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THE EFFECTS OF IMPULSIVITY ON THE PERCEPTUAL AND DECISION STAGES IN A CHOICE REACTION TIME TASK

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Summary—In order to determine the effects of impulsivity on the perceptual and response selection stages of information processing, 42 subjects were divided into high and low impulsivity groups according to their scores on the EPI subscale. The two groups performed a choice reaction time task in which stimulus complexity and stimulus-response compatibility were manipulated, following Sternberg's Additive Factor Method (AFM, Sternberg, *Acta Psychologica, 30*, 276–315, 1969). Impulsivity affected the response selection stage but not the perceptual stages. © 1997 Elsevier Science Ltd.

INTRODUCTION

The Additive Factor Method (AFM) was proposed by Saul Sternberg in 1969 in the chronometric approach to analysis of cognition processes. By using factorial designs it aimed to identify the stages of information processing that occur between stimulus and response in performing an experimental cognitive task. The method has been used in the study of individual differences by introducing personality dimensions in intra–inter factorial designs, and by observing the interactions of personality factors with intra-subject factors. This sheds light on the ways that individual differences in a particular personality dimension influence the operation of the stages of processing involved in the task (Andrés-Pueyo & Tous, 1989; Tous, 1986).

Expanding on reviews of the studies that used the AFM, Sanders (1990) suggests that at least six stages of processing are involved in the most traditional cognitive choice reaction time tasks. Of these six stages, three are perceptual (pre-processing, feature extraction and identification) one decisional (response selection) and two motor (programming and motor adjustment). Even though the distinction between these specific stages presents a number of difficulties from an empirical point of view, Jackson's distinction between functions of impression and expression, which dates from the end of the last century (quoted by Tous, 1986), and the parallel distinction between perceptual, response selection and motor stages are well established (Sanders, 1990). This approach has been expanded recently by authors such as Brebner (1985) or Tous (1986) who categorize all the cognitive operations in impression stages and expression stages. Coles (1989) and colleagues also adopt this distinction, identified as stimulus evaluation and response choice and execution stages (Meyer *et al.*, 1988).

Dickman and Meyer (1988) used the AFM to study the influence of impulsivity on the performance in a figure comparison task. They included in their design two intra-subject factors (stimulus complexity and response compatibility) to manipulate two cognitive stages of processing (feature comparison and response execution). The interaction between impulsivity and figure complexity was significant, while the interaction between impulsivity and response compatibility was not. The authors concluded that individual differences in information processing associated with impulsivity are located in the comparison stage rather than the execution stage. Dickman and Meyer's comparison stage, though, has little to do with their experimental task, in which *S*s had to decide whether the two figures presented were the same or not. We cannot refer to a comparison stage here, since there are no elements to compare. There is some doubt, then, whether the individual differences associated with impulsivity that these authors find are manifested only in the specific

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experimental situation, or whether these differences can be generalized to other situations. In our view, their comparison stage can be divided into two substages, which we could identify as stimulus analysis and response selection. The stimulus analysis stage corresponds to the groups of perceptual stages (probably to the feature extraction stage proposed by Sanders, 1990) and response selection to the decision stage. We make this distinction because *S*s perform a perceptual analysis of the two figures presented, and then choose their response on the basis of this analysis. Dickman and Meyer (1988) found that individual differences associated with impulsivity were located in the comparison stage. Following our line of argument above, we wonder whether these differences are located in the perceptual stages (impression) and/or in the response selection stage (expression).

Orlebeke *et al.* (1990) used the AFM to locate individual differences performance associated with disinhibition on a chronometric task. Disinhibition was considered to be a component of the sensation-seeking dimension; in the studies by Zuckerman, Kuhlman and Camac (1988) and by Zuckerman *et al.* (1991) it was considered one of the traits representative of the impulsivity dimension that Zuckerman (1989) includes in his model.

The parameters manipulated by Orlebeke *et al.*, (1990) were stimulus quality (degraded or non-degraded), stimulus-response compatibility (compatible or incompatible) and interval between warning signal and stimulus appearance (constant or variable). These three parameters affected the stages of encoding, decision and motor adjustment respectively. The disinhibition factor interacted significantly with stimulus-response compatibility and was additive with the two other factors. These results led the authors to conclude that the disinhibition trait affects the decision stage.

This study aims to determine whether the involvement of impulsivity in *S*s' performance on choice reaction time tasks is located in the perceptual stages and/or in the decision stage of information processing. We also aim to confirm the results or Orlebeke *et al.* (1990), who found an association between the influence of impulsivity and the decision stage, using a time task following the premises of the AFM.

METHOD

Subjects

Forty-two university students (16 male, 26 female) took part in the study. The average age was 22 years (range 18–28). *S*s were recruited via an advertisement and were paid to participate. Three *S*s (two male and one female) who made an excessive number of errors were excluded from the data analysis.

Materials

The chronometric task was a choice reaction time task. *S*s reacted to the stimulus presented by pressing one of two keys, one on the right and one on the left of a computer keyboard; they pressed the right-hand key with the right-hand forefinger and the left-hand key with the left-hand forefinger. The stimuli were presented in the centre of the computer monitor and the latency of correct responses was recorded.

Stimuli were figures formed by three angles, type $<$ and $>$, presented inside a 1.5×3 cm rectangle. *S*s had to push the right or left hand key according to the direction shown by two or all three of the angles in the figure presented. The keys that subjects used were $-/\_$, on the right of the keyboard, and z/Z on the left. In this way we manipulated: (1) figure complexity: the figure was formed by three angles that were all the same (simple) or by two equal and one different angle (complex) (see Fig. 1); (2) stimulus-response compatibility: *S*s had to respond either in the direction shown by the figure (compatible) or in the opposite direction (incompatible). Two instructions ("same direction" or "opposite direction") were presented on the monitor to show *S*s which type of response was required.

This task was programmed in GW-BASIC. As the TIMER sentence is reported to give inaccurate recordings of the reaction time (see Barrett & Kranzler, 1994), we adapted this program to obtain a level of discrimination of 1 msec, substantially higher than the level the TIMER sentence would give us.