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Ignoring irrelevant stimuli in latent inhibition and Stroop paradigms: The effects of schizotypy and gender

Oren Kaplan [a,*], Robert E. Lubow [b]

[a] School of Business, The College of Management, Rishon Lezion 75490, Israel
[b] Department of Psychology, Tel Aviv University, Ramat Aviv 69978, Israel

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ABSTRACT

Latent inhibition (LI), poor evidence of learning following preexposure to a task-irrelevant stimulus, reflects the ability to ignore inconsequential events. Stroop interference represents a failure to inhibit processing of a task-irrelevant word when it is incongruent with the required naming of the word's print color. The apparent commonality between the two effects is in contradiction to the literature, which indicates that LI is affected by schizotypy and schizophrenia, and perhaps gender, while Stroop interference generated by the trial-to-trial procedure is unaltered by those variables. In the present experiment, low schizotypal healthy males, but not females, exhibited LI. The same groups did not differ on Stroop interference. The results are discussed in terms of different processing requirements for task-irrelevant stimuli that are an integral part of the task-relevant target stimulus (as in Stroop) or separated from it in space (as in LI).

1. Introduction

It is generally accepted that schizophrenia, particularly when accompanied by positive symptoms, is characterized by an attentional dysfunction that can be described in terms of increased distractibility. Though impaired selective attention is not unique to schizophrenia, and some selective attention functions may also be intact in these patients (e.g., Gold et al., 2006), many writers regard a deficit in selective attention as a core psychological component of schizophrenia (e.g., Anscombe, 1987; Cadenhead and Braff, 1995; Gray, 1998).

Not surprisingly, then, patients with schizophrenia perform poorly on experimental tasks that assess the ability to ignore irrelevant stimuli. Two such tasks, latent inhibition (LI) and Stroop, both widely used for that purpose, are the focus of the present report. By administering these tasks to the same participants, we sought to obtain data that would differentiate amongst mechanisms involved in processing irrelevant information. Furthermore, by using healthy participants divided into groups with low and high schizotypy scores (LowSz and HighSz), we hoped to identify the conditions that are responsible for the relative inability of patients with schizophrenia to ignore irrelevant stimuli, while at the same time avoiding confounding factors, such as effects of overt symptoms, hospitalization, and medication (Mednick and McNeil, 1968).

Self-report questionnaires that assess schizotypy have been widely used for this purpose. They are based on the premise that psychotic tendencies lie on a continuum, with a normal population at one extreme, and a hospitalized patient group at the other extreme, a position that is supported by a variety of evidence (for review, e.g., Vollema and van den Bosch, 1995).

1.1. Latent inhibition (LI)

LI is observed when a repeatedly presented irrelevant stimulus is preexposed before becoming relevant in a subsequent learning task. Under those conditions, it becomes difficult for that stimulus to enter into new associations, as compared to learning with a novel stimulus. Functionally, LI protects the organism from information overload by attenuating the processing of previously irrelevant stimuli. As such, LI has been widely studied in animals and humans, often with schizophrenia-related neurophysiological and psychopharmacological manipulations (for reviews, see e.g., Lubow, 2005; Weiner and Arad, 2010).

In brief, LI is attenuated in acute, unmedicated, or recently medicated patients with schizophrenia (e.g., Gray et al., 1992, 1995; Sitskoorn et al., 2001). As opposed to this, chronic and medicated patients exhibit either normal LI (e.g., Baruch et al., 1988; Serra et al., 2001) or potentiated LI (e.g., Cohen et al., 2004). Relatedly, high as compared to low schizotypal healthy participants exhibit reduced LI (e.g., Braunstein-Bercovitz and Lubow, 1998a; Gray et al., 2002; for reviews, Kumari and Ettinger, 2010; Lubow, 2005). Since normal LI is

* Corresponding author. Tel.: +972 548181849.
E-mail addresses: okaplan@colman.ac.il (O. Kaplan), lubow@freud.tau.ac.il (R.E. Lubow).

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assumed to be the result of a stimulus-specific decline in attention to a repeatedly presented task-irrelevant stimulus, attenuated LI has been attributed to a failure to reduce the attentional response to that stimulus, i.e., an inability to ignore irrelevant stimuli (e.g., Lubow and Gewirtz, 1995; Lubow, 2005).

In addition to LI being modulated by schizophrenia and schizotypy, LI may be affected by gender. Some studies have reported that males have larger LI effects than females (e.g., Lubow et al., 2000; Gibbons et al., 2001; Lubow et al., 2001), while others have found no such difference (e.g., Swerdlow et al., 1996; Hofer et al., 1999), and yet others have reported LI × Gender × Schizotypy interactions. For example, Lubow and De la Casa (2002) obtained LI in LowSz females and HighSz males, but not in HighSz females and LowSz males. Such differences in LI may be related to the fact that positive symptoms are generally more prevalent in HighSz females compared to their male counterparts (Langdon and Coltheart, 1999) as well as in female patients suffering from schizophrenia compared to male patients with schizophrenia (Goldstein, 1997). However, gender differences originating from factors other than symptom type may interact with the positive factor of schizotypy to affect LI. For example, male patients with schizophrenia and healthy HighSz males generally show greater cognitive deficits compared with their female counterparts (Goldstein, 1997; Voglmaier et al., 2005, respectively).

1.2. Stroop

In a typical Stroop test, an interference effect is observed when the time to name the ink color of an incompatibly colored word is longer than the time to name the color of a non-color word or group of letters. The standard explanation of Stroop interference appeals to a processing or response conflict between the print color of the word and its discrepant orthography. Thus, to the degree that the participant, who is required to name the ink color, is unable to ignore the task-irrelevant written word, the interference effect will be increased. From this, it follows that patients with schizophrenia, who are deficient in their ability to ignore or suppress irrelevant stimuli, should exhibit greater Stroop interference than healthy controls.

However, there are two procedures for producing Stroop effects, the “card version”, where items are presented simultaneously, but with separate lists for the congruent, incongruent and neutral items, and the “single-trial version” in which the order of the three trials types is randomized. Importantly, data supporting increased Stroop interference in patients with schizophrenia have been obtained with the card procedure (e.g., Abramczyk et al., 1983; Albus et al., 1996), but not with the single-trial procedure (e.g., Salo et al., 1996; Henik et al., 2002; Salo et al., 2002; but see Orem and Bedwell, 2010; for a general review, see Henik and Salo, 2004). Similarly, two studies that used the card procedure with healthy participants reported greater Stroop interference in high as opposed to low scorers on measures of psychosis-proneness (Swerdlow et al., 1995; Suhr, 1997). On the other hand, with the single-trial procedure, two studies obtained similar levels of interference with low- and high-schizotypal healthy participants (Della Casa et al., 1999; Hofer et al., 1999). In addition, there was no effect of gender in these studies, a finding that fits with the conclusion in MacLeod's (1991) review of the Stroop literature. However, a recent study by Orem and Bedwell (2010) did find a positive correlation between delusion-proneness and the Stroop effect.

1.3. The present study

Although LI and Stroop interference effects represent outcomes from processes involved in the suppression/ignoring of irrelevant information, the two effects appear to be dissociated. LI, but not Stroop interference, is modulated by gender, schizophrenia, and schizotypy, at least as assessed with the single-trial procedure.

To directly explore the differential effects of gender and schizotypy on the processing of irrelevant stimuli, LI and single-trial Stroop procedures were administered to the *same* participants in a 2 × 2 design (males vs. females × low vs. high-schizotypal groups). On the basis of the literature cited above, it was predicted that LI, but not Stroop interference, would be functions of gender and schizotypy and their interaction, and that the correlation between LI and Stroop interference scores would be low. The differences in the patterns of effects should sharpen our understanding of the dysfunctional processing of task-irrelevant information by people scoring high on schizotypal questionnaires, and by extension, to patients with schizophrenia.

2. Method

2.1. Participants

Ninety-one students, 39 males (mean age = 26.13 years, S.D. = 3.32) and 52 females (mean age = 24.31 years, S.D. = 2.74), from the College of Management in Israel, volunteered for the experiment. The participants were informed that they would take part in an experiment with cognitive tasks. They were asked to decline if they suffered from any medical or personal problem that might interfere with their performance; none did so. However, three males were omitted from the final sample due to a high rate of errors (>45%) in the preexposure phase of the LI task. The average error rate in preexposure phase, without these participants, was 4.8%, with a maximum of 14%.

All participants were tested individually. The LI and Stroop procedures, and SPQ (the Schizotypal Personality Questionnaire, Raine, 1991) were administered, in that order, one immediately after the other.

2.2. Latent inhibition task

The LI effect was generated using a two-stage (preexposure and test) visual search procedure. In both stages, the participant had to detect a unique target amongst a group of similar distractors. Target and distractor conditions were changed from the preexposure to test stages, such that an LI effect was represented by slower target detection time (RT) for the condition in which the test stage target was a distractor in the preexposure stage and the test stage distractor was the target in the preexposure stage (PE condition), as compared to the condition in which a novel test target was presented on a background of distractors that had previously been target (NPE condition). With such conditions, the LI effect represents a difficulty to process a target that was previously irrelevant (the 19 distractors). For a detailed explanation of the design, see Lubow and Kaplan (2005).

2.2.1. Apparatus and stimuli

Experimental events were presented on a laptop with a 14.1″ screen. On any given trial in the practice, preexposure, and test stages, the screen displayed 20 white figures on a black background. Nineteen of the figures were identical (distractors) and one was unique (the target). All figures were constructed from five randomly connected straight lines constructed from a 3 × 3 matrix of points. Each figure on the screen fit within an imaginary 2 × 2 cm square (for illustration, see Lubow et al., 2000). In all stages (practice, preexposure, and test): 1) the target appeared an equal number of times on the left or right side of the screen; 2) side and position within a side were randomly determined; 3) a trial was terminated by the subject's response, with an interval of 1.5 s between the response and the next display.

2.2.2. Procedure

Participants were informed that they would see many different displays, all containing a unique target amongst 19 distractors. They were instructed to press the left or right arrow key in accord with the position of the unique figure that was either to the left or right of an imaginary midline on the screen.

2.2.2.1. Practice and preexposure stages. The experiment began with 12 practice trials with target and distractors that were different from those used in the next stages. After each practice trial response, but not in the subsequent stages, the participant received feedback, “correct” or “incorrect”. After a reminder of the instructions, the preexposure stage was initiated. It consisted of 96 trials, each containing the *same* target figure and the *same* distractor figures.

2.2.2.2. Test stage. The test stage began with a reminder of instructions, followed by a new set of 96-trials. In addition to the PE and NPE conditions (as discussed previously), there were two others, which were used to increase task difficulty. Each of the four trial-types appeared 24 times in a random order, with the restriction of no more than two successive identical trial-types. Figure shapes were completely counterbalanced across participants and across status as target and distractor.