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The Sensitivity to Punishment and Sensitivity to Reward Questionnaire (SPSRQ) as a measure of Gray's anxiety and impulsivity dimensions

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Abstract

Gray [In H. J. Eysenck, *A model for personality* (pp. 246–276). New York: Springer; 1981; *The neuropsychology of anxiety: an enquiry into the functions of the septo-hippocampal system*. Oxford: Oxford University Press; 1982] has described two motivational systems, the Behavioural Inhibition System (BIS) and the Behavioural Activation System (BAS), that control aversive and appetitive behaviour, respectively. Research on Gray's model of personality has been hindered by the lack of specific self-report measures of the reactivity and responsivity of these systems. We describe a set of studies that illustrate the main psychometrical characteristics of the Sensitivity to Punishment and Sensitivity to Reward Questionnaire (SPSRQ). The two scales of the questionnaire were developed by writing items to assess BIS and BAS functioning, respectively. Results showed that both scales were independent, and presented satisfactory internal consistency and test-retest reliability. Studies 2–5 reported data related to convergent and discriminant validity of the scales. The Sensitivity to Punishment scale was: (1) positively related to Eysenck's neuroticism dimension; (2) negatively related to extraversion; (3) not related to psychoticism; (4) significantly related to the STAI-Trait scale of Spielberger; and (5) related to the somatic, behavioral, and cognitive anxiety scales of Lehrer and Woolfolk [*Behavioral Assessment*, *4*, (1982) 167–177.]. The Sensitivity to Reward scale was: (1) positively related to Eysenck's extraversion and neuroticism; (2) moderately related to psychoticism; (3) positively related to the Eysenck's Impulsiveness scale [*Psychological Reports*, *43*, (1978) 1247–1255] and the Zuckerman's Sensation Seeking Scales [*Journal of Consulting and Clinical Psychology*, *46*, (1978) 139–149]. Although future construct validity studies are needed, discussion is

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focused on the importance of using specific designed measures to evaluate and develop Gray's model.

Keywords: Sensitivity to punishment; Sensitivity to reward; Behavioural Inhibition System; Behavioural Activation System; SPSRQ; Anxiety; Impulsivity; Gray's model

1. Introduction

Gray's model of personality consists of three independent neuropsychological systems that underlie three orthogonal personality dimensions (Gray, 1981, 1982). This approach follows the tradition of Pavlov and Eysenck, postulating the existence of a small number of major personality dimensions, each of which reflects individual differences in the functioning of an independent neurological system. In the case of Gray's model, these systems reflect brain structures that influence sensitivity to reinforcing events and control the experience of emotion. The best studied is the Behavioural Inhibition System (BIS). The BIS normally functions as a comparator, taking control of behaviour in response to signals of punishment, frustrative non-reward, and novel stimuli. In terms of individual differences in personality, the BIS is related to the trait-anxiety dimension. In accordance with the model, neurotic introverts should obtain higher scores in trait anxiety than stable extraverts.

Gray described a second system called the Behavioural Approach System (BAS; Gray, 1981) or the Behavioural Activation System (BAS; Fowles, 1980) that was independent of the BIS. The BAS is a conceptual system responsible for approach behaviour in response to incentives (signals of reward or non punishment). Individual differences in the functional capacity of the BAS are related to the impulsivity dimension of personality. The impulsivity dimension is orthogonal to anxiety, and runs from stable introvert to neurotic extravert quadrants.

Gray (1987a) has also proposed a less clearly defined system called the Fight/Flight System (FFS). This system is activated by the presence of unconditioned aversive stimuli promoting fight or escape behaviour. One of the most important issues in Gray's model is the neurobiological description of the three structures. Gray (1995) and Gray and MacNaughton (1996) have described precisely the neurological substrate of the BIS, the BAS and the FFS. However, this issue is beyond the scope of this paper.

2. Psychometric measures of Gray's dimensions

In research with human beings, Gray's hypotheses have been traditionally tested by examining the correlates of self-report measures of his anxiety and impulsivity dimensions. These measures should identify the habitual level of functioning of the BIS and the BAS. When contrasting hypotheses derived from Gray's model, one has the feeling of "playing an away-match" because in almost all cases the employed self-report measures were not directly derived from the model. Three different methods have been employed to classify subjects as a function of their level of BIS and BAS activation. First, several studies have classified subjects considering both Eysenck's dimensions of extraversion and neuroticism (for example, Gupta & Shukla, 1989; Patterson, Kosson, & Newman, 1987). This method is based on the classification of subjects in the four

quadrants derived from their scores on these two dimensions obtained from the Eysenck Personality Inventory (EPI; Eysenck & Eysenck, 1964), or the Eysenck Personality Questionnaire (EPQ; Eysenck, & Eysenck, 1975). The second method uses diverse measures related to trait anxiety and impulsivity, but not specifically designed to tap the dimensions depicted by Gray. The Trait-Anxiety scale of the State-Trait Anxiety Inventory (STAI-T; Spielberger, Gorsuch & Lushene, 1970), the Manifest Anxiety Scale (MAS; Taylor, 1953), or the Harm Avoidance scale (Cloninger, 1987) are examples of scales used to measure Gray's anxiety (for example, Díaz & Pickering, 1993; Zinbarg & Revelle, 1989). The Impulsivity subscale of the EPI (Eysenck & Eysenck, 1964), the Impulsiveness scale (I_7) of the Impulsiveness, Venturesomeness, and Empathy Questionnaire (IVE; Eysenck, Pearson, Easting & Allsopp, 1985), the Sensation Seeking Scale (SSS; Zuckerman, Eysenck & Eysenck, 1978), the Novelty Seeking and Reward Dependence scales (Cloninger, 1987) have been used as measures of Gray's impulsivity dimension (for example, Corr, Pickering & Gray, 1995; Díaz & Pickering, 1993; Zinbarg & Revelle, 1989). The third method consists of the construction of specific scales to measure Gray's dimensions. This approach has the advantage over the other two that scales are specifically designed to measure differences in the functioning of the BIS and the BAS. Thus, in most cases, this strategy produces scales with face and content validity. There have been several efforts to construct scales to measure Gray's dimensions.

As far as we know, the first attempt to develop a measure of Gray's anxiety dimension was the Susceptibility to Punishment scale (Torrubia & Tobeña, 1984). This scale had good reliability and construct validity properties, and has been used successfully by a number of researchers (Díaz & Pickering, 1993; Furnham, 1986; Pickering, Corr, Powell, Kumari, Thornton & Gray, 1997). Muntaner and Torrubia (1985) also developed the Susceptibility to Reward scale, a scale designed to measure Gray's impulsivity dimension (see De Flores & Valdés, 1986, for some of its psychometric properties). These two scales could be considered as forerunner versions of the scales presented in the present paper.

MacAndrew and Steele (1991) developed an MMPI-derived scale to measure BIS sensitivity. Selected items of the scale were included because: (1) they were able to differentiate between three different samples of females: psychiatric outpatients with dysthymic disorder, putative normal subjects, and incarcerated prostitutes (supposed to have an underactive BIS); and (2) correlated positively with the Neuroticism scale (N) and negatively with the Extraversion scale (E) of the EPQ. The final scale comprised 30 items, some of them with a content that did not reflect directly the functioning of the BIS.

A second questionnaire was constructed by Wilson, Barrett and Gray (1989, 1990). They constructed the Gray-Wilson Questionnaire based on six different scales designed to measure individual differences in the activity of Gray's three systems. The six scales measured situations tapping individual differences in different kinds of behaviour: Passive Avoidance and Extinction (BIS dependent), Active Avoidance and Approach (BAS dependent) and Flight and Fight (FFS dependent). The validation studies were not completely successful in finding the expected relationships between scales, because some results did not fit well in Gray's model (see also Wilson, Barrett & Iwawaki, 1995, for a later replication).

Recently, Carver and White (1994) have published one of the best attempts to measure Gray's dimensions: the BIS/BAS scales. They designed four different scales, one for measuring the BIS dimension, and three measures of the BAS dimension called Reward Responsiveness, Drive, and Fun Seeking. Although the authors did not fully justify the subdivision of the BAS dimension,

they also pointed out that the three scales loaded on one second-order factor which should be considered a BAS factor. One of the problems of these measures is their location in the Eysenckian space (Heubeck, Wilkinson, & Cologon, 1998; Zuckerman, Joireman, Kraft, & Kuhlman, 1999): the BIS scale did not correlate with E, and the BAS scales were not related to N. A second problem was related to item content, related to generalized sensitivity to reward and punishment, while Gray's theory deals with sensitivity to specific cues (Matthews & Gilliland, 1999; Zinbarg & Revelle, 1989).

The Generalized Reward and Punishment Expectancy Scales (GRAPES) were developed by Ball and Zuckerman (1990) by factor analyzing items reflecting expectations regarding outcomes for various life events in the future. The two factors obtained in the analysis reflected generalized reward and punishment expectancy. Ball and Zuckerman related them to Gray's impulsivity and anxiety dimensions, respectively. However, some studies by the authors themselves did not give support to this interpretation (Ball & Zuckerman; Zuckerman et al., 1999).

2.1. Issues derived from Gray's model at human level

The model depicted by Gray has acquired great relevance in different fields including personality, emotion, and psychopathology. Some authors have used Gray's conceptualization of the BIS and the BAS for explaining stable individual differences in personality in adults (Fowles, 1987; Newman, 1987; Tellegen, 1985) and children (Rothbart, Derryberry & Posner, 1995). Recently, Gray and his colleagues have used the term "Reinforcement Sensitivity Theory" to describe the application of Gray's model to human personality (Pickering et al., 1997). Another important field of research derived from Gray's model is its potential application in understanding several psychopathologies including phobias, obsessions and other anxiety disorders (e.g. Fowles, 1988; Gray, 1982, 1987b), panic disorders (Barlow, 1988; Gray & McNaughton, 1996), psychopathy (Fowles, 1980; Gray, 1988; Newman, 1987), schizophrenia (Gray, Feldon, Rawlings, Hemsley & Smith, 1991), and child psychopathologies such as Attention Deficit Disorder with Hyperactivity, Conduct Disorder (Quay, 1988, 1993, 1997) and callous-unemotional traits (Frick, 1998). Following the Eysenck approach, these researchers have located the predisposition to different disorders at both poles of the Gray's anxiety and impulsivity dimensions.

Despite the impact of this research in advancing the questions they are studying, we have noted a general lack of agreement between researchers with regard to several issues derived from Gray's model. Our interest in this point is to discuss these different issues to pre-establish the conditions that we consider self-report measures of Gray's dimensions should satisfy.

2.1.1. Anxiety and impulsivity are only labels

Anxiety and impulsivity are only labels for describing a particular behavioural expression. In most cases, researchers seem to give more importance to this label than to the description of behaviours depending on the BIS and the BAS. The label anxiety fits quite well with the behaviour controlled by the BIS, but not all the manifestations of anxiety are exclusively dependent on the BIS. Two examples are some somatic manifestations of anxiety and panic disorders (an anxiety disorder considered related to the FFS but not to the BIS, see Gray & McNaughton, 1996). The problem is greater for the term impulsivity. Gray and his colleagues described four types of impulsive behaviour, and only one of them was related to the BAS (Gray, Owen, Davis & Tsaltas, 1983). Several theoretical considerations (Barratt & Patton, 1983; Dickman, 1990;

Eysenck & Eysenck, 1978) and factor analytic studies (Eysenck & Eysenck, 1977; Gerbing, Ahadi & Patton, 1987) have confirmed that impulsivity should be conceived as a multifactorial concept (Parker & Bagby, 1997). This fact stresses the importance of delimiting Gray's dimensions to the functioning of the BIS and the BAS, considering the label as a general approach to the concept. Thus, not just any scale designed to measure anxiety or impulsivity could necessarily be considered an appropriate measure of Gray's anxiety and impulsivity dimensions.

2.1.2. Angle of rotation of Eysenckian axes

One of the most problematic aspects in Gray's model is the angle of rotation of his dimensions in the Eysenckian space delimited by neuroticism and extraversion. Gray (1970, 1981) located his dimensions at 45° from both Eysenckian axes. This rotation directly implies a change in the view of the nature of Eysenckian axes: extraversion could be conceptualized as a dimension reflecting the balance of BIS/BAS activation (extraverts are BAS-dominant and introverts are BIS-dominant), whereas neuroticism would be the degree of sensitivity to both signals of reward and punishment (Wallace & Newman, 1990). The 45° rotation was intended by Gray to be schematic to explain his model. Nevertheless, from the very start he proposed (Gray, 1970) that a smaller rotation (closer to 30° than 45°) would be more appropriate (Matthews & Gilliland, 1999; Pickering, Corr & Gray, 1999), whereas Eysenck (1987) reduced it to 10–15°. The discussion has sprung from the obtained correlations between scales designed to measure anxiety and impulsivity and Eysenckian dimensions. Although some correlational studies questioned the original rotation proposed by Gray, they are based on measures not designed to measure BIS and BAS activity. Also, some more theoretical proposals (Cloninger, 1986, 1988; Patterson & Newman, 1993; Wallace, Bachorowski & Newman, 1991) are derived from a rotation of 30 to 45°. Thus, we propose that any scale designed to measure Gray's anxiety dimension should be related positively with neuroticism and negatively with extraversion, and that any scale designed to measure Gray's impulsivity should be related positively with extraversion and neuroticism.

2.1.3. Orthogonality of the BIS and the BAS

The BIS and the BAS have been defined conceptually as independent systems. Although both systems could function with relative autonomy, the behavioural effects are also conceived to be as mutually inhibitory (Gray & Smith, 1969). In fact, Gray's description of brain structures has specified interactions between the BIS and the BAS. The situations in which interaction between both systems would be more probable are those involving approach-avoidance conflicts and discriminative learning (Fowles, 1987; Gray & Smith; Patterson & Newman, 1993). This type of reciprocal inhibition could be conceptualized as a competition between approach and inhibition in response to a particular situation. Although finding real situations lacking both appetitive and aversive components could be difficult (Pickering, 1997; Pickering et al., 1997), items constructed to measure the functioning of the BIS and the BAS separately should be written carefully to describe situations including either explicit reward or punishment, but not both. This approach should avoid the possibility of items measuring both BIS and BAS activation.

2.1.4. BIS/BAS activation during and after learning

Another interesting point in Gray's model is to consider that the BIS and the BAS could be activated in control mode at two different moments: during instrumental learning of the appro-

priate response to a motivational stimulus, and once this learning has been established (Gray, 1975; Pickering, Díaz & Gray, 1995). The question here is the system (i.e. BIS or BAS) activated when someone is learning an active avoidance response or extinguishing a response. Active avoidance learning requires in almost all cases an initial activation of the BIS because the situation is initially aversive. The problem is to understand how a stimulus could be signalling safety if it had not previously been aversive. Thus, active avoidance learning is a dynamic process that activates first the BIS, and later the BAS. The same case could be applied to extinction: extinguishing an instrumental response requires an initial expectancy of reward that activates the BAS before activating the BIS. Amsel (1992) called this change in the motivational value of a conditioned stimulus counter-conditioning.

This difference should be taken into account when constructing self-report measures of BIS and BAS activation. Items designed for these measures would serve to describe situations that differentiate subjects with an underactivity and an overactivity of both systems. However, including situations tapping active avoidance responses (for the BAS measure) or extinction (for the BIS measure) could cause problems. For example, the item "Do you visit the doctor for regular check-ups?" from the Active Avoidance scale of the Gray-Wilson questionnaire could be associated positively with the BAS-scale if the subject normally makes the avoidance response, but could be also related to the BIS-scale as a measure of fear.

Nevertheless, although the same reasoning could be used for extinction and active avoidance behaviours, both cases seem not to be equivalent. At the human level, there are some reasons to argue that extinction learning is more equivalent to passive avoidance than active avoidance to reward. We will cite two sources of data: first, experimental research in humans has shown that extinction learning was associated with individual differences in BIS activation (Ávila, 1994; Ávila & Parcet, 2000). Second, a study by Wilson et al. (1989, 1990) using self-report measures found a positive significant correlation between self-report Passive Avoidance and Extinction measures, but a significant negative correlation between measures of Approach and Active Avoidance. In summary, the above discussion should be specifically applied to active avoidance learning.

2.1.5. The importance of the comparator structure

Although Gray's theory is primarily concerned with the motivating properties of conditioned stimuli when the subject has learned a task to an asymptotic level (Pickering et al., 1997), items designed to measure BIS/BAS sensitivity should basically deal with the comparator function of the systems. The comparators described by Gray serve to monitor the environment searching for reward or punishment (Gray & Smith, 1969). This action determines, in part, sensitivity to reinforcers: subjects with overactivity in the BIS and the BAS should have a greater proneness to perceive neutral situations as threatening and rewarding, respectively. If the comparator function becomes relevant in humans, Gray's personality model would go beyond a motivational/emotional level: it should also explain the cognitive functions that allow detecting and storing motivational stimuli.

Thus, items should not reflect overlearned motivating situations in which almost all subjects would act in the same way. For example, the item "Would you go to get the money if you won a prize in the lottery?" will not serve to distinguish between impulsives and non-impulsives because almost all the subjects would respond yes to this question. Contrarily, items should reflect situations in which there is a given probability of activating the BIS or the BAS. For example, the item "Do

you often buy lottery tickets?'' could serve to measure BAS sensitivity in control mode. Differences in the functioning of the comparator would cause anxious subjects to have a higher rate of BIS activation than non anxious, and impulsive subjects to have a higher rate of BAS activation than non-impulsives.

2.1.6. Anxiety and impulsivity in a three dimensional space

Gray (1987a) has related his two dimensions to Eysenck's psychoticism. His proposal was based on the supposition that an underactive BIS (low trait-anxiety) predisposes to ''primary psychopathy'' (Fowles, 1980; Lykken, 1995). As psychoticism has also been related to primary psychopathy, Gray predicted a negative relationship between his anxiety dimension and psychoticism. The predicted negative relationship between the previous Susceptibility to Punishment scale and the Psychoticism scale of the EPQ was obtained in the seminal study of Torrubia and Tobeña (1984). However, other data have obtained closer-to-zero (Díaz & Pickering, 1993) or positive (MacAndrew & Steele, 1991) correlations between measures of Gray's anxiety dimension and psychoticism.

More speculatively, Gray also proposed that his impulsivity dimension should be positively related to psychoticism. This hypothesis has received partial support in studies that have used the Impulsivity scale of the EPI (Rocklin & Revelle, 1981) or the Impulsiveness scale of the IVE (Díaz & Pickering, 1993). However, these scales were not designed to measure individual differences in the functioning of the BAS. Thus, the relationship between Gray's impulsivity and psychoticism should be tested using specific measures of the functioning of the BAS.

2.1.7. Summary — requirements of scales designed to measure BIS and/or BAS functioning

Following the above review of Gray's model, we consider that scales designed to measure individual differences in the functioning of the BIS and BAS should satisfy these requirements:

1. the BIS and the BAS measures should be orthogonal;
2. a measure of BIS activity should be correlated positively with neuroticism and negatively with extraversion measures;
3. a measure of BAS activity should be correlated positively with both extraversion and neuroticism measures;
4. items constructed to measure BIS or BAS functioning separately should describe situations including an explicit predominance of reward or punishment, but never of both;
5. items included in the BAS measure should not contain situations tapping differences in active avoidance learning; and
6. items to measure BIS and BAS activity should be of two kinds: those related to the responsivity of these structures in the presence of signals of reward and punishment, and those related to the reactivity of these systems in checking mode.

3. Development of the Sensitivity to Punishment and Sensitivity to Reward Questionnaire (SPSRQ)

The Susceptibility to Punishment scale was first published by Torrubia and Tobeña (1984). The aim of the authors was to develop a questionnaire to measure individual differences in the activity of the BIS. It consisted of 36 yes-no items that included questions about habitual behaviours in

response to cues of punishment, frustrative non-reward and novel stimuli. Preliminary data presented in the first publication and later studies (Díaz & Pickering, 1993), showed adequate internal consistency and construct validity. However, careful item analyses have shown that the scale should be revised because some items included in the 36-item version scale did not show an adequate correlation with the total scale (Moltó, 1988). Thus, a revision of the Susceptibility to Punishment scale was initiated with the aim of improving its psychometric properties. First of all, eight new items were included in the scale. This experimental version of the Susceptibility to Punishment scale with 44 items was administered to a large sample of undergraduates. Psychometrical analyses of this data produced a 24-item version of the renamed Sensitivity to Punishment (SP) scale, which includes 18 items from the old version and 6 new items. The items included in this final version were designed to measure individual differences in some functions dependent on the BIS in checking and control modes: (1) behavioural inhibition (passive avoidance) in general situations involving the possibility of aversive consequences or novelty; and (2) worry or cognitive processes produced by the threat of punishment or failure.

The Sensitivity to Reward (SR) scale was created to assess differences in the impulsivity dimension following Gray's description of the BAS (Muntaner & Torrubia, 1985). The first version of the SR contained 31 items and yielded some promising results (De Flores & Valdés, 1986). A revised version was developed in order to improve psychometric properties of the scale, and to include new theoretical contributions to the functions of the BAS (Fowles, 1987; Gray, 1987c; Newman, 1987). This revised version initially included 54 items, and was also administered to a large sample of undergraduates. A final version of 24 items was finally obtained. Item content of this scale was varied as much as possible including topics such as money, sex partners, social events, power, sensation-seeking and so on, always trying to describe situations in which people could do something to obtain rewards.

The aim of this paper is to present some data about construct validity and psychometric properties of the SP and the SR scales, that constitute the SPSRQ. We report five studies in undergraduate samples related to psychometric properties of reliability and construct validity of the SPSRQ.

4. Study 1

The aim of this first study was to bring together data derived from the Catalan language version of the SPSRQ to calculate norms and reliability in a sample of undergraduates. These norms can be used by researchers interested in the questionnaire. A factor analysis of the items is also reported to study the orthogonality of the two scales.

4.1. Method

A total of 470 males and 1093 females selected from the Universitat Autònoma de Barcelona and the Universitat Jaume I de Castelló were included. The mean age was 19.62 (S.D. = 2.35) with a range from 17 to 40. The data were collected during the period of 1985–1997, and were compiled from studies 2–5. The sample consisted of psychology, law and medical undergraduates.

The SPSRQ is a 48 yes-no response item questionnaire containing two scales: Sensitivity to Punishment (SP; a 24-item revised version of the Susceptibility to Punishment scale), and Sensitivity to Reward (SR; a definitive version including 24 items). Even items belong to SR and odd items to SP. Scores for each scale can be obtained by adding all the "yes" answers.

Personality questionnaires were always administered in classroom situations in groups not larger than 150 undergraduates. The SPSRQ was completed either alone or included in a single questionnaire containing also all the items of the Catalan version of the EPQ (Eysenck, Garcia-Sevilla, Torrubia, Ávila & Ortet, 1992) and the I_5 scale of the IVE (Torrubia & Tobeña, 1984).

In order to study test-retest reliabilities at different time intervals, the SP was re-administered to three different small samples at intervals of 3 months, 1 year and 3 years. Pearson correlations between administrations were performed for each sample.

4.2. Results and discussion

Table 1 shows the descriptive data and some psychometric properties of the SP and SR scales separately for each sex. As can be observed, females obtained slightly higher scores than males on SP, and males clearly outscore females on the SR scale. Alpha and test-retest reliabilities reached acceptable levels for both scales, these being higher for the SP than SR scale. Correlations between both scales were 0.08 for males and 0.05 for females.

Item information including percentage endorsement, sex differences and factor analyses is shown in Table 2. Some items of the SR scale had an extreme percentage of endorsement. So, items like 4, 6 and 34 were affirmatively answered by a high percentage of subjects, whereas others like 8, 24, 36, 42, and 48 had a very low percentage of endorsement (especially in females). However, these items remained in the final scale because they had acceptable or high loadings on

Table 1
Study 1: Main descriptive statistics, internal consistency, and Pearson correlations for test-retest of the Sensitivity to Punishment (SP) and the Sensitivity to Reward (SR) scales

	SP		SR	
	Males	Females	Males	Females
n	468	1090	470	1093
Mean	11.65	11.98	12.18	10.11
S.D.	5.27	5.06	4.48	4.05
Median	12	12	11	9
Mode	10	12	12	9
Kurtosis	−0.73	−0.70	−0.60	−0.14
Skewness	0.05	−0.02	0.00	0.40
Alpha	0.83	0.82	0.78	0.75
Test-retest (r)				
3 months ($n=57$)	0.89		0.87	
1 year ($n=97$)	0.74		0.69	
3 years ($n=22$)	0.57		0.61	

Table 2
Study 1: Percentage of endorsement, differences between sexes (chi square) and highest loading in factor analysis after Varimax rotation of items of the SPSRQ[a]

	Percentage endorsement			Factor loadings			
	Male	Female	Difference	Males		Females	
				I	II	I	II
1. Do you often refrain from doing something because you are afraid of it being illegal?	45	45		0.20		0.06	
2. Does the good prospect of obtaining money motivate you strongly to do some things?	63	47	**		0.47		0.49
3. Do you prefer not to ask for something when you are not sure you will obtain it?	59	52	*	0.35		0.39	
4. Are you frequently encouraged to act by the possibility of being valued in your work, in your studies, with your friends or with your family?	81	83			0.38		0.30
5. Are you often afraid of new or unexpected situations?	31	41	**	0.55		0.58	
6. Do you often meet people that you find physically attractive?	93	81	**		0.11		0.25
7. Is it difficult for you to telephone someone you do not know?	58	52		0.50		0.43	
8. Do you like to take some drugs because of the pleasure you get from them?	22	12	**		0.24		0.19
9. Do you often renounce your rights when you know you can avoid a quarrel with a person or an organisation?	33	27	*	0.49		0.45	
10. Do you often do things to be praised?	40	30	**		0.51		0.50
11. As a child, were you troubled by punishments at home or in school?	58	55		0.35		0.30	
12. Do you like being the centre of attention at a party or a social meeting?	52	55			0.49		0.46
13. In tasks that you are not prepared for, do you attach great importance to the possibility of failure?	64	73	**	0.22		0.39	
14. Do you spend a lot of your time on obtaining a good image?	36	36			0.47		0.39
15. Are you easily discouraged in difficult situations?	32	39	*	0.47		0.54	
16. Do you need people to show their affection for you all the time?	53	69	**		0.31		0.29
17. Are you a shy person?	68	69		0.55		0.48	
18. When you are in a group, do you try to make your opinions the most intelligent or the funniest?	65	45	**		0.46		0.48
19. Whenever possible, do you avoid demonstrating your skills for fear of being embarrassed?	44	54	**	0.19		0.33	
20. Do you often take the opportunity to pick up people you find attractive?	62	47	**		0.37		0.34
21. When you are with a group, do you have difficulties selecting a good topic to talk about?	36	34		0.51		0.53	
22. As a child, did you do a lot of things to get people's approval?	41	36			0.45		0.49
23. Is it often difficult for you to fall asleep when you think about things you have done or must do?	52	52		0.29		0.34	
24. Does the possibility of social advancement, move you to action, even if this involves not playing fair?	22	10	**		0.52		0.49

Table 2 (*continued*)

	Percentage endorsement			Factor loadings			
	Male	Female	Difference	Males		Females	
				I	II	I	II
25. Do you think a lot before complaining in a restaurant if your meal is not well prepared?	45	48		0.47		0.43	
26. Do you generally give preference to those activities that imply an immediate gain?	54	41	**		0.47		0.51
27. Would you be bothered if you had to return to a store when you noticed you were given the wrong change?	41	40		0.42		0.39	
28. Do you often have trouble resisting the temptation of doing forbidden things?	36	25	**		0.24		0.36
29. Whenever you can, do you avoid going to unknown places?	28	27		0.36		0.38	
30. Do you like to compete and do everything you can to win?	62	42	**		0.41		0.47
31. Are you often worried by things that you said or did?	72	74		0.38		0.46	
32. Is it easy for you to associate tastes and smells to very pleasant events?	69	74	*		0.16		0.12
33. Would it be difficult for you to ask your boss for a raise (salary increase)?	55	67	**	0.47		0.41	
34. Are there a large number of objects or sensations that remind you of pleasant events?	77	83	**		0.18		0.09
35. Do you generally try to avoid speaking in public?	60	68	**	0.52		0.52	
36. When you start to play with a slot machine, is it often difficult for you to stop?	9	7			0.24		0.25
37. Do you, on a regular basis, think that you could do more things if it was not for your insecurity or fear?	57	66	**	0.59		0.62	
38. Do you sometimes do things for quick gains?	53	34	**		0.54		0.55
39. Comparing yourself to people you know, are you afraid of many things?	27	35	**	0.60		0.56	
40. Does your attention easily stray from your work in the presence of an attractive stranger?	65	54	**		0.38		0.29
41.Do you often find yourself worrying about things to the extent that performance in intellectual abilities is impaired?	65	65		0.44		0.34	
42. Are you interested in money to the point of being able to do risky jobs?	30	13	**		0.47		0.45
43. Do you often refrain from doing something you like in order not to be rejected or disapproved of by others?	44	38		0.54		0.50	
44. Do you like to put competitive ingredients in all of your activities?	44	23	**		0.41		0.40
45. Generally, do you pay more attention to threats than to pleasant events?	24	22		0.46		0.43	
46. Would you like to be a socially powerful person?	60	48	**		0.56		0.45
47. Do you often refrain from doing something because of your fear of being embarrassed?	48	49		0.66		0.65	
48. Do you like displaying your physical abilities even though this may involve danger?	33	18	**		0.46		0.40

[a] Odd items, SP; even items, SR; Males; $n = 468$; Females, $n = 1090$.

*$P < 0.05$.

**$P < 0.01$.

factor analyses and because of their importance in the face validity of the scale. Contrarily, items of the SP scale had a non-extreme percentage of endorsement.

Sex differences were calculated using chi-square tests. Most of the items of the SR scale showed a higher percentage of endorsement for males. Only items 16 and 34 showed the reverse pattern, whereas items 4, 12, 14, 22, and 36 did not yield significant differences between sexes. For the SP scale, no sex differences were found in 14 items, and a higher percentage of endorsement in females was found for another 8 items. Only items 3 and 9 showed a higher percentage of endorsement in males.

Item principal component analyses were conducted separately for each sex. The Scree test in males revealed two factors that explained 11.7% and 9.0% of variance, respectively. These factors were retained for Varimax rotation. Once rotated, the first factor had higher loadings on the items of the SP scale, whereas the second factor was loaded by the items of the SR. Each item had its highest loading on the expected factor. The items with the highest loadings on the SP factor were 47, 39, 37, 5, and 17, reflecting clearly the functioning of the BIS. The items with the highest loadings on the SR factor were 46, 38, 24, 10, and 12, tapping individual differences in seeking diverse kinds of reward.

The Scree test in the factor analysis with females also revealed the existence of two different factors accounting for 11.1 and 8.4% of variance, which after rotation were related to SP and SR, respectively. Item loadings on the SP and the SR factors were similar to those obtained for males.

5. Study 2

The main aim of this study was to place the scales of the SPSRQ within the Eysenckian personality space. Gray's rotation of Eysenck's dimensions located the anxiety and impulsivity dimensions at 30–45° from extraversion and neuroticism (Gray, 1981). Following Gray's model, the SP and SR scales should correlate highly with E and N. No hypothesis was made about the correlation between the SPSRQ and the Psychoticism (P) scale of the EPQ. The relationship of the SPSRQ with the I_5 scale was also analyzed. The I_5 scale is usually highly and positively correlated with E, N and P scales (Eysenck & Eysenck, 1978). Although this scale was not designed to measure the functioning of BAS, its location was expected to be similar to Gray's impulsivity dimension. We also expected that the I_5 scale should be correlated positively with the SR scale, and uncorrelated with the SP scale.

5.1. Method

A total of 240 male and 491 female undergraduates participated in this study. The mean age was 20.07 (S.D. = 2.58, range 18–36). The data was collected during the period of 1985–1993. The sample consisted of psychology, law and medical undergraduates from the Universitat Autònoma de Barcelona.

A single personality questionnaire of 161 items was constructed mixing the 48 items of the SPSRQ, the 89 items of the Catalan version of the EPQ (Eysenck et al., 1992) and the 24 items of

Table 3
Studies 2–5: Means, standard deviations and sex comparisons (Student *t*-tests) of the self-report measures[a]

	Males		Females		Dif.
	M	S.D.	M	S.D.	
A — Study 2 (Males, n = 240; Females, n = 491)					
SP	12.63	5.25	12.36	4.96	
SR	12.18	4.30	10.25	4.24	**
E	12.94	4.90	13.90	4.25	*
N	10.77	5.05	11.96	4.57	*
P	4.68	2.99	3.58	2.53	**
L	8.20	3.59	9.08	3.84	*
I_5	9.68	3.92	9.56	4.01	
B — Study 3 (Males, n = 96; Females, n = 276)					
SP	10.86	5.60	12.12	5.28	
SR[b]	12.14	4.59	10.15	4.34	*
E	13.63	4.92	13.58	4.20	
N	10.64	5.76	12.27	4.71	*
P	5.90	3.44	4.05	2.75	**
L	6.89	3.81	7.87	3.73	
I_5[c]	10.26	4.63	9.68	4.96	
STAI-T	23.84	10.26	26.86	10.25	*
C — Study 4 (Males, n = 117; Females, n = 223)					
Som	52.19	13.77	56.13	14.28	*
Beh	29.26	6.95	28.27	7.27	
Cog	35.74	9.28	35.96	9.44	
SP	11.80	5.47	12.06	5.44	
E	14.35	4.22	13.56	4.23	
N	10.24	5.02	11.16	4.52	
P	4.72	3.15	3.64	2.37	**
L	7.92	3.29	8.71	3.25	
I_5	8.63	4.23	8.84	4.55	
STAI-T[d]	20.34	9.81	25.64	10.08	**
D — Study 5 (Males, n = 229; Females, n = 599)					
SP	10.61	5.09	11.67	5.14	**
SR	12.20	4.68	10.02	3.88	**
TAS	6.94	2.55	6.60	2.59	
ES	6.07	1.93	6.06	1.72	
Dis	5.03	2.23	3.54	1.99	**
BS	4.28	2.10	3.65	1.99	**
SSS	22.33	5.69	19.84	5.44	**

[a] Dif. = differences by sex; SP, Sensitivity to Punishment scale; SR, Sensitivity to Reward scale; E, Extraversion; N, Neuroticism; P, Psychoticism; L, Lie; I_5 = Impulsiveness; STAI-T, Trait anxiety scale of Spielberger; Som, Somatic anxiety scale of the Lehrer–Woolfolk Anxiety Symptoms Questionnaire (LWASQ); Beh, Behavioral anxiety scale of the LWASQ; Cog, Cognitive anxiety scale of the LWASQ; TAS, Thrill and Adventure Seeking; ES, Experience Seeking; Dis, Disinhibition; BS, Boredom Susceptibility; SSS, Sensation Seeking Scale

[b] Males, $n = 51$; Females, $n = 156$

[c] Males, $n = 43$; Females, $n = 119$

[d] Males, $n = 47$; Females, $n = 112$

*$P < 0.01$; **$P < 0.001$

Table 4
Study 2: Intercorrelations between the Sensitivity to Punishment and Sensitivity to Reward Questionnaire (SPSRQ), the Eysenck Personality Questionnaire (EPQ), and the Impulsiveness Scale (I_5)[a]

	SP	SR	E	N	P	L	I_5
SP		0.08	−0.53**	0.62**	−0.04	0.09	0.04
SR	0.01		0.41**	0.33**	0.24**	−0.35**	0.41**
E	−0.48**	0.37**		−0.25**	0.14	−0.22**	0.27**
N	0.53**	0.25**	−0.23**		0.14	−0.07	0.37**
P	−0.07	0.19**	0.06	0.16**		−0.42**	0.53**
L	0.06	−0.29**	−0.21**	−0.09	−0.29**		-0.33**
I_5	−0.02	0.43**	0.34**	0.29**	0.49**	−0.40**	

[a] Results for males are above the diagonal; results for females are below the diagonal. SP, Sensitivity to Punishment scale; SR, Sensitivity to Reward scale; E, Extraversion; N, Neuroticism; P, Psychoticism; L, Lie; I_5, Impulsiveness
**$P < 0.01$.

the Catalan version of the I_5 (Torrubia & Tobeña, 1984). This questionnaire was always administered in a classroom situation in groups not larger than 150 undergraduates.

5.2. Results and discussion

Means and standard deviations for both sexes are shown in Table 3A. After performing Student's *t*-test, sex differences reached significance for SR, E, N, P and L scales. Pearson correlations between all the measures were calculated for each sex (Table 4). Intercorrelations showed much the same pattern for males and females, matching largely with predictions derived from Gray's personality theory: SP correlated positively with N and negatively with E, whereas SR was positively correlated with E and N; anxiety dimension measured by SP was located closer to N than E, and impulsivity measured by SR was located closer to E than N. As E, N, and P were slightly correlated in our data (as is usually found in other studies), we calculated partial correlations to ensure that the obtained correlations between the SPSRQ and the EPQ scales were not due to the common variance shared by E, N and P. Partial correlations between SP and E after controlling for N and P were $r = -0.48$ ($P < 0.001$) for males, and $r = -0.41$ ($P < 0.001$) for females; and partial correlations between SP and N after controlling for E and P were 0.60 ($P < 0.001$) for males and 0.55 ($P < 0.001$) for females. Correlations between SR and N increased when partialled out by E and P ($r = 0.52$, $P < 0.001$, for males; and $r = 0.38$, $P < 0.001$, for females), as did correlations between SR and E when partialled out by N and P, increasing for males ($r = 0.51$, $P < 0.001$) and also for females ($r = 0.43$, $P < 0.001$). Also consistent with Gray's predictions, the I_5 scale was highly correlated with the SR scale and not related to the SP scale. It is important to stress that the new version of the SP showed stronger correlations with Eysenck's scales than the old version (Torrubia & Tobeña, 1984).

In sum, this study has served to locate the SP and SR scales within the Eysenckian space, and to investigate differences between the SR and I_5 scales. The SP scale was more related to Eysenckian dimensions than the SR scale. The lowest correlation was found between SR and N scales in females. This relationship deserves further comment because of the item content of the N

scale. Gray's rotation of Eysenckian axes has significantly changed the conceptualization of the neuroticism dimension, which is defined as the sensitivity to both aversive and appetitive reinforcers. Eysenck and Eysenck (1985) described the following traits associated with high scorers in their neuroticism dimension: anxious, depressed, with guilt feelings, low self-esteem, tense, irrational, shy moody, and emotional. Thus, the N scale of the EPQ seems not to be equidistant from both anxiety and impulsivity dimensions, but is closer to the former. This implies that this scale would probably not be the best to measure sensitivity to aversive and appetitive reinforcers.

The SP scale was not correlated with the P scale of the EPQ, which is consistent with previous results of Díaz and Pickering (1993). Thus, Gray's prediction of a negative relationship between his anxiety dimension and psychoticism has not been confirmed in our data. However, the predicted association between the impulsivity dimension and psychoticism has been confirmed because the SR scale was moderately correlated with P.

Although correlations between the I_5 and SR scales were highly significant, the two scales do not measure the same construct. The main differences were that: (1) I_5 was more correlated with P than SR; and (2) the items of I_5 have little face validity as a measure of BAS functioning. The key to deciding on the best scale to measure BAS sensitivity would be whether the behavioural predictions for high BAS trait subjects are more consistently met for SR or for I_5.

6. Study 3

Some trait anxiety measures like the STAI-T (Spielberger et al., 1970) and the MAS (Taylor, 1953) have been proposed as psychometric instruments to measure Gray's anxiety dimension. Previous results have shown that both the STAI-T and the MAS are highly correlated with N (0.6–0.7) but moderately with E (−0.2 to −0.4) (Eysenck & Eysenck, 1985; Loo, 1979; Torrubia & Tobeña, 1984). The STAI-T is one of the most used trait anxiety scales both in clinical practice and in experimental research. In recent years, this measure has been widely employed to investigate cognitive functioning in anxious subjects (Williams, Watts, MacLeod & Mathews, 1998). This study was designed to compare the SP and the STAI-T scales as regards their relationships with E, N, P and I_5 scales. Although a high correlation between the two scales is hypothesized, some differences were also expected in the location of both scales in Eysenck's personality space: the STAI-T was expected to be more correlated with N and less correlated with E than the SP scale.

6.1. Method

Two different self-report measures were completed by 96 male and 276 female undergraduates from the Universitat Autònoma de Barcelona and the Universitat Jaume I de Castelló. One included the Catalan version of the EPQ and the SPSRQ in yes-no format. The other measure was the Spanish version of the STAI-T (Seisdedos, 1982). This scale contains 20 items that can be rated in a range from 0 to 3. The mean age was 20.14 (S.D. = 2.98) with a range of 18–37. Data

were obtained at two different times: 162 subjects were tested in 1989 and the other 210, in 1996. As in 1989 the new SR scale was not available, only 207 subjects of the second sample (51 males and 156 females) completed this scale. Contrarily, subjects in 1989 completed the I_5 scale.

6.2. Results and discussion

Means and standard deviations for all the scales are presented in Table 3B. Mean comparisons were performed by using Student's *t*-test. As can be seen in this table, there were sex differences for the STAI-T, but not for the SP scale.

Table 5 shows a comparison between the SP scale and the STAI-T scale in their correlations with the other measures. Pearson correlations between SP and STAI-T were of 0.68 for males and of 0.59 for females. However, both measures showed quite a different pattern of correlations with the EPQ scales. STAI-T was closer to N than E, positively related to I_5, and positively related to P in males. SP was not so close to N and was closer to E, orthogonal to I_5, and tended to be negatively related to P in females. This pattern of results suggests that SP and STAI-T are related but not interchangeable measures.

7. Study 4

The main purpose of this study was to investigate which components of anxiety (i.e. somatic, behavioural and cognitive) are related to the SP scale. Additionally, the relationship between these anxiety components and the EPQ scales, the STAI-T and the I_5 were investigated. Some authors have stressed the importance of distinguishing the three components of anxiety in personality research (Cloninger, 1986; Eysenck & Eysenck, 1985; Schalling, 1978). Eysenck proposed that neuroticism was a predisposing factor to anxiety, and especially to worry (Eysenck & Eysenck, 1975). However, there is increasing evidence suggesting that neurotic introverts would

Table 5
Study 3: Correlations of SP, N and STAI-T with several personality measures for males and females[a]

	Males ($n=96$)			Females ($n=276$)		
	SP	N	STAI-T	SP	N	STAI-T
SP		0.69**	0.68**		0.47**	0.59**
SR[b]	0.02	0.10	−0.03	−0.05	0.18	0.10
E	−0.50	−0.28**	−0.31*	−0.52**	−0.20*	−0.32**
N	0.69**		0.75**	0.47**		0.61**
P	−0.02	0.07	0.13*	−0.21	0.11	0.05
L	−0.11	−0.07	−0.03	0.05	−0.08	0.03
I_5[c]	0.13	0.37*	0.43*	0.05	0.50**	0.28**
STAI-T	0.68**	0.75**		0.59**	0.61**	

[a] SP, Sensitivity to Punishment scale; SR, Sensitivity to Reward scale; E, Extraversion; N, Neuroticism; P, Psychoticism; L, Lie; I_5, Impulsiveness; STAI-T, Trait anxiety scale of Spielberger.
[b] Males, $n=51$; females, $n=156$
[c] Males, $n=43$; females, $n=119$.
*$P<0.05$.
**$P<0.01$.

be more prone to cognitive anxiety while neurotic extraverts would be to somatic anxiety: first, Eysenck's classical distinction indicating that neurotic introverts are prone to 'dysthymic' syndromes (i.e. phobias, obsessive-compulsive syndrome and reactive depression) while neurotic extraverts are more predisposed to hystero-psychopathic syndromes (Eysenck, 1967); second, Cloninger's distinction between cognitive and somatic syndromes of chronic anxiety and their different locations in the Eysenckian space (Cloninger); and third, Schalling's distinction between Psychic Anxiety and Somatic Anxiety subscales in the Karolinska Personality Scales, and their different relationship with the extraversion dimension (Schalling).

The behavioural component of anxiety has not been directly considered by these authors. However, cues of punishment should produce a stronger behavioural anxiety in neurotic introverts (Gray, 1981). Thus, a higher correlation is expected between behavioural anxiety and Gray's anxiety dimension.

The Lehrer–Woolfolk Anxiety Symptoms Questionnaire (LWASQ) is a reliable and valid self-report measure of somatic, behavioural and cognitive components of anxiety for both normal and clinical samples (Lehrer & Woolfolk, 1982; see Scholing & Emmelkamp, 1992, for a cross validation). The questionnaire was constructed with items that came from the MMPI, the Spielberger's STAI and the authors' clinical experience. Factor analyses with these items produced three orthogonal dimensions from which the subscales of somatic (hyperventilation), behavioural (social avoidance) and cognitive (worrying) anxiety were developed (Lehrer & Woolfolk; Scholing & Emmelkamp).

7.1. Method

The sample consisted of 340 undergraduates (117 males and 223 females) from the Universitat Autònoma de Barcelona with a mean age of 20.21 (S.D. = 2.67; range 18–36). Personality was evaluated with Catalan versions of the EPQ, the I_5, and the SP scale of the SPSRQ. A reduced group of 159 subjects (47 males and 112 females) also completed the Spanish version of the STAI-T (Seisdedos, 1982).

A Spanish version (Tejero & Torrubia, 1986) of the LWASQ (Lehrer & Woolfolk, 1982) was used for measuring the somatic, cognitive and behavioural components of anxiety. This scale consists of 36 items (16 of somatic anxiety, 11 of cognitive anxiety and 9 of behavioural anxiety). Subjects were asked to rate from 1 (never) to 5 (very frequently) their experience of the symptoms described.

7.2. Results and discussion

Mean scores and standard deviations of all the measures are shown in Table 3C. Alpha reliabilities for the somatic, behavioural, and cognitive anxiety scales were 0.87, 0.77, and 0.85, respectively. We calculated Pearson correlations between anxiety components and personality measures (Table 6). The main relationships between personality dimensions and components of anxiety were: (1) N was highly related to the three components of anxiety, but especially to the cognitive one; (2) E was negatively related to behavioural anxiety in males and females, and negatively related to cognitive anxiety in females; (3) P was related to cognitive anxiety and somatic anxiety in males; (4) as expected, SP was highly correlated with the cognitive and

Table 6
Study 4: Correlations of the Somatic (Som), Behavioral, (Beh) and Cognitive (Cog) scales of the LWASQ with several personality measures for males and females[a]

	Males ($n=117$)			Females ($n=223$)		
	Som	Beh	Cog	Som	Beh	Cog
Som		0.24*	0.49**		0.32**	0.59**
Beh			0.56**			0.49**
SP	0.14	0.66**	0.56**	0.27**	0.65**	0.54**
E	0.06	−0.54**	−0.08	−0.09	−0.62**	−0.24**
N	0.35**	0.45**	0.70**	0.50**	0.37**	0.65**
P	0.23*	0.05	0.31**	0.11	−0.08	−0.01
L	−0.20	−0.21	−0.27	−0.21*	−0.10	−0.14
I_5	0.29*	0.04	0.37**	0.21*	0.01	0.25**
STAI-T[b]	0.09	0.34	0.52**	0.39**	0.49**	0.62**

[a] SP, Sensitivity to Punishment scale; SR, Sensitivity to Reward scale; E, Extraversion; N, Neuroticism; P, Psychoticism; L, Lie; I_5, Impulsiveness; STAI-T, Trait anxiety scale of Spielberger.
[b] Males, $n=47$; females, $n=112$
*$P<0.05$
**$P<0.01$

behavioural components of anxiety, but only showed a low correlation with somatic anxiety in females; (5) I_5 showed low but significant correlations with somatic and cognitive anxiety; and (6) STAI-T showed a positive correlation with cognitive anxiety in males and females, and positive correlations with somatic and behavioural anxiety in females but not in males.

Although more research is needed, this study also allows us to tentatively locate anxiety components into Eysenck's and Gray's spaces. Behavioural anxiety may be located between E and SP dimensions, closer to SP. Cognitive anxiety may be located between N and SP dimensions, but closer to N. Finally, somatic anxiety may be situated between N and impulsivity dimensions, but also closer to N. In conclusion, the N scale appears to be more associated with worrying, whereas introversion to behavioural anxiety (Gray, 1981). Additionally, impulsivity is slightly related to somatic anxiety in males. The main difference found between SP and STAI-T in this study was that the former was more related than the latter to behavioural anxiety.

In summary, this study would question the use of single-scale measures of trait anxiety in personality research especially when including items related to somatic symptoms. Location of such measures within Eysenck's and Gray's spaces would be different depending on the anxiety component most represented.

8. Study 5

Zuckerman (1979) defined the sensation seeking trait as "the need for varied, novel and complex sensations and experiences and the willingness to take physical and social risks for the sake of such experiences (p. 10)". In relationship with EPQ scales, the Sensation Seeking Scale (SSS)

correlates positively with both E and P, but shows no relationship with N (Zuckerman et al., 1978).

Zuckerman (1979) hypothesized that sensation seeking was related to Gray's reward sensitivity but not to punishment sensitivity. The absence of correlation between self-report measures of anxiety and the SSS has been used to confirm this hypothesis. However, some authors have related risk-taking behaviour to an underactive BIS (Fowles, 1987; Lykken, 1982). Zuckerman's predictions would derive from a closer location of Gray's impulsivity and anxiety dimensions to E and N, respectively. However, these predictions would not be logical if we locate Gray's dimensions at an angle of 30–45° from E and N.

In summary, our hypotheses in this study were a positive correlation between SR and the SSS, and a negative correlation between SP and the SSS. Previous empirical self-report data have found a negative correlation between punishment expectancy and the SSS (Ball & Zuckerman, 1990).

8.1. Method

The SPSRQ and the Spanish version (Pérez & Torrubia, 1986) of the SSS (Form V) were administered to 229 males and 599 females (mean age = 19.45, S.D. = 2.07; range 18–40) of the Universitat Autònoma de Barcelona. The SSS (Zuckerman et al., 1978) contains 4 ten-item subscales: Thrill and Adventure Seeking (TAS), Experience Seeking (ES), Disinhibition (Dis) and Boredom Susceptibility (BS). Total scores for the SSS scale were also calculated.

8.2. Results and discussion

Table 3D shows means and standard deviations for SSS and SPSRQ scales. As in other studies, Student's *t*-test showed that males scored higher on Dis, BS and SSS total score than females ($P < 0.01$), but no differences were obtained for TAS and ES. Intercorrelations between the SSS and the SPSRQ are shown in Table 7. The most important results were that SSS total score was

Table 7
Study 5: Intercorrelations between the SPSRQ and the Sensation Seeking Scales[a]

	SP	SR	TAS	ES	Dis	BS	SSS
SP		0.08	−0.21*	−0.18*	−0.12	0.08	−0.18
SR	0.08		0.19*	0.14	0.45**	0.37**	0.45**
TAS	−0.19**	0.14*		0.24**	0.16	0.08	0.62**
ES	−0.23**	0.13*	0.31**		0.43**	0.13	0.67**
Dis	−0.11*	0.41**	0.20**	0.40**		0.30**	0.72**
BS	−0.04	0.27**	0.17**	0.10	0.25**		0.57**
SSS	−0.21**	0.36**	0.71**	0.65**	0.68**	0.57**	

[a] Results for males are above the diagonal; results for females are below the diagonal. SP, Sensitivity to Punishment scale; SR, Sensitivity to Reward scale; TAS, Thrill and Adventure Seeking; ES, Experience Seeking; Dis, Disinhibition; BS, Boredom Susceptibility; SSS, Sensation Seeking Scale.

*$P < 0.05$.

**$P < 0.01$

strongly positively correlated with SR in both sexes, and showed moderate negative correlations with SP. The subscales of SSS more related to SR were Dis and BS, whereas the TAS and ES scales were negatively related to SP.

Even though SR and SSS are correlated, both measures could not be measuring the same construct. If compared with SR, studies with the SSS have shown a stronger positive correlation with P and lower correlation with E. Additionally, whereas SR and SP are not correlated, SSS was negatively correlated with SP. This result is also important to differentiate the SP scale from other trait-anxiety measures. Previous studies have shown no relationship between the SSS and neuroticism and anxiety trait measures, but low sensation seekers may be highly risk aversive (Ball & Zuckerman, 1990; Fowles, 1988).

9. General discussion

Anxiety and impulsivity measures not specially constructed for measuring individual differences in the BIS and the BAS, respectively, have been used for testing Gray's model in a variety of studies. A good indicator of validity for the model is that some of these scales have shown the predicted results in psychometric and experimental research. Nevertheless, in order to finely test the predictions derived from the model it is much better to have special purpose measures (Zinbarg & Mohlman, 1998).

We have shown in this paper the initial development of a self-report measure designed to assess individual differences in two dimensions depicted by Gray: the anxiety or sensitivity to punishment dimension, and the impulsivity or sensitivity to reward dimension. This development has followed different steps. First, we conducted a theoretical analysis of Gray's model in its application to humans. This analysis, developed in the introduction, has produced diverse reflections from which we have derived a set of items that serve to measure the functioning of the BIS and BAS in control and checking modes. Both final scales have shown good psychometric properties of reliability and construct validity, the latter having been studied in three different ways. We were first interested in testing Gray's predictions by studying correlations of final scales with other dimensions. The present paper concentrates mainly on these results. Another set of studies conducted to investigate construct validity of the SPSRQ were those that related both scales with other measures of the functioning of the BIS and BAS. The third aspect of construct validity was associated with proneness to psychopathological disorders (Caseras, Torrubia & Farré, 2001). The results of the last two sets of studies will be presented elsewhere. The SPSRQ has served to generate a set of experimental studies to test Gray's predictions (Ávila, 1994, 1995; Ávila & Parcet, 1997, 2000; Ávila, Parcet, Ortet, & Ibañez, 1999; Torrubia, Ávila, Moltó, & Grande, 1995). These and other unpublished studies provide great support for the validity of the SPSRQ. A final step consisted of: (1) testing the SPSRQ in the corresponding languages in other countries such as Australia (Brebner, 1998; Brebner & Martin, 1995), the United States (Zuckerman, 1999; Zuckerman, et al., 1999), or Slovakia (Sarmany, Pérez & Torrubia 2000); and (2) the development of a junior version of the SPSRQ (Aluja & Torrubia, 1998; Torrubia, García-Carrillo, Ávila, Caseras & Grande, 2000).

The SP scale is formed by a set of items reflecting situations which describe individual differences in reactivity and responsivity of the BIS. Although this scale is strongly correlated with

neuroticism and some trait-anxiety measures, we have described some important differences between these measures. We could summarize these differences indicating that SP, when compared with other trait anxiety or neuroticism measures: (1) has items of a different content; (2) correlates strongly and negatively with E; (3) shows a tendency to correlate negatively with SSS; (4) does not correlate with I_5 and SR scales; and (5) is more related to behavioural and cognitive than somatic components of anxiety. In sum, the anxiety dimension depicted by Gray as measured by SP seems to be a mixture of neuroticism and introversion with components of risk aversion.

The SR scale posed more difficulties for us compared to the development of the SP scale. In recent years, the sensitivity to reward construct has evolved a lot, and this has meant the appearance of different related developments such as those by Carver and White (1994) and Cloninger (1986, 1988). The BIS/BAS scales of Carver and White (1994) were made up of one scale to measure individual differences in the BIS, but three different measures in the case of the BAS: Drive, Reward Responsiveness, and Fun Seeking. The authors did not offer a clear idea of how these three scales are all related to the functioning of the BAS. Comparing with the SR scale, we want to stress that BAS scales are the result of a different approach to developing item-content. Whereas items on the SR scales deal with specific rewards (i.e. money, sex, social power and approval, and praising), items of the BAS scales are related to a non-specific concept of reward. This meant that the scores of these scales produced right-skewed distributions (Carver & White, 1994; Heubeck et al., 1998).

Meanwhile, Cloninger described two reward dimensions: novelty seeking and reward dependence. The first dimension was theoretically similar to Gray's impulsivity (Gray, 1988), but the second was positively correlated with both E and N (Corr et al., 1995). However, results obtained with the recently developed TCI have not replicated this location (Zuckerman & Cloninger, 1996). In sum, a measure of Gray's impulsivity dimension is difficult to construct.

Our SR scale was conceived as a single measure of the functioning of the BAS and the items were designed to describe specific situations with different kinds of rewards in which subjects with a hyperactive BAS were more prone to display approach behaviour. This was a risky approach to constructing the scale because we assumed that the functioning of the BAS should be phenotypically related to all kinds of rewards. At the same time, we also knew that subjects should not necessarily be motivated by all kinds of rewards (i.e. environmental influences could produce a different level of motivation for money). However, we considered that our approach was better than one based on a non-specific concept of reward because items could be interpreted with less ambiguity. This has produced a more complex scale with heterogeneous items. The results reported in this paper support our approach because the SR scale reached acceptable levels of internal consistency and test-retest reliability. Additionally, the factor analysis of items produced a single SR factor in which the different kinds of items loaded acceptably.

The SR scale has shown important differences with other impulsivity-related scales such as I_5 and SSS. The most important differences were: (1) the low to moderate relationship with P; and (2) the absence of correlation with SP. Thus, the functioning of the BAS could be considered a separate facet within the broader concept of impulsivity.

SR has less internal consistency and lower correlations with E and N, compared to SP. These differences could be attributed to several reasons: (1) The SP scale could be better than SR; (2) sensitivity to punishment could be easier to assess in humans using self-report techniques than

sensitivity to reward; (3) the negative correlations, though slight, observed between E and N could make it more difficult to find positive correlations with both scales; and (4) different kinds of punishment or signals of punishment could produce more homogeneous effects than different kinds of reward or signals of reward; this would produce a greater consistency of fear reactions to different punishments than would approach responses to different rewards.

A comment should be made about the lack of reverse coded items in the SPSRQ. Preliminary versions of the scales included both direct and reverse coded items, but psychometric analyses showed that direct coded items presented better psychometric properties than reverse coded ones, and thus were the only ones finally retained for the final version. This could produce some endorsement bias that could sharpen the obtained orthogonal factor structure in SPSRQ. However, orthogonality is just one of the validity criteria we required for any BIS and BAS measure. The results presented in the present paper show that the SP and SR scales have shown the predicted relationships with other personality measures. Furthermore, they have also shown the expected relationships with other BIS and BAS related measures (Caseras, Ávila & Torrubia, 2000) and have provided a set of differential results in laboratory research (see above).

In sum, we have presented in this paper the initial development of the SPSRQ. This instrument may serve as a tool to investigate Gray's model of personality in normal populations. A specific measure of Gray's dimensions will allow researchers to test the model adequately, and to develop and restructure it in humans (Pickering et al., 1997).

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