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SOCIABILITY/IMPULSIVITY AND CAFFEINE-INDUCED AROUSAL: CRITICAL FLICKER/FUSION FREQUENCY AND PROCEDURAL LEARNING

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Summary—The influence of sociability/impulsivity in caffeine-induced arousal effects was investigated in two separate experiments: Experiment 1 examined critical flicker/fusion frequency change scores (ΔCFFT) in 60 subjects; and Experiment 2 investigated procedural learning in 30 subjects. In the two experiments, subjects received either caffeine citrate (500 mg) or placebo. The pattern of results was consistent across both studies: (1) a strong interactive effect of sociability (as measured by the EPQ extraversion scale) by caffeine/placebo which showed that (a) subjects low in sociability showed the greatest increase in ΔCFFT and learned most under placebo, while the reverse was true under caffeine; (b) subjects high in sociability, showed no increase in ΔCFFT and learned least under placebo, while the reverse was true under caffeine; and (2) in neither experiment did impulsivity (as measured by the EPS impulsiveness scale) significantly interact with caffeine/placebo. The results are consistent with Eysenck's (*The Biological Basis of Personality*, 1967) theory of personality in suggesting that subjects low in sociability are highly arousable under low-arousal (placebo) but over-aroused under high-arousal (caffeine), with the reverse pattern of effects holding for subjects high in sociability. The implications of these data for the respective roles of sociability and impulsivity components of extraversion in arousal-mediated performance are discussed.

GENERAL INTRODUCTION

The concept of general arousal continues to play an important role in unifying disparate constructs (e.g. cortical arousal, task difficulty and extraversion) in personality psychology, although doubts have been expressed concerning the value of the unitary arousal system hypothesis (e.g. Neiss, 1988). Since the discovery of the ascending reticulocortical activating system [ARAS (Morruzi & Magoun, 1949)], both theoretical developments (e.g. Eysenck, 1967; Humphreys & Revelle, 1984) and empirical evidence (e.g. Anderson, 1994) attest to the utility of general arousal theory.

Eysenck's (1967) well-known model assumes that introverts and extraverts differ with respect to the sensitivity of their arousal system and the thresholds of ARAS responsivity to sensory stimulation. Introverts are said to have lower response thresholds and in consequence higher cortical arousal. In general, introverts are more cortically aroused and more arousable when faced with incoming sensory stimulation. However, the relationship between arousal-induction and actual arousal is subject to the moderating influence of protective transmarginal inhibition (TMI; a protective mechanism that breaks the link between increases in arousal and increases in response strength at high levels of stimulation): under low stimulation (e.g. quiet or placebo) introverts should be more aroused/arousable than extraverts, but under high stimulation (e.g. noise or caffeine) introverts may experience over-arousal, which with the evocation of TMI may lead to lower increments in arousal as compared with extraverts; conversely, extraverts under low stimulation should show low arousal/arousability, but under high stimulation they should show relatively higher increments in arousal.

Eysenck's (1967) theory does not make a theoretical distinction between the power of sociability and impulsivity components of extraversion to influence performance. Although these two traits are correlated (≈ 0.50), some authors (e.g. Carrigan, 1960) have suggested that they represent independent factors, combined together by a 'shot gun wedding' (Guilford, 1975) of concepts. Indeed, changes in the factorial nature of Eysenck's model, removing the majority of impulsivity items from the Eysenck Personality Questionnaire [EPQ (Eysenck & Eysenck, 1975)] extraversion scale, where

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previously they formed part of the Eysenck Personality Inventory [EPI (Eysenck & Eysenck, 1964)] extraversion scale (Rocklin & Revelle, 1981), indicates that such a distinction may be warranted.

The contribution of sociability and impulsivity components of extraversion to arousal-mediated performance remains an important but unresolved issue in personality psychology (Gray, 1981). For as noted by Eysenck and Eysenck (1985), the impulsivity component of extraversion is often found to be more predictive of arousal effects than the sociability component. There is evidence to show that impulsivity, and not sociability, often influences putatively arousal-mediated performance. This literature encompasses classical conditioning (e.g. Barratt, 1971; Eysenck & Levey, 1972), electrodermal responses (e.g. Smith, Rypma & Wilson, 1981), and academic-type cognitive performance (Humphreys & Revelle, 1984; Revelle, Humphreys, Simon & Gilliland, 1980). There is also impressive evidence that the interaction of arousal and impulsivity conforms to the Yerkes–Dodson Law (Yerkes & Dodson, 1908; e.g. Anderson, 1994), providing further theoretical support for the importance of impulsivity over sociability.

However, there is another body of equally compelling evidence to show that sociability, and not impulsivity, interacts with arousal or arousal-related phenomena. For example, Wilson (1990) found that sociability was related to diurnal variation in arousal, as measured by skin conductance (a relatively direct measure of arousal); and Gupta (1990) found sociability and not impulsivity affected verbal operant conditioning under positive reinforcement. Sociability and not impulsivity also has been found to interact with self-reported energetic arousal and time of day effects on sustained information processing tasks (e.g. Matthews, Davies & Holley, 1990a; Matthews, Davies & Lees, 1990b). These latter findings may be contrasted to the findings of Revelle and colleagues, which show complex but consistent interactions between impulsivity, caffeine-induced arousal and time of day. However, apart from Revelle and colleagues, few attempts have been made to manipulate arousal with caffeine in studying the respective effects of sociability and impulsivity components of extraversion. Therefore, the different results reported in these studies might simply reflect different conceptualizations and manipulations of arousal.

As Eysenck's theory (e.g. Eysenck & Eysenck, 1985) continues to associate arousal/arousability with (EPQ) extraversion (i.e. sociability), despite evidence for the unique role of impulsivity (also reviewed by Eysenck & Eysenck, 1985), it seems clear that the respective roles of sociability and impulsivity in arousal-mediated learning and performance need clarification. The aim of this paper is to make a contribution to the resolution of this problem.

Now, although there is empirical support for both sociability and impulsivity in mediating the effects of arousal, one major problem with the existing literature, in respect of drawing conclusions across studies, has been: (1) the different methods used to induce arousal, and (2) the different types of performance variables employed to measure the effects of arousal. It would be desirable to have unambiguous agents and indices of arousal. Bullock and Gilliland (1993) noted that to study the role of personality and arousal it is necessary to use a converging measures approach in which theoretically significant personality measures are taken, central nervous system arousal is experimentally manipulated, and psychophysiological, behavioural and self-report arousal measures are employed as response outcomes.

In order to explore the relationship between sociability/impulsivity components of extraversion in mediating the effects of arousal on theoretically-relevant measures of performance, two experiments were conducted. In Experiment 1, the effects of extraversion and arousal in critical flicker/fusion frequency (CFF) change scores were investigated; and in Experiment 2, a relatively automatic process of knowledge acquisition (also known as procedural learning) was employed. If comparable effects of extraversion and arousal could be found across these very different performance domains then these effects would lend considerable support to general arousal theory and help to discriminate between the respective roles of sociability and impulsivity in arousal-mediated effects.

Caffeine was chosen to provide an unambiguous agent of arousal, as it is known to affect all parameters of general arousal [e.g. skin resistance, muscle tension, and cardiovascular measures (Duffy, 1962)]. Caffeine is also known to have powerful effects on the central nervous system (Lader & Bruce, 1989), cognitive processes [e.g. vigilance; see Lieberman (1992) for a review] and self-reported mood (Thayer, 1989). The general arousal effects of caffeine are thought to result from the blocking of the neuromodulator, adenosine (Snyder, 1984), which itself has potent inhibitory effects on electrophysiological, biochemical and behavioural measures (Hirsh, 1984). Revelle has