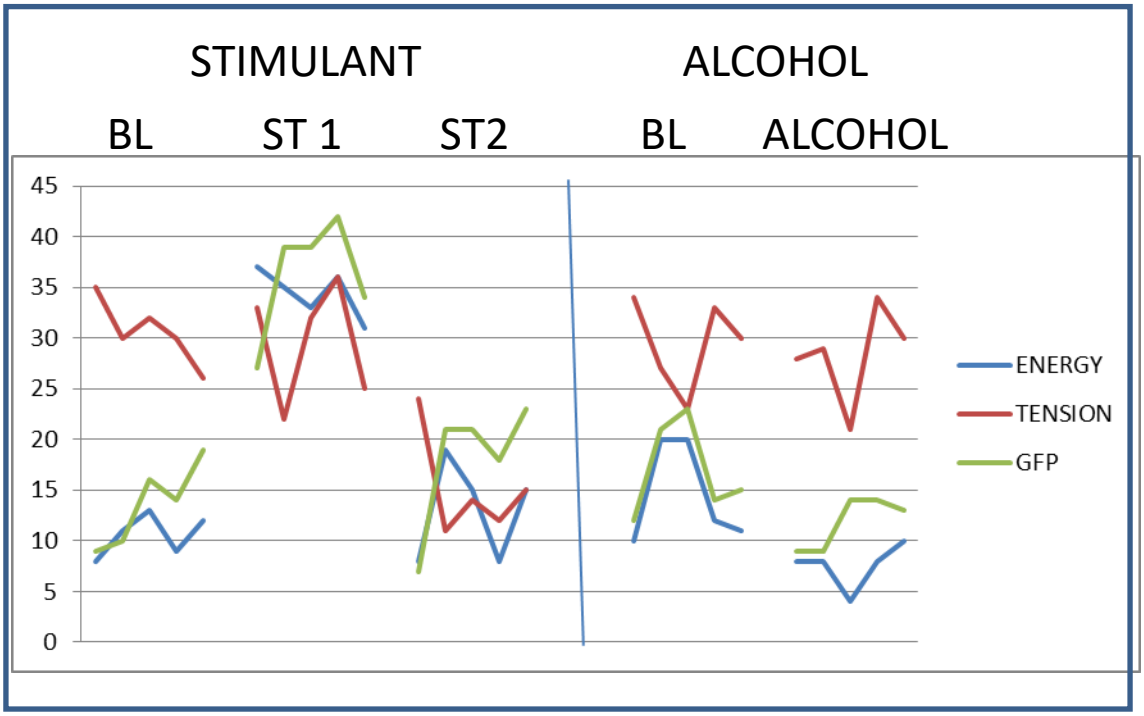


Figure 3. Scores on scales Energy, Tension and *GFP-FAS* for both the Stimulant and Alcohol Conditions and for all the phases.



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Chanching the externalizing and internalizing spectrum of personality with self-regultaion therapy

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***Abstract*— This article presents an integrator model of changes in the externalizing and internalizing factors of personality grouped in the General Factor of Personality (GFP), based on the Unique Trait Personality Theory (UTPT) [1]. This theory proposes that a continuum exists between personality and psychopathology, as well as the existence of a GFP that occupies the apex of the hierarchy of personality, and extends from an impulsiveness-and-aggressiveness pole (externalizing spectrum) to an anxiety-and-introversion pole (internalizing spectrum). With an experimental intra-group design, 30 regular users of stimulant drugs (cocaine and amphetamine) used the Self-Regulation Therapy (SRT). The SRT is a psychological procedure based on classic conditioning and suggestion used to experience a relaxation effect after the first session, and a stimulation effect during the second session. This stimulation is achieved by reproducing, by the SRT, the sensations produced by stimulant drugs. Effects were recorded on format-state scales of personality adjectives and activation, which represented both externalizing and internalizing factors. The results showed that both relaxation and stimulation, by imitating the effects of drugs, brought about short-term changes in both the GFP, and the externalizing and internalizing factors, and also in the predicted direction, i.e., changes in global personality.**

Keywords-*General Factor of Personality; externalizing spectrum; internalizing spectrum; Self-Regulation Therapy; stimulant drugs.*

1. Introduction

William James [2] had already reported the existence of individual differences in the tendency to express or inhibit impulses.

There is a growing empirical evidence for the co-occurrence of disorders through abuse of drugs and antisocial personality disorders, where impulsiveness would presumably be one of their most important shared elements [3]. Such disorders would be grouped as a psychological super-disorder. Gorenstein and Neuman [4] used the term *disinhibitory psychopathology* to refer to this super-factor. Later other authors presented an integrator model of the disinhibitory factors, which were grouped by the term Externalizing Spectrum [5,6].

Evidence reveals the existence of an Internalizing Spectrum. Unipolar mood disorders and anxiety disorders are often comorbid, as shown in adolescent [7,8] and adult samples [9]. So disorders like anxiety and depression can be subsumed in this super-factor "that can be defined as the tendency to experience feelings or states that

are inner-directed and usually accompanied by over-controlled behaviour" [10; p. 1125]. Other authors have also found evidence for the existence of the internalizing super-factor, which would include disorders like major depressive disorder, dysthymia, generalized anxiety disorder, social phobia, specific phobia, agoraphobia, and panic disorder [11-13].

The common cause that links the different disorders of both spectra has been speculated. Some authors assume that these disorders are related with personality [3]. These authors have reviewed studies from which strong correlations between these disinhibitory personality constructs and mental disorders, which involve substance problems and antisocial behavior, have been obtained. These results are consistent with the dimensional conception of personality and psychopathology, which is explicit in many studies and implicit in the Fifth Edition of the Diagnostic and Statistical Manual of Mental Disorders [14]. Thus personality is closely linked to psychopathology [15,16].

In line with the externalizing spectrum, some of the personality factors that are especially related with the disinhibition of impulses are disinhibition [4,17] impulsivity [18-21], sensation-seeking [22], and novelty-seeking [23].

In line with the internalizing spectrum, the personality factors considered particularly basics are Neuroticism [10,24,25], and negative emotionality [5].

An integrator model of these two groups of disorders and personality factors exists, and proposes a single factor to explain complete personality: the General Factor of Personality (GFP), based on the Unique Trait Personality Theory (UTPT) [1]. This theory proposes that a continuum exists between personality and psychopathology, as well as the existence of the GFP, which occupies the apex of the hierarchy of personality, and extends from an impulsiveness-and-aggressiveness pole (approach tendency) to an anxiety-and-introversion pole (avoidance tendency). The approach tendency, therefore, groups all the personality factors and disorders of the externalizing spectrum, whereas avoidance tendency groups all the personality factors and disorders of the internalizing spectrum.

The possibility of short-term changes being made in the GFP in response to stimulant substances, like caffeine and methylphenidate, and predicting the result using a dynamic mathematical model have been demonstrated [26-28]. The possibility of training drug users so they can reproduce the effects of stimulating drugs and experience similar effects to those a drug produces has also been demonstrated by the so-called Self-Regulation Therapy (SRT) procedure [29,30]. This procedure, based on classic conditioning and suggestion, is provided in detail by Amigó [31].

This article presents the procedure and results of an experiment carried out with a group of regular drug users. These subjects used the SRT to experience relaxation during a first session and to experience effects of stimulant drugs (cocaine and amphetamine) during a second session. This is, therefore, an intra-subject experimental design to compare two different effects of the SRT: relaxation and immediate stimulation. For this purpose, several format-state scales of adjectives, filled out by subjects before and after the SRT were used, which assessed the factors that represented both the externalizing spectrum (GFP, extraversion, energetic arousal, sensation-seeking, openness to experience) and the internalizing spectrum (neuroticism, tense arousal, conscience). Several studies have verified that these format-state scales well represent stable personality factors when it comes to studying their short-term modification [32,33].

2. Methodology

Participants

Thirty regular stimulant drug users participated in this study, whose mean age was 26.53 years (SD= 5.36), of whom 17 were males (56.7%) and 13 were females (43.3%). Sixteen worked (53.3%) and 14 were students (46.7%), especially university students.

Table 1 offers the levels of drug use: times and quantity in one's lifetime, times in the last 12 months and times in the last month.

(The section Appendix, after the section References, is devoted to present some tables).

We can see that a high percentage of the participants had tried drugs once in their lifetime: 100% for cannabis and 96.7% for cocaine. The drugs they had most widely used in their lifetime were cannabis, followed by cocaine, ecstasy and amphetamine. Drug use in the last 12 months and in the last month showed a higher percentage for cannabis (66.7% and 56.7%, respectively), and significantly lower percentages for all the other drugs.

Instruments

Several personality and activation scales were chosen for being representative of the factors grouped in the externalizing and internalizing spectra. These were format-state scales, which record the variations that certain experimental conditions can immediately cause. These scales were:

1. The Five-Adjective Scale of the General Factor of Personality (GFP-FAS) [34]. The 5 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 [34]. Two versions of the GFP-FAS were used: trait-format version and state-format version ("Are you like this at the moment?" or "do you feel so at the moment?"). All the participants filled out the state-format version form every 15 minutes to obtain a situational measure of the GFP.

2. The Big Five Personality Adjectives List (BFPAL) [35]. This list is made up of 25 adjectives. A state-format version ("Are you like this at the moment?") was used. The twenty subjects completed the state-format version every 15 minutes to obtain a situational measure of the BFPAL.

3. List of adjectives from the Sensation-Seeking Scale (SS), selected from the Multiple Affect Adjective Checklist Revised (MAACL-R) [36]. The 132-item MAACL-R provides valid measures of anxiety, depression, hostility, positive affect and sensation seeking. SS is a 12-Likert response item scale. Its adjectives are: active, adventurous, aggressive, daring, energetic, enthusiastic, merry, mild, quiet, tame, wild and bored. Two versions were used for the list of adjectives from the Sensation-Seeking Scale: trait format (SS-T) ("Are you like this in general?") and state format (*SS-S*) ("Are you like this at the moment?" or "do you feel so at the moment?"). This scale is used in this study because it is a good approach to the GFP.

4. A short form of the Activation-Deactivation Adjective Check List (AD ACL) [37]. 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 4-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.

Procedure and study hypothesis

An intra-subject experimental design was used to compare the results of applying the SRT during two different sessions. During each session, subjects filled out the scales before and after applying the SRT. During the first session, the SRT was applied to the relaxation state, and it was applied during the second session to achieve strong stimulation. In the latter case, the SRT was addressed to reproduce effects of the stimulant drugs that the subjects normally used, particularly cocaine and amphetamine.

The main hypothesis put forward in this study was that relaxation and stimulation would have effects in the opposite direction, as measured by the different scales used herein. Accordingly, stimulation (reproducing the effects of stimulant drugs with the SRT), unlike relaxation, was expected to increase the score on the scales that represented both the externalizing spectrum (GFP, extraversion, energetic arousal, sensation-seeking and openness to experience) and the internalizing spectrum, which represented activation (neuroticism and tense arousal), and would, in parallel, reduce Conscientiousness. Inverse effects can be expected to be the result of the SRT relaxation session.

3. Results

All the subjects participated under the two experimental conditions: relaxation and drug effects reproduction. Two-way repeated measures ANOVAs were used for all the study variables. One factor was the experimental condition with two levels (Relaxation and Reproduction), while the other factor was each state variable (GFP, Big Five, Sensation-Seeking, Arousal) with two levels (before and after each session).

The tables below present the estimated marginal means, the mean differences before and after each session, and for each experimental condition (relaxation *vs.* stimulation), for those scales on which the interaction between the two factors was significant. This was done in this way in order to verify the hypothesis of this study, i.e., the interaction of the two factors was indeed relevant.

Table 2 provides a summary of the two-way repeated measures ANOVA results for The Five-Adjective Scale of the General Factor of Personality (GFP-FAS).

Table 2. The ANOVA results for The Five-Adjective Scale of the General Factor of Personality (GFP-FAS) (Sig.= significance).

CONDITION	TIME	Estimated marginal mean	Mean difference	Sig.
RELAXATION	BEFORE	16.033	1.533	.027
	AFTER	14.500		
STIMULATION	BEFORE	13.800	-4.667	.000
	AFTER	18.467		

We can see that there were significant differences for the SRT in the opposite direction depending on the experimental condition, which lowered after the relaxation session and increased after the stimulation session.

Table 3 provides a summary of the two-way repeated measures ANOVA results for The Big Five

Personality Adjectives List (BFPAL). (See Appendix).

We can see that the results were similar to those obtained for the GFP scale. Thus Extraversion and Neuroticism varied in the opposite direction depending on whether the relaxation or stimulation session was being performed, and they increased with stimulation and reduced with relaxation. Although Conscience was not modified by the relaxation session, it significantly reduced after the stimulation session. No significant interaction effects were observed in the Agreeableness and Openness to Experience factors, so mean differences were not calculated.

Table 4 provides a summary of the two-way repeated measures ANOVA results for the List of adjectives from the Sensation-Seeking Scale (*SS*).

Table 4. The ANOVA results for the list of adjectives from the Sensation-Seeking Scale (*SS*). (Sig.= significance).

CONDITION	TIME	Estimated marginal mean	Mean difference	Sig.
RELAXATION	BEFORE	25.933	8.167	.000
	AFTER	27.767		
STIMULATION	BEFORE	31.967	-11.467	.000
	AFTER	43.433		

The obtained result was similar to that obtained in the previous cases. The relaxation session significantly reduced the Sensation-Seeking score, while this score significantly rose after performing the stimulation session with the SRT.

Table 5 provides a summary of the two-way repeated measures ANOVA results for the Energy and Tension Scales, from a short form of the Activation-Deactivation Adjective Check List (AD ACL). (See Appendix).

Similar results were obtained to those in the previous cases. While the relaxation session significantly reduced both arousal types, the opposite was achieved after reproducing the effects of stimulant drugs with the SRT.

4. Discussion

This study verified the possibility of significantly changing personality and arousal factors in the short term by modifying participants' level of activation with the SRT, a procedure based on classic conditioning and suggestion. The intra-group experimental design verified that the relaxation and stimulation produced by the SRT during different sessions had opposite effects, which were measured using the scores of different personality format-state scales before and after applying the SRT.

These format-state scales were selected to represent the GFP extremes, which we conceptualized herein as the externalizing and internalizing spectra.

Let's remember that the initial hypothesis stated that stimulation with SRT would produce an increased response in the scales that represented both the externalizing spectrum (GFP, extraversion, energetic arousal, sensation-seeking and openness to experience) and the internalizing spectrum, which represented activation (neuroticism and tense arousal), and that Conscientiousness would reduce. Indeed this is what the present study achieved, except for openness to experience, for which neither significant effect of interaction was obtained with the ANOVA, nor was a significant effect of interaction obtained for the Agreeableness dimension. Furthermore, SRT did not influence level of conscience.

All the scores for the other factors were modified in the direction postulated by this study; i.e., stimulation, unlike relaxation, significantly increased the factors grouped in the externalizing spectrum. The opposite was achieved after the relaxation session had taken place. It was noteworthy that two outstanding effects were observed after stimulation, increased neuroticism and reduced conscience, which we now go on to indicate in detail.

Neuroticism has been considered a common dimension to internalizing disorders [10], and even the genetic foundation has been postulated, which relates this dimension with internalizing disorders [38]. This study verified that, as expected, relaxation significantly lowered the Neuroticism score. However, stimulation significantly increased Neuroticism, which also agreed with the hypothesis set out herein because in this case, as with the Tension scale, Neuroticism was considered a type of activation with negative emotionality.

Regarding conscience, several meta-analyses and reviews have concluded that a close relation exists between conscience and externalizing psychopathology (negatively) [39-41]. Change in conscience throughout one's lifetime has been studied. Indeed when conscience starts to increase with age, dependence on alcohol and drug abuse, antisocial conduct and criminal activities lessens [42,43]. However, what the present study attempted to do was to analyze the short-term changes (after one session) in conscience after a relaxation session and a stimulation session. Although relaxation did not influence change in conscience, stimulation significantly lowered the conscience score, which agreed with the general increase noted in the externalizing factors that stimulation with the SRT produced.

In short, we conclude that it is possible to modify the integrated series of externalizing and internalizing personality factors in the short term by using a suggestion and classic conditioning technique like the SRT. If we consider externalizing and internalizing factors to be the two opposite poles of the GFP, we can also conclude that it is possible to change global personality in the short term, which has been previously demonstrated in the above-cited studies [26,27,44]. If it is possible to change global personality in the short term, it is feasible to think

about the possibility of changing personality in the long term. A dynamic mathematical model exists that predicts the long-term effect on personality of drug use [45].

It is also possible to significantly increase scores on externalizing personality factors by a procedure, the SRT, based on reproducing the effects of stimulating drugs, as well as basic biological mechanisms of personality, as revealed by brain imaging and genetic studies [29]. This result opens up a series of considerable possibilities to apply this procedure to the psychotherapy field and to transform the human being in general.

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Appendix

Table 1. Frecuencies of drug use. Times and quantity in one's lifetime, in the last 12 months and in the last month.

DRUGS	Some time in your life	How often in your lifetime			How often in the last 12 months				How often in the last month			
		1-5	6-30	>30	0	1-5	6-30	>30	0	1-5	6-30	>30
Cannabis	100	3.3	3.3	93.3	13.3	3.3	16.7	66.7	20	20	3.3	56.7
Ecstasy	90	26.7	26.7	36.7	33.3	37.7	13.3	6.7	73.3	16.7	-	-
Cocaine	96.7	23.3	26.7	46.7	23.3	43.3	26.7	3.3	60	36.7	-	-
Amphetamine	80	13.3	30	36.7	23.3	20	30	6.7	43.3	30	6.7	-
Hallucinogens	86.7	23.3	40	23.3	40	33.3	13.3	-	76.3	13.3	-	-

Table 3. The ANOVA results for The Big Five Personality Adjectives List (BFPAL). (Sig. = significance).

	CONDITION	TIME	Estimated marginal mean	Mean difference	Sig.
Extraversion	RELAXATION	BEFORE	15.933	3.767	.000
		AFTER	12.167		
	STIMULATION	BEFORE	14.333	-4.067	.000
		AFTER	18.400		
Neuroticism	RELAXATION	BEFORE	9.300	5.667	.000
		AFTER	3.633		
	STIMULATION	BEFORE	7.833	-2.400	.014
		AFTER	10.233		
Agreeableness	RELAXATION	BEFORE	15.233	-	-
		AFTER	14.867		
	STIMULATION	BEFORE	13.900	-	-
		AFTER	14.967		
Conscientiousness	RELAXATION	BEFORE	13.300	.967	.226
		AFTER	12.333		
	STIMULATION	BEFORE	11.833	3.867	.000
		AFTER	7.967		
Openness to Experience	RELAXATION	BEFORE	12.833	-	-
		AFTER	14.433		
	STIMULATION	BEFORE	11.100	-	-
		AFTER	12.233		

Table 5. The ANOVA results for the Energy and Tension Scales. (Sig. = significance).

	CONDITION	TIME	Estimated marginal mean	Mean difference	Sig.
ENERGY	RELAXATION	BEFORE	13.200	3.500	.000
		AFTER	9.700		
	STIMULATION	BEFORE	12.033	-4.400	.000
		AFTER	16.433		
TENSION	RELAXATION	BEFORE	8.700	6.033	.000
		AFTER	2.667		
	STIMULATION	BEFORE	7.733	-5.500	.000
		AFTER	13.233		

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A genetic algorithm to calibrate dynamical systems: Confidence intervals for parameters and residuals

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***Abstract*—This paper presents a genetic algorithm to calibrate dynamical systems that is able to calculate confidence intervals for the parameters of the system. As an application case is used to calibrate the system that reproduces the dynamical response of the General Factor of Personality (GFP) to a given stimulus, particularly to a stimulant drug dose. The model is called in Literature as the *response model* and includes an integro-differential equation. The presented application case is a single case ABC experimental design where the stimulus is methylphenidate.**

***Keywords*-*General Factor of Personality; genetic algorithm; dynamics; integro-differential equation; calibration; methylphenidate*.

1. Introduction

The here presented genetic algorithm has been designed for a particular case but, changing the corresponding system equations it can be used to calibrate any other system. The considered particular case is a system that determines the evolution of the personality of a subject as a consequence of receiving a certain stimulus, for instance a drug dose. In the application case here presented, methylphenidate is the drug being used. It is a powerful psycho-stimulant. This psycho-stimulation can be measured by the *General Factor of Personality* (*GFP*), as a universal observable feature of personality. A questionnaire containing the five adjectives scale that is described by Amigó, Micó & Caselles [3][5] and constructed specifically to assess *GFP* in the context of the *Unique Trait Personality Theory* (*UTPT*) [1][5] is used for the considered case. The *UTPT* claims for a unique trait, as synonymous of single trait, substituted later by the equivalent concept of *GFP*, to represent the overall human personality. The *GFP* is the psychological expression of the activation level of the organism stress system. In fact, in the context of the *UTPT*, *GFP* is called also *extraversion* in a wider sense than the one used in behavioral science, i.e., in the sense of activation level of the organism stress system.

The evolution of the *GFP* is calculated by the *response model* that is an integro-differential equation that has been widely assessed in the context

of different experimental designs. It can reproduce the acute effect of a stimulant drug [2][6][9][10][11]. The model reproduces the dynamical pattern forecasted by Solomon & Corbit [13] and Grossberg [7], by using the hedonic scale, and by Amigó [1] for the *GFP*, i.e., a typical inverted-U.

The here performed calibration of the model is based on a genetic algorithm. Genetic algorithms (*GAs*) are Evolutionary Algorithms (*EAs*) (they adapt their parameters according to previous results) that try to imitate Natural Selection inside a population through parent selection, recombination, mutation and migration. About details on *GAs* and its use in systems calibration, see for instance: Whitley, [14], Guzmán-Cruz et al., [8] and Muraro & Dilao [12]. Nevertheless there are a lot of possible options for their definition, obviously related on how to perform *selection*, *crossover* and *mutation*. The here introduction of *immigration* could be a novelty.

2. The response model

The kinetic part of the response model provides the evolution of the stimulus amount $s(t)$, present in plasma after intake by the individual. It is given by the time function:

$$s(t) = \begin{cases} \frac{\alpha \cdot M}{\beta - \alpha}(exp(-\alpha \cdot t) - exp(-\beta \cdot t)) : \alpha \neq \beta \\ \alpha \cdot M \cdot t \cdot exp(-\alpha \cdot t) : \alpha = \beta \end{cases} \quad (1)$$

Equation (1) is the solution of two coupled differential equations [11], which assumes that no drug/stimulus is present in the organism before consumption. In (1) *M* is the initial amount of a drug single dose, α is the stimulus assimilation rate and β is the stimulus elimination rate. The dynamics of the *GFP* is given by the following integro-differential equation [11]:

$$\left.\begin{array}{c} \frac{dy(t)}{dt} = a\big(b - y(t)\big) + \frac{p}{b}s(t) \\ -b \cdot q \cdot \int_0^t e^{\frac{x-t}{\tau}} \cdot s(x) \cdot y(x)\, dx \\ y(0) = y_0 \end{array}\right\} \quad (2)$$

In (2), *s(t)* represents the stimulus; *y(t)* represents the *GFP* dynamics; and b and y_0 are respectively its tonic level and its initial value. Its dynamics is a balance of three terms, which provide the time derivative of the *GFP*: the *homeostatic control a(b-y(t))*, i.e., the cause of the fast recovering of the tonic level *b*, the *excitation effect p·s(t)/b*, which tends to increase the *GFP*, and the *inhibitor effect* $\int_0^t e^{\frac{x-t}{\tau}} \cdot s(x) \cdot y(x)\, dx$, which tends to decrease the *GFP* and is the cause of a continuously delayed recovering, with the weight $e^{\frac{x-t}{\tau}}$. Parameters *a*, *p*, *q* and τ are named respectively the *homeostatic control power*, the *excitation effect power*, the *inhibitor effect power* and *the inhibitor effect delay*. All the parameters of the model depend on the individual personality or individual biology and on the type of stimulus.

3. The genetic algorithm used for the response model calibration

The program we use for calibration has been ad hoc designed for the previously described model but it can be adapted easily for systems with the following characteristics:

(1) Real data are deterministic. In the case of the *response model*, real *GFP* is measured by the responses of an individual to a questionnaire every some minutes. And model parameters are specific of the individual.
(2) The system to be calibrated is deterministic.
(3) All parameters have a continuous range of possible or plausible values from a maximum to a minimum value.
(4) A single objective variable (function) must be considered, but it may be designed as a weighted combination of several other ones.
(5) Parameter space (search space) is a multidimensional compact space (continuity is assumed in parameter values inside a range of possible or plausible values).
(6) In order to assure the global character of the found optimum three strategies are considered:
    a. A random sample may be analyzed, from the entire search space or from specific zones, in order to identify starting points.
    b. Random migrants with reproduction capacity are introduced inside the current population in every generation.
    c. Several iterations are performed using the previous optimum as a new starting point, up to no improvement is found or the top number of iterations is reached.

3.1. The needed data

The *response mode* has seven parameters: α, β, a, b, p, q, τ and M (M may also be adjusted like the other parameters when the stimulus is not measurable, for instance: a placebo), which meaning has been previously explained. A vector of nine components containing a value for each parameter plus the corresponding *GFP* (y) may be considered as an individual of a population of possible characterizations of the system. The staring values of the parameters (given by previous knowledge), their maximum values, their minimum values, their search window width (% of their initial value), and their search step width (% of their initial value) have to be introduced at the beginning of the search process. Other needed data are the number of experimental values, their time step, and their values. The integration method (Euler or Runge-Kutta-4) and the integration step size have to be also specified. The function to be optimized may be the mean squared deviation (s^2), the determination coefficient (R^2) or the relative mean deviation.

The *GA* may be optionally used, and in the case it is used the following options must be specified: number of individuals of the population, percentage of the population corresponding to reproducers (the best individuals), number of immigrants per generation, mutant genes per thousand in a new individual, number of generations inside a given iteration, and maximum number of iterations. In the case of not using the *GA* but only analyzing a sample, it may be exhaustive or uniformly random. This sampling process also admits iterations.

3.2 The GA pseudo-code

The proposed *GA* intends to be the simplest possible one in order to be as fast as possible without restricting the possibility to find a global optimum. The following pseudo-code might be enough descriptive of the here presented *GA* that we name *PARDOSU*.

```
Introduce data and options
Define the initial population (vectors with random values for parameters and the objective function value)
For i=1 to “number of iterations”, do:
  For j=1 to “number of generations”, do:
    Arrange population from lower to higher the objective function
    Retain the best individuals and eliminate the remaining ones
    Incorporate some immigrants (randomly defined inside parameters’ ranges)
    “Complete the population by reproduction (with mutation) of the present individuals, i.e.:”
    For k=”number of reproducers”+1 to “population size”, do:
      Choose randomly the “father” and the “mother” of the new individual
      For each gen (parameter) choose randomly whether it comes from “father” or “mother”
      For each gen (parameter) choose randomly whether it is newly randomly defined or not
    Next new individual
  Next generation
  If “previous optimum is not improved” Then Exit-Iterations-Loop Else Continue
  Use the optimum individual as new starting point
Next iteration
Calculate residuals by comparing the found optimum with the experimental values
Test residuals for Normality and zero-mean
If “yes” Then “calculate confidence intervals to define the optimal fitting evolution band”
For j=1 to “number of parameters + objective function” do:
  Test parameter j for normality inside the best individuals group
  If p-value for normality is acceptable Then
    Calculate and write the corresponding mean, standard deviation, chi-squared, t of Student and the upper and lower bounds of the confidence interval
    Else write only the corresponding mean, standard deviation and chi-squared
  End If
Next parameter
Write all other results
```

4. The response model calibration

The studied application case consists in one subject that consumed 20 mg of methylphenidate. The Five Adjectives scale questionnaire (adventurous, daring, enthusiastic, merry and bored) was filled out before consumption and after consumption every 15

minutes during 4 hours. The interval of the *GFP* measures is $y \in [0,25]$. The calibration result of the response model for the *GFP* dynamics is provided in Figure 1. With respect to parameters, inside the best individuals group, most of them were not normally distributed (very high chi-squared values), others were constants or with relatively low standard deviations. Note in Figure 1 that it considers the confidence intervals, for a 95% of confidence level, provided by the random variablility values of the parameters.

5. Conclusions

Figure 1 shows the calibration result of the response model for the *GFP* response as a consequence of 20 mg of methylphenidate obtained with the proposed *GA*. The obtained determination coefficient value R^2 supports model applicability as in other studies from literature (see Section 1). The algorithm shows a good performance and time efficiency.

For future work we aim to compare the efficiency of the present features of *PARDOSU* with alternative specific features, such as for instance: mutation of each parameter restricted to values close to the present one, optional equipotency of gens (at present all gens are dominant/recessive), and incest prevention. Options such as selection by competition are discarded due to they do not guarantee the permanence of the best individuals inside the population.

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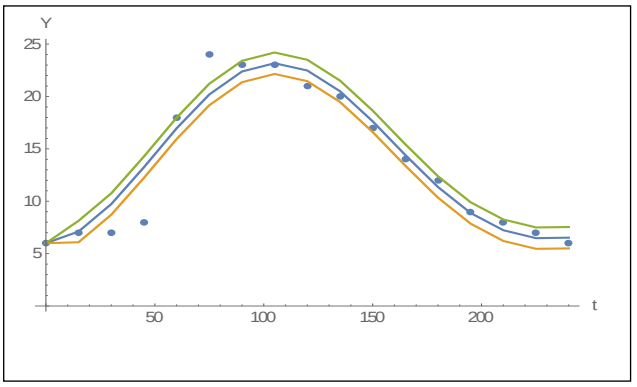

Figure 1: *GFP* (Y) versus time (t). Experimental values (dots) and the calibrated response model (line). R^2=0.92.

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Advances in the general factor of personality dynamics

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***Abstract*—This paper presents a dynamical integro-differential equation to reproduce the dynamical response of the General Factor of Personality (GFP) to a stimulus dose, particularly to a stimulant drug dose. The model is called in the past authors publications as *response model*. We refer to it as the *old response model*, due to a *new response model* presented here that solves partially the problem of the model validation: how to forecast the GFP dynamical response from a previous model calibration. The application case presented is an individual ABC experimental design where the stimulus used is methylphenidate.**

Keywords: *General Factor of Personality; dynamics; integro-differential equation; calibration; validation; methylphenidate.*

1. Introduction

The aim of this paper is to present the advances deduced from new research about the General Factor of Personality (GFP) dynamics performed with the response model.

The GFP is a trait of human personality defined for the first time by Salvador Amigó [1]. It asserts for a single trait, the GFP, to describe the overall personality, which has a biological base inside the general activation of the stress system. A questionnaire to measure the individual GFP is provided in [2]. The dynamical response of the GFP to a stimulus can be described by the response model: a dynamical integro-differential equation. The response model has been evaluated in different works by using different drug stimulus, such as caffeine or methylphenidate [3, 4, 5, 6, 7]. A list of 5 adjectives was developed to measure the dynamical change of the GFP [8]. The results of this questionnaire correlate positively with the questionnaire provided in [2]. In addition, it is used in this paper in the context of the application case to measure the individual GFP dynamical change.

The advances presented on the GFP dynamics are provided by a new response model, which has two novelties respect the old one: (1) the term of the new response model called as excitation effect becomes nonlinear; (2) the parameter called as tonic level acts in a different mathematical way in the new response model. These changes can be considered advances because, on a hand, the nonlinear term provides a more realistic dynamics for the stimulus and, on the other hand, the change in the tonic level, maintaining constant the rest of the parameter values, provides a better way to validate the response model.

These advances are implemented on part of the ABC experimental design presented in [5] as application case. The part considered is that devoted to the GFP measured by the five adjectives scale: a basic line (A), a subsequent individual consumption of 20 mg of methylphenidate (B), and a subsequent consumption of 40 mg of methylphenidate (C). The results of the response model calibration are presented for both the old response model and the new response model. The differences are then stressed in favour of the new response model. In addition, a new way to validate de model is also provided.

Section 2 is devoted to present the old response

model and the changes that provide the new one, as well as the hypotheses under which these changes are done. Section 3 is devoted to the calibration of the old response model, while Section 4 is devoted to the validation of the new response model, as well as the obtained advances. Section 5 is devoted to the paper conclusions. After the section References, the section Appendix is devoted to present figures and tables.

2. The old and new response models

The kinetic part of the old response model provides the evolution of the stimulus amount in organism after being consumed. It is given by two coupled differential equations:

$$\left.\begin{array}{c}\frac{dm(t)}{dt} = -\alpha \cdot m(t) \\ m(0) = M\end{array}\right\} \quad (1)$$

$$\left.\begin{array}{c}\frac{ds(t)}{dt} = \alpha \cdot m(t) - \beta \cdot s(t) \\ s(0) = s_0\end{array}\right\} \quad (2)$$

In (1) *m(t)* is the non-assimilated stimulus amount, *M* is the initial amount of a drug single dose, and α is the stimulus assimilation rate. In (2) *s(t)* represents the stimulus, i.e., the amount of stimulus in the organism not yet consumed (or metabolized) by cells, s_0 is the amount of stimulus present in the organism before the dose intake, and β is the stimulus elimination rate. Integrating the system (1)-(2), the analytical solution of the stimulus as a function of time *t* and the referred parameters is obtained:

$$s(t) = \begin{cases}\frac{\alpha \cdot M}{\beta - \alpha}(\exp(-\alpha \cdot t) - \exp(-\beta \cdot t)) : \alpha \neq \beta \\ \alpha \cdot M \cdot t \cdot \exp(-\alpha \cdot t) : \alpha = \beta\end{cases} \quad (3)$$

Equation (3) assumes that $s_0 = 0$, i.e., no stimulus is present in the organism before the experiment.

The dynamics of the GFP is given by the following equation:

$$\left.\begin{array}{c}\frac{dy(t)}{dt} = a\big(b - y(t)\big) + \frac{p}{b}s(t) - \\ -b \cdot q \cdot \int_0^t e^{\frac{x-t}{\tau}} \cdot s(x) \cdot y(x)\, dx \\ y(0) = y_0\end{array}\right\} \quad (4)$$

In (4), *s(t)* represents the stimulus given by (3); *y(t)* represents the GFP dynamics; and *b* and y_0 are respectively its tonic level and its initial value.

The dynamics of (4) is a balance of three terms, which provide the time derivative of the GFP: the homeostatic control $a\big(b - y(t)\big)$, i.e., the cause of the fast recovering of the tonic level *b*, the excitation effect $(p \cdot s(t)/b)$, which tends to increase the GFP, and the inhibitor effect $(b \cdot q \cdot \int_0^t e^{\frac{x-t}{\tau}} \cdot s(x) \cdot y(x)\, dx)$, which tends to decrease the GFP and is the cause of a continuously delayed recovering, with the weight $e^{\frac{x-t}{\tau}}$. Parameters *a*, *p*, *q* and τ are named respectively the homeostatic control power, the excitation effect power, the inhibitor effect power and the inhibitor effect delay. All the parameters of the model depend on the individual personality or individual biology and on the type of stimulus. The correct interpretation of the tonic level *b* is important to be stressed: its value is situational and depends on the individual and the kind of stimulus.

In conclusion, Equations (3) and (4) define the old response model. The proposed changes on this model are referred to (4), i.e.:

$$\left.\begin{array}{c}\frac{dy(t)}{dt} = a\big(b - y(t)\big) + \frac{p}{b}s(t) \cdot y(t) - \\ -\frac{q}{b}\int_0^t e^{\frac{x-t}{\tau}} \cdot s(x) \cdot y(x)\, dx \\ y(0) = y_0\end{array}\right\} \quad (5)$$

Eqs. (3) and (5) define the new response model. Note in (5) that the excitation effect becomes now nonlinear $(\frac{p}{b}s(t) \cdot y(t))$. This hypothesis tries to reproduce in a more realistic way the fact that, in the sensitization process the more an individual consumes a drug the more he/she wishes the drug. In fact, the inhibitor effect assumes a similar role in the habituation process [1]. In addition, the other hypothesis assumes that the tonic level divides both effects. This assumption is due to the more extraverted individuals perceive of a stronger manner both effects and vice versa [1].

3. Calibration of the old response model

The necessary figures and tables are presented in the Appendix at the end of the paper. Note that the calibrations of the old and new response models do not fit the amount of the methylphenidate dose because they are provided to the individual with determined values: *M*=20 mg for Phase B, and *M*=40 mg for Phase C.

First of all the results of Phase A are presented in Fig. 1. Note that Phase A works correctly as a control phase: the GFP values oscillate inside a small interval around a mean value, the initial condition excepted. The comparatively great value of the initial condition can be explained for the expectation created in the individual by the experimental design.

The calibration of the old response model corresponding to Phase B is presented in Fig. 2, with a determination coefficient R^2=0.96 and random residuals. The corresponding optimal parameter values are presented in Table 1. It may be observed that these parameter values do not fit Phase C. Even arbitrary subsets of these parameter values neither fit Phase C. Thus, Phase C needs an independent calibration, which is presented in Fig. 3, with a determination coefficient R^2=0.83 and random residuals. The corresponding optimal parameter values are presented in Table 2.

The conclusion obtained from these facts is that the old response model can be calibrated, but it does not resist a validation process, which would imply the use of the optimal parameter values of Phase B to reproduce Phase C with a high determination coefficient and random residuals.

In addition, the stimulus dynamics (the amount of

methylphenidate in organism) presents non-realistic patterns, represented in Fig. 4 for Phase B and in Fig. 5 for Phase C. In both patterns the amount of methylphenidate is still increasing as the effect on the GFP has almost vanished (see Figs. 1 and 2). This fact is also an important validation objection for the old response model. A realistic pattern would be the practical vanishing of the stimulus after the four hours of both experiments.

Thus, the new response model presented in the next section is the tool considered to try to solve these validation problems.

4. Validation of the new response model

The new response model (Eqs. 3 and 5) can be validated in the context of the ABC experimental design in the following terms.

Phase A is the same than that of the old response model (Fig. 1). Thus, the new response model is calibrated for Phase B, and the corresponding optimal parameter values are obtained. These values are used to reproduce the dynamics of Phase C, with the exception of the tonic level, which is re-calibrated. Fig. 6 (Phase B) and Fig. 7 (Phase C) shows that the new response model can be calibrated for Phase B and subsequently validated for Phase C, with the only change of the tonic level. In fact, the determination coefficients are very high and similar to those of the old response model (R^2=0.96 for Phase B and R^2=0.76 for Phase C), with random residuals. Table 3 provides the optimal parameter values for both phases.

In addition, note that the stimuli dynamics corresponding to both phases have the same parameter values (α or stimulus assimilation rate and β or the stimulus elimination rate), thus the stimulus of Phase C is double of the one of Phase B due to the double methylphenidate dose provided in Phase C respect to Phase B. The stimulus dynamics of Phases B and C are represented, respectively, in Fig. 8 and Fig. 9. The important feature of these stimuli is that both represent realistic patterns, due to they practically vanish after the four hours of the experiment duration period.

This last shared pattern of both stimuli, and the possibility of the model validation by only changing the tonic level in Phase C respect to Phase B, support the convenience to use the new response model as a mathematical tool to reproduce the dynamical response of the GFP to a drug dose consumption, particularly to a methylphenidate dose consumption, instead of the old response model.

5. Conclusions

The main conclusion of this paper is that the new response model solves the problem of the dynamical response validation with the re-calibration of an only parameter value. In fact, in the context of the experimental design here presented, the old response model can only be used to calibrate it inside each phase. It implies that once calibrated (Phase B), the old response model can inform nothing about a future time (Phase C), and it must be calibrated again. In addition the calibration of the stimulus presents non-realistic patterns, i.e., the non-vanishing stimulus amount in the organism after the experiment duration period.

However, the new response model, also in the context of the experimental design here presented, can be validated with: (a) its previous calibration in the first dynamical response (Phase B); (b) its subsequent reproduction of a future dynamical response (Phase C) by the only re-calibration of the tonic level. In addition the calibration of the stimulus presents realistic patterns, i.e., the vanishing stimulus amount after the experiment duration period holds.

Nevertheless, actually the re-calibration of the tonic level in Phase C provides only a partial validation. New investigations should provide the way to validate the new response model with no new recalibrations.

A metaphor thought to investigate the answer to the presented problem may be the following. Imagine that the dynamical response to a stimulus is similar to the electron state in a hydrogen atom in a determined energy level, for instance, the basic level for the principal quantum number n=1. This state is mathematically a space distribution with a known probability. Due to a stimulus (in the metaphor, a photon radiation), the electron can jump to an excited energy level, for instance, the second principal quantum number n=2. In the new state the space distribution is different and can be known in advance by the quantum theory.

However, the necessary additional theory, equivalent to the quantum theory, is not known in the context of the new response model. Nevertheless, a hypothesis can be stated: similarly to the energy levels of a hydrogen atom, the tonic level values can change depending on some quantum numbers. But this hypothesis implies as well the existence of quantum dynamical responses, and to investigate the reach of this hypothesis, a spatio-temporal approach must be stated for the dynamical responses, similar to the one presented in [9]. The authors think that a spatio-temporal approach can provide the quantization of the tonic level, knowing in advance its possible values. The investigation is thus open.

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Appendix

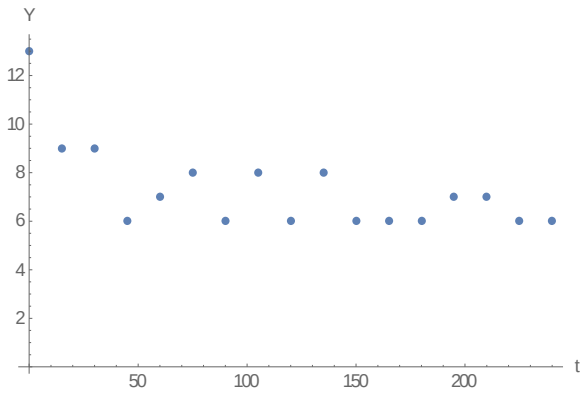

Fig. 1: GFP (Y) versus time (t) in Phase A

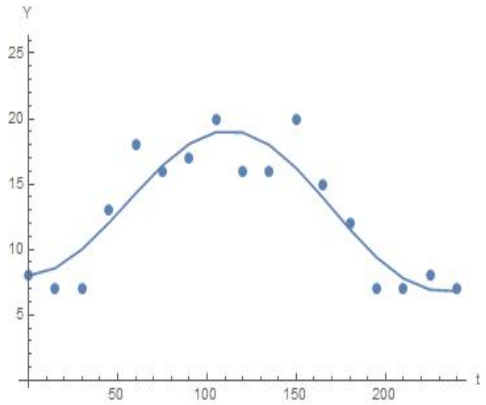

Fig. 2: GFP (*Y*) versus time (*t*) in Phase B fitted by the old response model. R^2=0.96.

Table 1: optimal values of the old response model parameters for Phase B, corresponding to the GFP dynamics (*Y*).

Parameter symbol	Name	Optimal value
M	Methylphenidate dose	20.0
τ	Inhibitor effect delay	154.8481019072612500
α	Assimilation rate	0.0008391856122216
β	Elimination rate	0.0003031001785003
a	Homeostatic control power	0.0000865266711130
b	Tonic level	14.6301269531250000
p	Excitation effect power	4.0442358031868935
q	Inhibitor effect power	0.0000161711124331

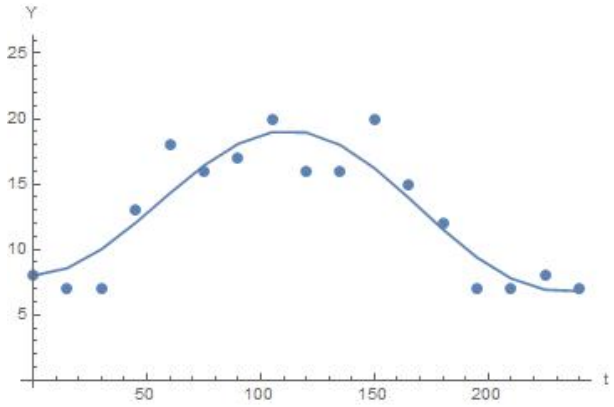

Fig. 3: GFP (*Y*) versus time (*t*) in Phase C fitted by the old response model. R^2=0.83.

Table 2: optimal values of the old response model parameters for Phase C, corresponding to the GFP dynamics (*Y*).

Parameter symbol	Name	Optimal value
M	Methylphenidate dose	40.0
τ	Inhibitor effect delay	78.9311993122100830
α	Assimilation rate	0.0012873707711697
β	Elimination rate	0.0035044766097142
a	Homeostatic control power	0.0005049673774340
b	Tonic level	13.4796142578125000
p	Excitation effect power	1.3499921431412076
q	Inhibitor effect power	0.0000112408190355

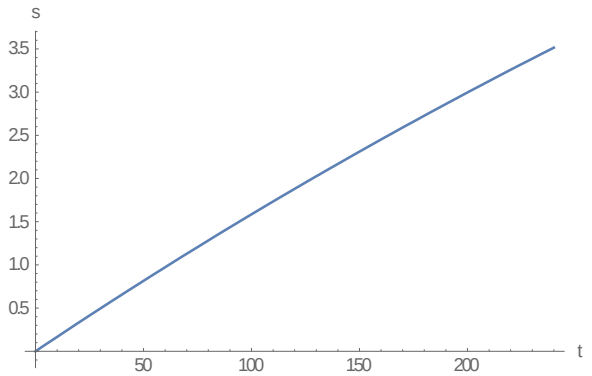

Fig. 4: Stimulus or amount of methylphenidate (*s*) versus time (*t*) in organism in Phase B fitted by the old response model.

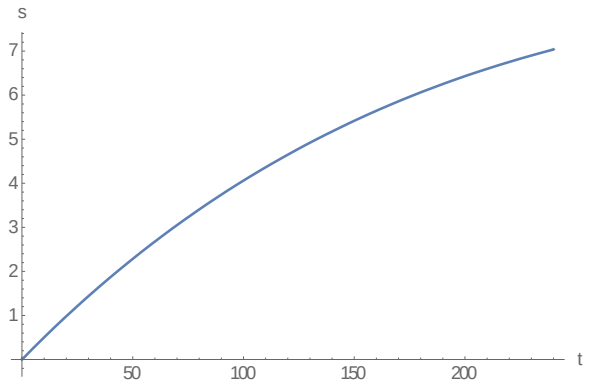

Fig. 5: Stimulus or amount of methylphenidate (*s*) versus time (*t*) in organism in Phase C fitted by the old response model.

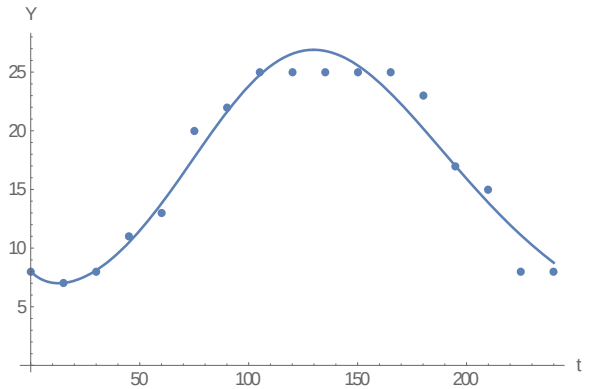

Fig. 6: GFP (*Y*) versus time (*t*) in Phase B fitted by the new response model. R^2=0.96.

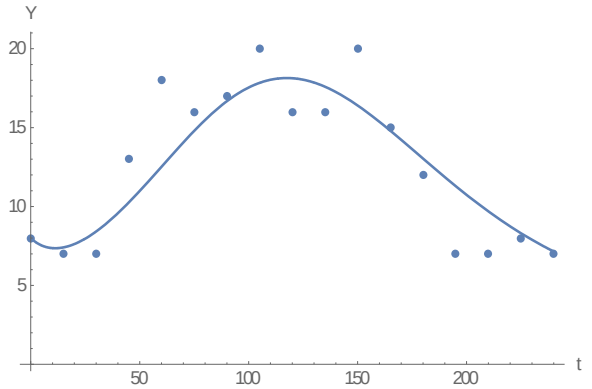

Fig. 7: GFP (*Y*) versus time (*t*) in Phase C fitted by the new response model. R^2=0.76.

Table 3: optimal values of the new response model parameters for Phases B and C, corresponding to the GFP dynamics (*Y*).

Parameter symbol	Name	Optimal value
M	Methylphenidate dose	20.0 (Phase B) 40.0 (Phase C)
τ	Inhibitor effect delay	1.7947700937950430
α	Assimilation rate	0.0260413702093316
β	Elimination rate	0.0130043770613345
a	Homeostatic control power	0.0269896307547583
b	Tonic level	1.1960178709357143 (Phase B) 3.1104237023479389 (Phase C)
p	Excitation effect power	0.0053418060584095
q	Inhibitor effect power	0.0001222167981174

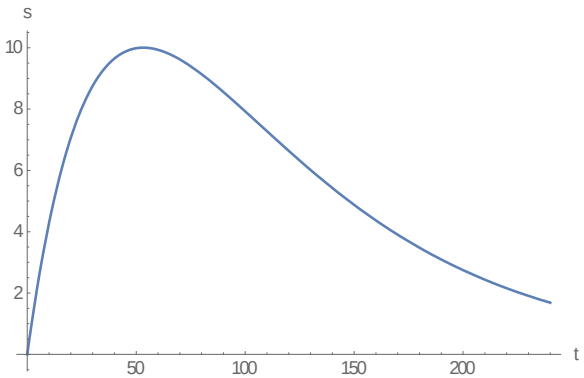

Fig. 8: Stimulus or amount of methylphenidate (*s*) versus time (*t*) in organism in Phase B fitted by the new response model.

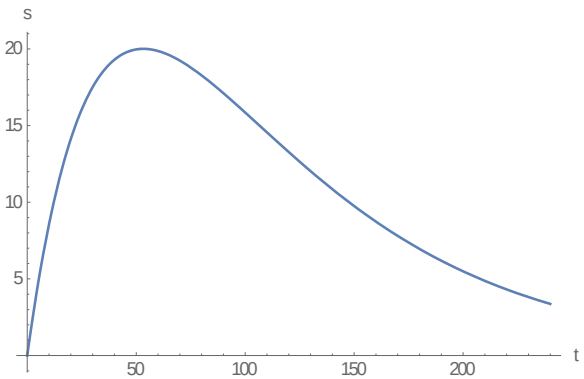

Fig. 9: Stimulus or amount of methylphenidate (*s*) versus time (*t*) in organism in Phase C fitted by the new response model.

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La personalidad de las sociedades. Descripción y dinámica

Personality of societies. Decription and dynamics

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***Abstract*— La Extraversión es considerada como la dimensión fundamental y básica de la personalidad desde la Teoría del Rasgo Único de Personalidad [1]. La Extraversión, como dimensión temperamental, engloba dimensiones cognitivas como la racionalidad y la emocionalidad. La teoría de los tipos de Carl Jung [2] establece una dinámica compleja entre estas dimensiones, a partir de la cual se obtiene una tipología de la personalidad. Amigó [3] adaptó la teoría de Jung para aplicarla a las sociedades. Así, al igual que los individuos, las sociedades poseen una determinada personalidad y pueden también ser clasificadas según una tipología de personalidad. Se reflexiona sobre la historia como la dinámica de las sociedades a lo largo del tiempo, que parte de la idea de Jung de las dimensiones opuestas que se complementan e imprimen movimiento, y de la teoría de la supervivencia de las sociedades de Amigó [4], que sostiene que las crisis provocan cambios socioeconómicos que tienen a perpetuarse a través de la estructura ideológica resultante. Finalmente, se propone una metodología para aplicar la matemática de la teoría de sistemas a esta nueva concepción de la personalidad individual y social.**

Keywords-*Factor General de Personalidad; Extraversión; Carl Jung; Teoría de la supervivencia de las sociedades*

***Abstract*— Extraversion is considered as the fundamental and basic dimension of personality from the Unique Trait Personality Theory [1]. Extraversion, as temperamental dimension, involves cognitive dimensions such as racionality and emotionality. Carl Jung's theory of types [2] states a complex dynamics among these dimensions. From this theory a typology of personality arises. Amigó [3] adapted Jung's theory to applye it to societies. A reflexion about history is given by the dynamics of societies through time. This approach starts from Jung's idea of the opposite dimensions that complement and imprint movement, and from Amigó's theory about societies survivance [4], which argues that crises cause socio-economic changes that have to perpetuate themselves through the resulting ideological structure. Finally, a methodology is proposed to apply the mathematics of systems theory to this new conception of the individual and social personality**

Keywords- *General Factor of Personality; Extraversion; Carl Jung; Societies survivance theory*

1. La extraversión como dimensión clave de la personalidad

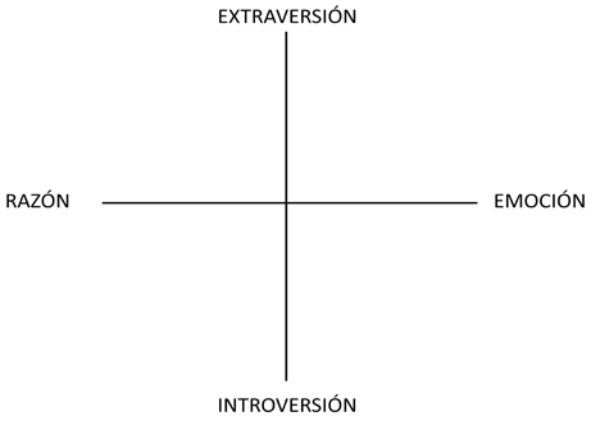
Los términos *extraversión* e *introversión* fueron introducidos en el ámbito de estudio por primera vez por Carl Jung en su obra *Los tipos psicológicos* [2]. Estos términos fueron retomados por Eysenck en los años 50, demostrando la importancia de la dimensión de Extraversión con experimentos y estudios taxonómicos [5] para, posteriormente, en la década de los 60 y 70 desarrollar los cuestionarios EPI y EPQ, en los que la dimensión de extraversión es fundamental, como lo ha seguido siendo en todos los modelos factoriales contemporáneos [6]. Actualmente, y sobre todo influido por el modelo biológico de la personalidad de Eysenck, la extraversión se considera un dimensión temperamental de primer orden.

Para Jung los extravertidos están interesados en el mundo exterior, son abiertos y sociales, mientras que los introvertidos enfocan su interés hacia su interior, y son más reservados. Las dos actitudes son opuestas pero complementarias, las dos se compensan mutuamente. Algo parecido se desprende del modelo de Eysenck, ya que para este autor el término *extraversión* es en realidad la representación de un continuo *extraversión-introversión* y, por tanto, representa dos polos extremos de una única dimensión y, en cierta manera, opuestos pero relacionados. Posteriormente, Amigó [1] propuso la Extraversión como la dimensión central y fundamental que aglutina y representa toda la personalidad, y que se situaría en la cumbre de la jerarquía de dimensiones de personalidad. Esta superdimensión se conoce también como Rasgo Único de Personalidad o Factor General de Personalidad [7]. La existencia de esta dimensión está avalada por una intensa investigación que ha desembocaba en un modelo sistémico complejo [8,9].

La teoría de los tipos de personalidad de Jung nos permite establecer una dinámica entre las dimensiones temperamentales y cognitivas. Así, el temperamento vendría dado por la dimensión Extraversión-Introversión, que representa la dirección de la energía psíquica: hacia el exterior en el caso de la Extraversión y hacia el interior en el caso de la Introversión. En cuanto a las dimensiones cognitivas, Jung contempla dos de ellas: Racional (pensamiento y emoción), que tiene que ver con los juicios y toma de decisiones de los individuos, e Irracional (sensación e intuición), que tiene que ver con la forma en que se percibe la información.

Basándose, por una parte, en las teorías de personalidad desde la perspectiva factorialista y, por otra parte, en el esquema de Jung, Amigó [3] propuso un nuevo modelo de personalidad. La dimensión temperamental es la Extraversión-Introversión (E-I), mientras que las dos dimensiones de Jung se reducen a una: Razón-Emoción/Intuición, que podemos simplificar en la dimensión Razón-Emoción (R-E). Esta dimensión cognitiva agrupa las dos dimensiones cognitivas de Jung, y considera que la Emoción (también la Intuición) no es un proceso racional, como defendía Jung, sino irracional.

Con estas modificaciones, el nuevo modelo de personalidad quedaría representado en el siguiente gráfico de dos ejes:



En algunos estudios se ha comprobado que hay una relación entre estas dos dimensiones. Así, la Extraversión está positivamente relacionada con la Intuición (en nuestro caso, el equivalente a la Emoción) [10]. Siendo así, el Factor General de Personalidad (FGP), que considera la superdimensión E-I como la cúspide de la jerarquía de dimensiones de personalidad, sigue siendo acertada, ya que el resto de las dimensiones, como las dimensiones cognitivas, están integradas en el modelo del FGP.

Ahora bien, a la hora de explicar el comportamiento complejo del ser humano y, en particular, su dinámica, considerar las dos dimensiones de forma separada puede ser más interesante.

En este sentido, Jung también ofrece un mecanismo de interrelación entre las dimensiones temperamentales y cognitivas. Según este autor, existe una función dominante, que representa a la persona (la imagen social del ser humano), que integra ambas dimensiones (por ejemplo, *extravertido racional*) y una función inferior (por ejemplo, *introvertido intuitivo*) opuesta a la dominante, y que constituye la sombra (el inconsciente individual). Entre estas funciones (y otras que considera Jung) se establece una dinámica que explica el funcionamiento complejo del ser humano.

Partiendo de su teoría y de la modificación realizada por Amigó [3], las dos dimensiones representan tendencias de personalidad estables, pero que se interrelacionan de forma dinámica. Así, si bien desde la perspectiva nomotética de la Psicología podemos afirmar que los extravertidos son más emocionales que los introvertidos. A nivel idiográfico podemos encontrar todas las variaciones que nos permita la combinación de las dos dimensiones, que son cuatro: extravertido-racional, extravertido-emocional, introvertido-racional, introvertido-emocional.

Si una persona tiene la *extraversión-razón* como función dominante, su función inferior será la *introversión-emoción*, que complementa la función principal, dando como resultado un equilibrio de fuerzas psicológico. Ahora bien, en una situación crítica o de estrés agudo, es probable que emerja con más determinación la sombra, es decir, la función inferior. Incluso es posible que durante un tiempo, la función inferior ocupe el lugar de la función dominante, para, más adelante y una vez superada la crisis, volver a su posición original. Veámoslo en el siguiente diagrama:

También lo podemos ilustrar con un sencillo ejemplo:

Un profesional del marketing, extravertido-racional, está organizando un equipo de trabajo para diseñar una campaña de publicidad. Su planificación de los detalles de la campaña no está siendo bien comprendida por los miembros del equipo e, incluso, algunos se muestran irresponsables en sus funciones. En este caso, el organizador puede echar mano de algunas de sus habilidades "ocultas" y emplear más recursos emocionales y/o intuitivos, atendiendo en mayor medida las motivaciones e intereses de los miembros de su equipo (extraversión-emocional). Pero también puede mantenerse rígido y llevar la situación a un límite de elevado estrés. En este caso, la función inferior puede emerger, y esta persona puede necesitar tomarse un tiempo de descanso, de relax, para meditar y estar solo (introvertido-emocional).

Este ejemplo nos hace pensar en la idea de "agotamiento" de las habilidades o los recursos personales para conseguir una meta, y la necesidad de cambiar de estrategia. Una teoría en boga hoy en día sobre el autocontrol defiende que la mente emplea recursos limitados y que el autocontrol favorece el agotamiento de esos recursos. En un estudio pionero, Baumeister et al. [11] pusieron a prueba esta hipótesis. A los participantes en un estudio se les mostraron dos platos de comida, uno con galletas y el otro con rábanos. A un grupo de ellos se les dijo que podían comer las galletas y al otro grupo que solo podían comer los rábanos. Posteriormente debían realizar un difícil rompecabezas. Los que comieron los rábanos desistieron de completar el rompecabezas a los 8 minutos, mientras que los que comieron las galletas aun perseveraban en el intento a los 19 minutos. Los investigadores dedujeron que los que comieron rábanos y, por tanto, resistieron la tentación de comer las galletas, agotaron sus recursos psicológicos en mayor medida que los demás, lo cual se plasmó en un menor tiempo de dedicación a la tarea mental de resolver el rompecabezas. Posteriormente, otros autores han obtenido resultados similares [12,13].

Así, los cambios de dirección en nuestro comportamiento, o bien la sustitución de una tendencia racional a una tendencia emocional, pongamos por caso, después de una situación de estrés, puede ser el resultado de un "agotamiento" de los recursos personales para hacer frente a esa demanda y buscar nuevas alternativas en un intento del organismo por adaptarse al ambiente.

Esto nos lleva también a una reflexión ciertamente inquietante, y es que las relaciones humanas pueden estar regidas, en gran parte, por este mecanismo de cambio basado en el "agotamiento" de los recursos. Buscamos un buen empleo, las personas más atractivas como pareja, la fama o reconocimiento, etc. Pero todo esto son recursos limitados. Nuestras relaciones sociales reflejan claramente la pugna, competencia, por esos recursos limitados, determinando nuestras aspiraciones, conflictos, envidias, y luchas con nosotros mismos.

2. Personalidad y drogas

Nuestro grupo de investigación ha profundizado intensamente el estudio de la relación entre el llamado Factor General de Personalidad (FGP), equivalente a la dimensión E-I, y el efecto de drogas [8,9,14]. Así, los E tenderán a reaccionar a las drogas con más excitación, en condiciones de reposo, que los I, además de inhibir el efecto más rápidamente. Esto favorece la repetición de la experiencia y, por ende, predispone a la adicción a largo plazo.

Ahora bien, con el nuevo modelo de personalidad ampliado que se presenta aquí, es posible entender mejor

la relación entre personalidad y drogas.

Pensemos en una persona diagnosticada de trastorno por déficit de atención. Su función dominante será la extraversión emocional. En este caso, emocional sería equivalente a impulsiva y con poca adecuación social al medio. Si se le administra a esta persona metilfenidato (un estimulante), su función inferior puede emerger con claridad, y convertirse en introvertido racional, al menos por un tiempo, con un trato social más adecuado (racional).

Por otro lado, el introvertido racional que consume una dosis suficiente de alcohol, puede experimentar un cambio hacia la extraversión emocional, sintiéndose más desinhibido, sociable y más atrevido, dejándose llevar más por los impulsos.

2. La personalidad de las sociedades

Amigó [3] propone aplicar su modelo de personalidad de los individuos a las sociedades, tomando la personalidad social como una propiedad emergente de una sociedad en un momento histórico determinado. Para ello, Amigó incorpora a este modelo la teoría de la supervivencia de las sociedades [4], que considera que los grandes cambios socio-económicos e ideológicos de una sociedad son resultado de crisis de supervivencia.

Así se puede entender la historia de occidente, como la evolución dinámica de su personalidad. Cada sociedad, en un determinado momento histórico, tendrá una función dominante y otra inferior. Tras una situación de crisis de supervivencia, la función inferior ocupará el lugar de la función dominante hasta una nueva crisis, en la que se invertirá el orden de los factores.

Podemos, por tanto, describir las sociedades como compuestas por dos dimensiones complementarias: Extraversión-Introversión y Razón-Emoción/Intuición.

Empecemos por exponer los rasgos que caracterizan a cada uno de los polos de las dos dimensiones:

EXTRAVERSIÓN: modernidad, progreso, sociedad más abierta al cambio y al mundo.

INTROVERSIÓN: conservadurismo, sociedad más cerrada, tradicional, autárquica, proteccionista.

EMOCIONAL: idealismo, predominio de las emociones y los sentimientos, espontaneidad.

RACIONAL: realismo, predominio del pensamiento, organización y planificación.

En principio, cabría esperar que, al igual que con la personalidad individual, las sociedades extravertidas sean más emocionales y las introvertidas más racionales. Pero lo que encontrarnos, al menos en la historia de occidente, es que las sociedades más cerradas (introversión) son más emocionales/intuitivas, ya que las emociones e intuiciones representan aspectos más estáticos y contemplativos. Por su parte, las sociedades abiertas (extraversión) son más racionales, en el sentido que organizan los procesos productivos y la convivencia de la población para favorecer el progreso. Pero, también, como sucede con la personalidad de los individuos, en un momento histórico determinado podemos encontrar cualquiera de las 4 combinaciones de las dos dimensiones, dependiendo de las condiciones iniciales (historia previa).

Partiendo de estas premisas, podemos ahora exponer las características básicas que surgen de la combinación de las dos dimensiones:

EXTRAVERSIÓN EMOCIONAL: idea de progreso basada fundamentalmente en la iniciativa individual, liberalismo.

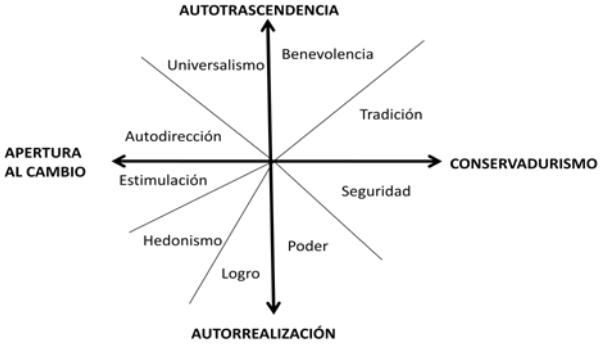
EXTRAVERSIÓN RACIONAL: búsqueda de pactos y armonía internacional, libre mercado internacional.

INTROVERSIÓN EMOCIONAL: ideal nacionalista, romanticismo, conflicto con otras naciones.

INTROVERSIÓN RACIONAL: orden, burocracia, planificación y proteccionismo.

Esto nos remite, hasta cierto punto, a la estructura bidimensional de los valores culturales de Schwartz [15], compuesta por dos dimensiones bipolares básicas de orden superior: apertura al cambio vs conservadurismo y autorrealización vs autotrascendencia [16].

En la siguiente gráfica podemos ver la estructura bidimiensional más desarrollada:



Podemos observar cómo, con nombres algo diferentes, las dos estructuras, la de Schwartz y la presentada aquí, contienen elementos muy similares integrados en una estructura bidimensional.

Veamos cómo quedan las dimensiones E-I y R-E en una gráfica y vamos a escribir en los cuadrantes los sistemas económico-sociales que les corresponde considerando la historia más reciente de occidente.

Podemos ver cómo la extraversión, que implica la apuesta por el progreso y el cambio, puede ser racional o emocional. El sistema basado en la extraversión racional se basa en la idea de facilitar el progreso a través de la organización de un Estado de Bienestar que promueva la paz social en el interior y la búsqueda de pactos internacionales para garantizar la paz y armonía con el exterior. Es el caso de la moderna Unión Europea. Por su parte, el sistema basado en la extraversión emocional apuesta por una sociedad poco organizada que potencie al máximo la iniciativa individual. Aquí la idea de progreso se basa en dejar al individuo la máxima libertad de acción. Es el caso del liberalismo, fundamentalmente, de los países anglosajones, como EEUU y Reino Unido.

En cuanto a la introversión, la sociedad introvertida racional apuesta por el orden y la estabilidad y el desarrollo socio-económico basado en la planificación. Sería el caso del comunismo soviético. En cuanto a las sociedades introvertidas emocionales, el orden y la estabilidad se consiguen a base de someterse a liderazgos particulares de "salvapatrias", cuyos designios se siguen incondicionalmente por buena parte de la sociedad. Son las dictaduras fascistas.

Vemos claramente que podemos elaborar una definición operativa de la IDEOLOGÍA de una cultura a partir de las premisas que estamos manejando. La ideología de una sociedad es una combinación de las dimensiones de Extraversión-Introversión y Razón-Emoción, en un momento dado de su historia. Si estas dimensiones cambian con el tiempo será que la ideología está también sufriendo modificaciones.

Pero nos interesa aquí desarrollar una teoría de la dinámica del cambio social a partir de las dos dimensiones que estamos considerando. Vamos para ello a retomar un importantísimo período histórico que marcó la historia de Europa y del mundo, y que analizamos en un artículo anterior [17]. Se trata de la Revolución Francesa y el cambio que trajo consigo: del Antiguo Régimen al Nuevo Sistema.

El sistema de gobierno del Antiguo Régimen era el Despotismo Ilustrado, con el poder absoluto del rey, que emanaba directamente de Dios. El orden social estaba constituido por estamentos estancos donde el ascenso de las clases bajas era inviable. A esta época histórica corresponde el estilo artístico del Barroco. Así, los aspectos emocionales (arte barroco, fundamento religioso del poder, nacionalismo) eran preeminentes en la supraestructura ideológica del Antiguo Régimen.

A partir de aquí podemos deducir fácilmente cual es la personalidad del Antiguo Régimen en términos de las dos dimensiones que estamos considerando: INTROVERSIÓN EMOCIONAL.

En cuanto al Nuevo Régimen, con un sistema de gobierno basado en la República Constitucional, una nación abierta al mundo, un sistema económico liberal, ideales de progreso y la razón como bandera, identifican esta nueva etapa surgida de la Revolución Francesa. El neoclasicismo y academicismo es el nuevo estilo artístico de la época.

También podemos deducir, a partir de esta información, qué personalidad define al nuevo sistema: EXTRAVERSIÓN RACIONAL.

La crisis demográfica y económica del Antiguo Régimen, junto a la pujanza de la burguesía y los nuevos aires de libertad que llegaban de las colonias de América, con la Declaración de Independencia de los Estados Unidos en 1775, condujeron a la Revolución Francesa de 1789. Como ya quedó expuesto anteriormente [17], la teoría de la supervivencia de las sociedades predice que en respuesta a una grave crisis socio-económica, surgirá un nuevo orden social y una nueva ideología que lo sustentará. Esta nueva ideología es la Ilustración, con su ideario de igualdad, universalidad y progreso sustentado en la razón.

Vamos ahora a aplicar el mismo esquema que anteriormente nos sirvió para entender el cambio individual al cambio social, el cambio de una época, a partir de la nueva concepción dinámica de la personalidad.

Con toda esta información, podemos proponer un mecanismo de cambio social desde el Antiguo Régimen hasta el Nuevo Régimen surgido de la Revolución Francesa, que ilustra el siguiente diagrama:

Podemos observar cómo la función dominante de la personalidad del Antiguo Régimen es la INTROVERSIÓN EMOCIONAL, y cómo la función inferior es la opuesta, es decir, la EXTRAVERSIÓN RACIONAL, como una corriente de pensamiento y acción que, poco a poco, va creciendo y tomando fuerza, oponiéndose al Antiguo Régimen. Producto de la crisis, se produce el cambio (Revolución Francesa) y la EXTRAVERSIÓN RACIONAL pasa a ser la función dominante. Con el tiempo, una nueva corriente de pensamiento y acción irá tomando fuerza y oponiéndose al nuevo sistema, de forma que, tras una nueva crisis, surgirá el Romanticismo, con una función dominante INTROVERTIDA EMOCIONAL. Y así sucesivamente.

De lo expuesto podemos deducir, tal como hicimos en el caso del cambio individual y en relación con la hipótesis de los recursos limitados del autocontrol, que las sociedades "agotan" sus recursos de subsistencia e ideológicos ante situaciones críticas (estrés), lo que conduce a cambios sociales y económicos en nuevas direcciones. La teoría de la supervivencia de las sociedades [4] ya anunciaba estos mecanismos. En el presente artículo se concreta la dirección que la supraestructura ideológica tomará en respuesta a la crisis.

Si bien, como tuvimos ocasión de comprobar cuando abordamos el cambio individual, la dinámica puede ser más compleja, este sencillo esquema nos sirve para ilustrar el mecanismo básico del cambio. Pero, no obstante, tengamos en cuenta que la función dominante puede no ser sustituida completamente por la función inferior, lo que dependerá, entre otros factores, de la intensidad de la crisis y de las condiciones iniciales (la historia previa en una determinada sociedad). Un análisis detallado de la secuencia de cambios sociales por períodos históricos breves, nos dará una idea más detallada y aproximada de la dinámica que se está produciendo.

4. Propuesta de modelo dinámico de la personalidad social

Ahora bien, a la hora de operacionalizar esta propuesta, de forma que pueda ser estudiada empíricamente, y así diseñar un modelo dinámico matemático, sería conveniente empezar por cuantificar productos sociales que puedan, con cierta facilidad, representar una de las dos dimensiones. Por ejemplo, la dimensión RAZÓN-EMOCIÓN a partir de la producción artística, del predominio de lo racional y/o emocional de los estilos artísticos que coexistan en un determinado período histórico.

Pongamos por caso la arquitectura. Podemos concretar qué aspectos se consideran más racionales y cuales más emocionales. Así:

Racionalidad en la arquitectura: predominio de líneas rectas y figuras geométricas, espacios prácticos, pocos adornos en fachadas e interiores, estilo convencional, etc.

Emocionalidad en la arquitectura: predominio de líneas curvas, edificios poco prácticos pero llamativos, profusión de adornos, diseños arriesgados y provocadores, etc.

A partir de estos criterios, es posible cuantificar el número de construcciones arquitectónicas importantes en una época histórica, y anotar cuántas de ellas cumplen en mayor medida los requisitos para ser consideradas obras racionales o emocionales.

Si cuantificamos las obras por años, podemos seguir con mucha precisión la evolución y dinámica del estilo arquitectónico de toda una época. Lo mismo podemos hacer con otras producciones artísticas, como pintura, escultura, también con la literatura, etc., y así establecer varios subsistemas.

Si además queremos hacer lo mismo con la dimensión EXTRAVERSIÓN-INTROVERSIÓN, podemos seguir las leyes que regulan el comercio, los valores sociales y culturales de la población a través de cuestionarios, tal como hacen autores como Shwartz, Triandis, etc., estableciendo también varios subsistemas. Obviamente, también podemos considerar la influencia mutua entre los sistemas y subsistemas que representan a estas dimensiones.

Con el fin de construir el modelo dinámico propuesto es necesario tener en cuenta la estructura matemática de los estímulos que producen las respuestas descritas, tanto en individuos como en sociedades. Por ejemplo, para el caso de las drogas en los individuos, ese estímulo ya ha sido descrito matemáticamente [8,9,14]. Sin embargo, la descripción del estímulo para las sociedades sigue siendo un reto matemático.

Amigó da la clave con el concepto de crisis [3,4]: la

descripción cuantitativa del concepto de crisis proporcionaría el patrón matemático buscado para el estímulo en las sociedades. Pero aún se puede profundizar más desde el trabajo de Arnold J. Toynbee [18]. Toynbee suele llamar *incitación* al estímulo, aunque a veces lo denomina también estímulo. Es equivalente al concepto de crisis de Amigó. El provecho de este trabajo es que describe con detalle el tipo de estímulos y sus características, lo que puede ayudar a diseñar el patrón matemático de los mismos. Además, los contextualiza como detonantes no sólo de los cambios en las sociedades, sinó también del nacimiento y desaparición de civilizaciones. Por ejemplo, aparecen estímulos como la desertización, que fueron capaces de hacer emerger las tres primeras civilizaciones de la Historia: la sumeria, la egipcia y la minoica.

La desertización es sólo un caso concreto de un verdadero motor de la Historia, el estímulo de la adversidad: sólo ante la adversidad nacen, crecen, cambian y mueren las civilizaciones y las sociedades que las contienen. Es paradigmático este tipo de estímulo general, que podría sugerir una estructura matemática también general, incluso a nivel del indivíduo. ¿Y si la U-invertida descrita arriba como patrón de cambio de la extraversión respecto al estímulo de una droga estimulante fuera una reacción del organismo que se opusiera a la adversidad de la droga? Si fuera así, habría que ver la droga como un factor adverso, que compensa el organismo con un incremento del nivel de estrés, de la misma manera que las civilizaciones respondieron ante la adversidad de la desertización con un "estrés", del que carecían las sociedades primitivas, y que compensara el estímulo de la desertización. De hecho, también Amigó [4] describe el Neolítico como una respuesta a otra adversidad: la superpoblación, otro estímulo también descrito en Toynbee [18] para el cambio de la civilización helénica, que la llevó a su expansión en el mediterráneo.

En definitiva, el estímulo *adversidad* sinónimo de *crisis*, sería clave para una descripción matemática del modelo dinámico propuesto, que tendría al "estrés" o extraversión generalizada como respuesta, tanto para individuos como para sociedades.

Es factible, por tanto, elaborar y comprobar un modelo dinámico matemático del desarrollo de las sociedades y de los cambios sociales. Además, esta nueva teoría de la personalidad es capaz de integrar tanto la personalidad individual como la social, abriendo una nueva perspectiva científica para el conocimiento más profundo y completo del ser humano, tanto en su vertiente individual como social. Decía Pelechano [19] que la personalidad individual hay que estudiarla en el contexto histórico particular. En ese sentido, la nuestra es una propuesta integradora que va aún más allá, dispuesta a descubrir los mecanismos fundamentales que determinan el comportamiento humano, tanto como individuos como colectivos o sociedades.

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