Chapter 11
Psychopathology and Individual Differences in Latent Inhibition: Schizophrenia and Schizotypality

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Introduction

When a stimulus is repeatedly presented in such a manner that it is not attended (i.e., it is not followed by a consequence), it subsequently becomes deficient in its ability to enter into or express new associations. This phenomenon, latent inhibition (LI), has been widely explored in animal and humans with a variety of learning tasks (for a review, see Lubow, 1989). Functionally, LI appears to protect the organism from information overload by attenuating the processing of previously irrelevant stimuli.

The first demonstration of the LI effect occurred 50 years ago (Lubow & Moore, 1959). In the following 20 years, LI studies focused mainly on establishing the generality of the phenomenon, and then on attempts to integrate it with extant learning theories, mostly by appealing to a loss of stimulus salience and, in relation to that, to the conditioning of inattention. The publication of an early review article (Lubow, 1973) and several papers that related LI deficits to schizophrenia (e.g., Baruch, Hemsley, & Gray, 1988a; Gray, Hemsley, & Gray, 1992; for a review, see Lubow, 2005) led to an accelerated expansion of research. The rationale for such LI studies was based on the conjunction of two premises: (1) LI reflects the operation of the normal ability to ignore irrelevant stimuli; and (2) schizophrenic patients (at least acute patients with positive symptoms) are highly distractible, displaying an inability to focus attention on task-relevant information (e.g., Barch, Carter, Hachten, Usher, & Cohen, 1999; McGhie & Chapman, 1961; Ohman, Nordby, & d'Elia, 1986).

There are many different procedures for producing LI in humans, ranging from classical conditioning to visual search, but the most common of them is associative rule-learning (for reviews, see Lubow, 1989; Lubow & Gewirtz, 1995; Lubow & Kaplan, 2005). Irrespective of the particular paradigm, they all contain a stimulus preexposure phase followed by a phase that requires the learning of a new association and then a test phase. Very often, the acquisition and test phases are combined. In preexposure, a stimulus that is not followed by any consequence (CS-0) is presented a number of times, anywhere between 1 and 100, depending on the preparation. In animals and in young children, this condition results in an interference with the subsequent acquisition or expression of any new association with that stimulus. However, there is considerable evidence to indicate that LI in adult humans requires a "masking task" in the preexposure phase, the purpose of which is to divert attention from the critical to-be-tested preexposed stimulus (PE). This issue, which impacts on LI theories, will be addressed later in this paper.

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In a typical example of a masked LI experiment, Zalstein-Orda and Lubow (1995) preexposed the same meaningless shape (to-be-CS) over a series of many trials. Each trial was accompanied by a different trigram from a finite set that repeated itself several times. This masking task, designed to divert attention from the PE stimulus, required the subject to determine the number of repetitions of the set. In the test, the masking stimuli continued to be present on each trial, but on any given trial either the preexposed shape or a novel shape might appear. The subject had to learn that a change in the numerical value of a counter was associated with the presence of the previously irrelevant PE stimulus. The PE group reached the learning criterion more slowly than the NPE group, thereby demonstrating the LI effect (for similar results with between-group designs, see e.g., Burch, Hemsley, & Joseph, 2004; Gray, Fernandez, Williams, Ruddle, & Snowden, 2002; and with within-subject designs, e.g., De La Casa & Lubow, 2001; Gray, Snowden, Peoples, Hemsley, & Gray, 2003; Swerdlow et al., 2003).

Pathology-Based Individual Differences

There are four categories of human LI studies that have examined individual differences that relate to pathology. The first three concern LI and schizophrenia and include groups of schizophrenia patients, healthy subjects who score high on schizotypal questionnaires and healthy subjects who have been administered drugs known to attenuate or provoke symptoms of schizophrenia. The fourth category contains a heterogeneous grouping of LI experiments with participants suffering from a variety of *apparently* unrelated pathologies.

Latent Inhibition and Schizophrenia

Much knowledge has been accumulated regarding LI and schizophrenia, particularly in regard to the involvement of dopaminergic systems (for reviews, see e.g., Lubow, 2005; Weiner, 2003). In the first LI-schizophrenia study, Lubow, Weiner, Schlossberg, and Baruch (1987) investigated LI effects in paranoid and nonparanoid patients. Based on the animal literature, they expected to find attenuated LI in the two patient groups compared to healthy controls. However, both groups had intact LI, arguably because they were under a medication regimen that at least partially restored normal attentional functions. Subsequent research in this area has concentrated on two subpopulations of schizophrenic patients, acute and chronic. The first group is characterized by either being free of antipsychotic drugs and/or at the beginning of treatment. Many studies have indicated that this latter group is deficient in LI (Baruch et al., 1988a; Gray, Hemsley, et al., 1992; Gray, Pilowsky, Gray, & Kerwin, 1995; Lubow, Kaplan, Abramovich, Rudnick, & Laor, 2000a; Rascle et al., 2001; Vaitl et al., 2002; Williams et al., 1998; Young, Moran, & Joseph, 2005; for an exception, see Swerdlow et al., 2005).

As opposed to acute nonmedicated patients, chronic medicated schizophrenics exhibit intact LI (Baruch et al., 1988a; Gray, Hemsley, et al., 1992; Leumann, Feldon, Vollenweider, & Ludewig, 2002; Lubow et al., 1987). However, a recent study by Cohen et al. (2004) suggests that the LI effect in schizophrenia is even more complex. Based on Weiner (2003), they expected patients with negative symptoms and patients with positive symptoms to exhibit different patterns of LI. Indeed, schizophrenic patients who simultaneously displayed high levels of negative symptoms and low levels of positive symptoms had *potentiated* LI. Schizophrenic groups with other combinations of positive and negative symptoms did not differ from controls. These findings may explain some of the contradictory results in the literature, and together with Weiner's (2003) "two-headed" model of schizophrenia, based on animal studies, may have important implications for treatment and drug development.

Latent Inhibition and Schizotypy

If one accepts the assumption that psychotic tendencies exist on a continuum (e.g., Chapman, Edell, & Chapman, 1980; Claridge & Broks, 1984; Eysenck & Eysenck, 1976), with one extreme being the well-adapted normal, and the other a hospitalized patient group, then *healthy* subjects who are differentiated on the basis of high symptom-related scores should exhibit behavioral/cognitive effects that parallel those that occur in the pathological state. The concept of schizotypy, or psychotic-proneness, is based on this assumption, and it receives support from family studies that indicate that the genetic vulnerability to schizophrenia may be manifested in nonpsychotic individuals as a schizophrenia-like personality (e.g., Nuechterlein et al., 2002). Investigating cognitive dysfunctions in these otherwise healthy groups has the advantage of isolating the predisposition to schizophrenia from possible confounding factors, such as symptoms that interfere with testing, hospitalization, medication, and social stigma (Mednick & McNeil, 1973).

In general, the schizotypal personality includes four components: aberrant perceptions and beliefs (unusual experiences), cognitive disorganization, introvertive anhedonia, and asocial behavior. It can be assessed with self-report instruments such as the Schizotypal Personality Questionnaire (SPQ; Raine, 1991), which draws on the nine features of schizotypal personality disorder as defined by DSM-III-R (American Psychiatric Association, 2000). Six of the subscales relate to positive symptoms of schizotypy (ideas of reference, odd beliefs/magical thinking, unusual perceptual experiences, eccentric/odd behavior and appearance, odd speech, and suspicious/paranoid ideation). Two subscales relate to negative symptoms (no close friends and constricted affect).The ninth subscale, social anxiety, is related to affective symptoms of schizotypy.

Given the above rationale, the study of the relationship between LI and schizophrenia has been extended to healthy populations that are differentiated on the basis of schizotypy scores, usually by median-split (e.g., Baruch, Hemsley, & Gray, 1988b; Braunstein-Bercovitz & Lubow, 1998) but sometimes also by subscale scores (e.g., Burch et al., 2004; Gray et al., 2002).

As would be expected from the results with schizophrenic patients, healthy subjects who score high on schizotypal personality questionnaires exhibit reduced LI compared to low psychotic-prone subjects (e.g., Baruch et al., 1988b; Braunstein-Bercovitz & Lubow, 1998; Gray et al., 2002; Lubow, Ingberg-Sachs, Zalstein-Orda, & Gewirtz, 1992; for an exception, see Wuthrich & Bates, 2001; for a review, see Braunstein-Bercovitz, Rammsayer, Gibbons, & Lubow, 2002). In a study that raised questions in regard to the continuity hypothesis, Serra, Jones, Toone, and Gray (2001, Exp. 2) examined LI in three groups: chronic schizophrenic patients, their symptom-free first-degree relatives who were divided into schizotypal and nonschizotypal groups, and, for comparison, an unrelated healthy group from Experiment 1. All three groups from Experiment 2 showed reduced LI compared to the control group. However, the differences in LI were primarily a result of very rapid learning by the NPE control group.

In the meantime, the overwhelming majority of experiments show that nonsymptomatic high-schizotypal normals exhibit attenuated LI compared to low-schizotypals, as do acute nonmedicated schizophrenic patients compared to healthy controls. Furthermore, the attenuated LI appears to be associated with the positive symptoms that characterize the acute, unmedicated state of patients and with the schizotypal questionnaire subscale scores that also reflect positive type symptoms. In regard to this latter point, Evans, Gray, and Snowden (2007) found that attenuated LI in high-schizotypal normals was limited to those subjects who scored high on the dimension of Unusual Experiences. Such data would seem to support the continuity model as do the parallel effects of antipsychotic and psychosis-producing drugs on LI in patient and healthy control groups (see below).

Latent Inhibition in Healthy Groups that Receive Dopaminergic-Related Drugs

The predictive validity for the animal-LI model of schizophrenia is reinforced by results from pharmacological studies (for reviews, see e.g., Moser, Hitchcock, Lister, & Moran, 2000; Tzschentke, 2001; Weiner, 2003). Thus, amphetamine, an indirect dopamine agonist, which by itself produces positive symptoms of schizophrenia in normal subjects (e.g., Ellinwood, 1967; Zahn, Rappaport, & Thompson, 1981) and exacerbates such symptoms in schizophrenics (e.g., Angrist, Rotrosen, & Gershon, 1980; Sato, Numachi, & Hamamura, 1992), attenuates LI in rats (e.g., Weiner, Lubow, & Feldon, 1984, 1988) and humans (e.g., Gray, Pickering, Hemsley, Dawling, & Gray, 1992b; Kumari et al., 1999). On the other hand, nonselective dopamine-receptor antagonists, such as chlorpromazine and haloperidol, effective neuroleptics, reverse this attenuation and produce a super-LI effect, again both in rats (e.g., Peters & Joseph, 1993; Weiner & Feldon, 1987) and humans (e.g., McCartan et al., 2001; Williams et al., 1996, 1997).

Atypical antipsychotic drugs also produce the expected potentiation of LI. Thus, clozapine (e.g., Moran, Fischer, Hitchcock, & Moser, 1996; Shadach, Feldon, & Weiner, 1999), olanzapine (e.g., Gosselin, Oberling, & Di Scala, 1996), remoxipride (Nadal, 2001; Trimble, Bell, & King, 1997), and rispiridone (e.g., Alves, Delucia, & Silva, 2002; Alves & Silva, 2001) enhance LI or reverse the LI-reducing effects of the indirect dopamine agents. In general, the effective dosages of most clinically effective neuroleptics are similar to those dosages that enhance LI (Dunn, Atwater, & Kilts, 1993).

Latent Inhibition and Pathologies Other than Schizophrenia

In addition to the schizophrenia-related experiments, LI has been studied in a number of other pathologies, including Parkinson's Disease, Tourette's Disorder, Anxiety, Attention Deficit Hyperactivity Disorder, and Obsessive Compulsive Disorder.

Anxiety. There is considerable evidence in the cognitive literature that anxiety interferes with the ability to ignore irrelevant stimuli (for review, see Eysenck, Derakshan, Santos, & Calvo, 2007). On this basis, plus the fact that anxiety, in addition to having serotonergic involvement, is also related to elevated dopaminergic activity (e.g., Nutt, Bell, & Malizia, 1998), one might expect that LI would be attenuated by high levels of anxiety. In support of this possibility, Braunstein-Bercovitz (2000) factor analyzed SPQ scores and found significant components for anxiety and perceptual-disorganization. Furthermore, there was a significant correlation between the first factor and trait-anxiety as measured by the State and Trait Anxiety Inventory (Spielberger, Gorsuch, & Lushene, 1970). Perceptual disorganization was also significantly correlated with trait-anxiety, but it was significantly lower than that with anxiety. These findings suggest that low LI in schizotypal and schizophrenic subjects may be due to anxiety and not necessarily to the positive symptoms themselves (Braunstein-Bercovitz et al., 2002). Indeed, the positive symptoms may serve to increase anxiety (see below).

Since subjects characterized as Type-A personalities are considered to have a highly stressful life style, and stress is related to anxiety, one also would expect Type-As to exhibit less LI than Type-Bs. Indeed, this was demonstrated in the only study that examined this prediction (De la Casa, 1994).

Braunstein-Bercovitz, Dimentman-Ashkenazi, and Lubow (2001) tested the anxiety hypothesis by manipulating stress in two rule-learning experiments, one in the laboratory and one in the field. In both cases, adult subjects in the low-stress but not high-stress condition exhibited LI. However, Lubow, Toren, Laor, and Kaplan (2000b), using the visual search paradigm with clinically diagnosed anxious children found no difference in LI between these children and healthy controls.

Obsessive–compulsive disorder (OCD). A rule-learning study by Swerdlow, Hartston, and Hartman (1999) found potentiated LI in a group of OCD adults. Such an effect was absent in an

earlier study (Swerdlow, Braff, Hartston, Perry, & Geyer, 1996a), perhaps due to a ceiling effect imposed by task difficulty. Indeed, Kaplan et al. (2006) replicated the super-LI effect in OCD patients using the relatively simple visual search LI task. Although OCD and Tourette's syndrome have high rates of bidirectional comorbidity, Swerdlow, Magulac, Filion, and Zinner (1996b) reported that children and adults with TS showed normal LI effects compared to healthy controls.

The super-LI effect in OCD patients poses an apparent paradox. Since OCD belongs to the category of DSM-IV TR anxiety disorders (American Psychiatric Association, 2000), one might expect such patients to show attenuated LI (see above). However, the difficulty that OCD individuals have in *switching* between cognitive sets (e.g., Head, Bolton, & Hymas, 1989) may also interfere with their ability to learn that the previously irrelevant stimulus has become relevant in the test, and thus may generate a super-LI effect. That OCD patients display a super-LI effect suggests that, for them, "rigidity" is stronger than "anxiety," at least within the stimulus preexposure paradigm.

Attention deficit hyperactivity disorder (ADHD). The pharmacological treatment for ADHD creates yet another paradox for LI theory. On the one hand, methylphenidate (a dopamine agonist) should reduce LI. On the other hand, the improvement of attention caused by this drug should enhance LI.

Two studies have looked at LI in ADHD children. Lubow and Josman (1993), using a rule-learning procedure, reported no LI in ADHD children, although LI was present in healthy controls. With the visual search procedure, Lubow et al. (2005) found that nonmedicated ADHD children had less LI for left-side targets than right-side targets. This effect was absent in the normal control and the medicated ADHD groups, suggesting that methylphenidate may have normalized a lateralized attentional deficit in ADHD. Such an effect would be congruent with the claim that ADHD is related to right frontal striate dysfunction (for a review, see Stefanatos & Wasserstein, 2001).

Parkinson's disease (PD). PD patients suffer from a deficiency of dopamine and they typically are treated with a dopamine agonist (L-dopa). Therefore, it was expected that de novo, unmedicated patients would exhibit potentiated LI. Lubow, Dressler, and Kaplan (1999), using the visual search procedure, found potentiated LI, but only in female PD patients with right-side motor symptoms compared to normal controls and to female PD patients with left-side symptoms. Male patients with right-side symptoms did not exhibit LI. Thus, as with the ADHD children, the LI abnormalities in PD patients appear to have a lateralized component.

Theoretical Issues for Latent Inhibition and Their Implications for Schizophrenia

Although there have been many explanations of the LI effect in the animal literature (for reviews, see Hall, 1991; Lubow, 1989), current theories reside within two major categories, attentional/association deficit (A-theories), and retrieval-competition (R-theories). A-theories, of which there are several versions (e.g., Lubow, 1989; Mackintosh, 1975; Pearce & Hall, 1980), assume that irrelevant stimulus preexposure degrades attention to that stimulus (salience reduction). As a consequence, future associability of the stimulus is decreased and new learning is made more difficult. In contrast, R-theories, tested in three-stage experimental paradigms consisting of separate preexposure, acquisition, and test stages, claim that there is no impairment of preexposed stimulus associability. Instead, the PE and NPE groups enter the acquisition phase with the same capacity to form new associations with the test stimulus, i.e., the associative strength that accrues to the conditioned stimulus in the acquisition phase is the same for both groups. According to R-theory, in the stage-three test, the association that was formed during the preexposure phase (CS-0) competes with the CS-US association that was formed in the acquisition phase (e.g., Bouton, 1993; Miller, Kasprow, & Schachtman, 1986). Thus, the NPE group performs better than the PE group because there is only

the second association to be retrieved, whereas the PE group retrieves both associations, ones that are in conflict with each other.

Although A- and R-theories may disagree as to whether the source of the LI effect is in the preexposure or in the test stage, both accounts accept that something is learned during preexposure. Whether that association is CS-0, CS-context, context-0, or a higher order conditional association whereby the context becomes an occasion-setter for the expression of a CS-0 is, as yet, unresolved. Nor is it evident, which if any of these possibilities is uniquely compatible with an A- or R-interpretation of LI.

Since most human-LI studies were designed on the background of their implications for schizophrenia, they were significantly influenced by the attentional component of A-theories. Nevertheless, it has become increasingly clear that a comprehensive theory of LI has to incorporate attentional processes in preexposure *and* retrieval processes in test. Furthermore, it would seem to be important to relate this distinction between learning and performance factors to the schizophrenia-modulated LI data.

To begin with, the consensus opinion that schizophrenia represents a disorder of attention (e.g., Anscombe, 1987; Braff, 1993; Mirsky & Duncan, 1986; Nuechterlein & Dawson, 1984) requires a confirmation that LI, at least in part, is indeed governed by such processes. This position gains support from experiments that demonstrate that generating LI in adult humans requires a masking task in the preexposure stage, and that LI is modulated by the difficulty (load) of the masking task.

The Role of the Masking Task

With the exception of several electrodermal conditioning studies (see below), the vast majority of experiments that have successfully elicited LI in adults have preexposed the to-be-target stimulus while the subject was occupied with a masking task (e.g., Gray, Hemsley, et al., 1992; Gray, Pickering, et al., 1992; Lubow et al., 1992; Pineno, De la Casa, Lubow, & Miller, 2006; for an exception, Escobar, Arcediano, & Miller, 2003). Furthermore, numerous experiments with nonmasked stimulus preexposures have failed to produce an LI effect (e.g., Graham & McLaren, 1998; for a review, see Lubow, 2005). Most importantly, studies that have *explicitly* compared masked and nonmasked conditions have obtained LI with the former but not with the latter (Braunstein-Bercovitz & Lubow, 1998; De la Casa & Lubow, 2001; Ginton, Urca, & Lubow, 1975; Graham & McLaren, 1998; Lubow, Caspy, & Schnur, 1982). Notably, in all of these experiments, the masking task response was qualitatively *different* from the test task response. In fact, the cluster of electrodermal conditioning studies that have obtained LI without masking (e.g., Lipp, Siddle, & Vaitl, 1992; Lipp & Vaitl, 1992) invariably elicit the *same* response in the preexposure and conditioning/test stages, a condition that allows for simple interference effects.

That the masking task is a necessary condition for the production of LI can be accounted for by accepting the assumption that it diverts attention or processing resources from the preexposed stimulus. Additional compelling evidence for the role of attention in LI was provided by Braunstein-Bercovitz, Hen, and Lubow (2004) and Braunstein-Bercovitz and Lubow (1998). Both papers reported that LI was not only a function of masking task load but that there was significant interaction between load and schizotypy level. With a low-load masking task, low schizotypals exhibited normal LI. However, LI was abolished in high-schizotypals. With a high-load masking task, the effects were reversed; low-schizotypals did not exhibit LI, and high schizotypals demonstrated intact LI. Similar results have been reported by Della Casa, Hoefer, Weiner, and Feldon (1999) and Hoefer, Della Casa, and Feldon (1998).

Although these studies clearly indicate that LI is modulated by a stage-1 attentional process, they do not negate the possibility that LI also is affected by stage-2 and/or stage-3 retrieval factors. Indeed, this option is supported by LI experiments that have examined the effects of context-change and retention interval.

The Roles of Context and Retention Interval

Normally, LI experiments make a point of using the same context in the preexposure and acquisition/test stages. However, if the contexts are different from each other, then LI, even in humans, is disrupted (e.g., Gray et al., 2001; Nelson & Sanjuan, 2006; Zalstein-Orda & Lubow, 1995; for review of animal literature, see Lubow, 1989, pp. 74–82). These results are critical for R-theories because in the preexposure phase the subject has no knowledge of the forthcoming acquisition-test conditions, context or otherwise. Therefore, during the preexposure stage, the context-same and the context-different groups must process the PE stimulus and context information in an *identical* manner, and any difference in performance between the two groups in the test must be attributed to a process occurring *after* preexposure.

A retrieval-failure account of LI also gains support from animal experiments that have manipulated the time between the stage-2 acquisition and stage-3 test stages. Most of these studies have found that LI decreases as a function of the retention interval (e.g., for a review, see Lubow & De la Casa, 2005). Recall that R-theory proposes that, following stimulus preexposure, the acquisition of the new association to the old stimulus proceeds normally. However, in the test stage, when the subject again encounters the stimulus that was preexposed and then conditioned, two competing associations are retrieved, representing the opposing associations previously learned in the prior phases. However, if one varies the time between acquisition and test, and LI is found after a short but not long delay, this is evidence that with the short-delay the CS-US association was acquired but not manifest, and that something occurred during the longer delay that allowed the *normal* association that was encoded in the acquisition phase to be retrieved.[1]

Integrating and Expanding A- and R-Theories of Latent Inhibition

In summary, although the acquisition of normal LI may be explained primarily by A-theory processes operating in the stimulus preexposure stage, the modulation of LI by post-preexposure variables requires explanatory constructs from R-theory. In other words, an inclusive theory of LI must not only incorporate postulates that allow for *different* preexposure conditions (e.g., PE and NPE) to produce differential effects but also ones that allows for the *same* stimulus preexposure conditions to produce different test-dependent condition effects. The two sets of variables correspond to those that are manipulated *during* the preexposure phase (e.g., number and duration of stimulus preexposures, masking task load) and modulate the acquisition of LI, and those that are manipulated *after* the preexposure stage and frequently correspond to retrieval processes that produce a "release" from LI (e.g., context change, delay of testing).

[1] Several recent studies have failed to find a diminution of LI after a long acquisition-test interval. Quite the opposite, when the long retention interval was spent in a context that was different from the contexts of the other stages, a super-LI effect was obtained (for a review, see Lubow & De la Casa, 2005).

However, in addition to accepting the *general* premises of A- and R-theories, there are other potentially important considerations that should be recognized. For one, it is necessary to differentiate between two processes operating in stage-1, stimulus-property encoding (e.g., shape, color), and stimulus-relationship encoding (e.g., CS-0; CS-context, CS-US), and to acknowledge that the former precedes the latter (Lubow, 2005). This latter point follows from the fact that LI is stimulus-specific (i.e., preexposure to stimulus A does not affect performance to stimulus B; for review, see Lubow, 1989, pp. 58–59). If LI is stimulus-specific, then relationships with that stimulus cannot be acquired without first encoding the qualitative aspects of the stimulus itself. As a consequence, a *small* number of stimulus preexposures should produce facilitation of subsequent learning as compared to no preexposure or to extensive preexposures. This should occur because during the first few stimulus preexposures, some of the stimulus properties were encoded *before* the critical association, CS-0 and/or CS-context, could be acquired. Thus, a subject with very few stimulus preexposures has an advantage in the acquisition of the subsequent CS-US association because that association also depends on stimulus-property encoding. With an increase in the number of stimulus preexposures, relationship-encoding proceeds, and the initial positive transfer eventually becomes negative (LI), at least if the context remains constant across stages. The evidence that relatively few stimulus preexposures facilitate subsequent learning, even when contexts are constant, comes primarily from animal studies (e.g., Bennett, Tremain, & Mackintosh, 1996; Hoffmann & Spear, 1989; Prados, 2000). However, one experiment suggests a similar effect for humans (Burch et al., 2004).

Implications for Schizophrenia

The above analyses indicate that the apparently simple LI effect is, in fact, quite complex. This point needs no further emphasis than that of noting that explanations of LI have invoked such different general processes as those found in A- and R-theories. The complexity becomes even more compelling when one tries to relate the LI abnormalities in schizophrenia to specific underlying cognitive mechanisms. In doing so, one can appeal to stimulus encoding deficits for either stimulus properties or stimulus relationships; and, if stimulus properties, then one can ask whether it is unique to punctate stimuli that are not followed by consequences, or to the stimuli that compose the context; and, if stimulus relationships, which ones- CS-0, CS-context, or some higher order occasion setting function? And, of course, it must be determined whether the same answers apply equally to patients with different symptoms, as for example, positive and negative.

In short, knowing that schizophrenic patients and high-schizotypal normals exhibit aberrant LI data does not, *by itself*, provide critical information in regard to understanding the pathologies of schizophrenia. Nevertheless, the LI anomalies in schizophrenia patients and high schizotypal normals may clarify some of the experiential aspects of the disease. For example, if attenuated LI reflects the patient's inability to ignore objectively meaningless irrelevant stimuli (e.g., Lubow, 1989, 2005), then this suggests some accompanying phenomenological effects. On the one hand, experiencing the "mad" rush of relatively unfiltered stimuli can be a symptom of the underlying pathology. At the same time, this can be a *cause* of further disorientation and confusion that, in turn, would increase anxiety and exacerbate the original problem. Within this framework, positive symptoms such as delusions and hallucinations can be viewed as adaptive responses. The imposition of some apparent order on an otherwise chaotic experiential array of stimuli can reduce anxiety and thereby suspend a devastating iterative process. Alternatively, escape from the maelstrom of meaningless events can be achieved by summoning up negative symptoms, such as apathy and withdrawal. In brief, schizophrenia can be seen as a defense against a system breakdown that would otherwise result in conscious experience being inundated with phenomenally novel, meaningless stimuli. Frith (1979) has described the end product of this collapse in similar terms, referring to the inability of schizophrenics to limit

the contents of consciousness. Abnormal LI effects in schizophrenia patients appear to reflect this state, with attenuated LI being associated with positive symptoms, and potentiated LI with negative symptoms. For the subject with positive symptoms, LI may be decreased because *attention* to the preexposed irrelevant stimulus is maintained, a condition that can affect either subsequent associability directly, as originally proposed by A-theories, or subsequent retrieval of the one or more associations acquired during the preexposure stage. For the subject with negative symptoms, LI may be increased because the preexposed stimulus is relatively unattended in the first place. As a consequence, CS-0 and/or CS-context associations may be acquired more effectively than for normals, thereby facilitating subsequent retrievability of those associations.

Although the above accounts combine the major themes of A- and R-theories, the specific descriptions of their operations remain quite speculative, perhaps because of the scarcity of data regarding stimulus property and stimulus relationship encoding. Clearly, given the number of different processes that may underlie the apparently simple LI effect, one can generate a variety of alternative explanations for the relationship between schizophrenia symptom types and the effects of irrelevant stimulus preexposures. It is equally clear that we have reached a point where we now know the direction that future research has to take in order to provide more definitive explanations.

References

Alves, C. R. R., Delucia, R., & Silva, M. T. A. (2002). Effects of fencamfamine on latent inhibition. *Progress in Neuro-Psychopharmacology and Biological Psychiatry, 26*, 1089–1093.

Alves, C. R. R., & Silva, M. T. (2001). Facilitation of latent inhibition by the atypical antipsychotic risperidone. *Pharmacology Biochemistry and Behavior, 68*, 503–506.

American Psychiatric Association. (2000). *Diagnostic and statistical manual of mental disorders DSM-IV-TR*. Washington, DC: American Psychiatric Association.

Angrist, B., Rotrosen, J., & Gershon, S. (1980). Differential effects of amphetamine and neuroleptics on negative vs positive symptoms in schizophrenia. *Psychopharmacology, 72*, 17–19.

Anscombe, R. (1987). The disorder of consciousness in schizophrenia. *Schizophrenia Bulletin, 13*, 241–260.

Barch, D. M., Carter, C. S., Hachten, P. C., Usher, M., & Cohen, J. D. (1999). The "benefits" of distractibility: Mechanisms underlying increased Stroop effects in schizophrenia. *Schizophrenia Bulletin, 25*, 749–762.

Baruch, I., Hemsley, D. R., & Gray, J. A. (1988a). Differential performance of acute and chronic schizophrenics in a latent inhibition task. *Journal of Nervous and Mental Disease, 176*, 598–606.

Baruch, I., Hemsley, D. R., & Gray, J. A. (1988b). Latent inhibition and 'psychotic proneness' in normal subjects. *Personality and Individual Differences, 9*, 777–784.

Bennett, C. H., Tremain, M., & Mackintosh, N. J. (1996). Facilitation and retardation of flavor conditioning following prior exposure to the CS. *Quarterly Journal of Experimental Psychology, 49B*, 220–230.

Bouton, M. E. (1993). Context, time, and memory retrieval in the interference paradigms of Pavlovian learning. *Psychological Bulletin, 114*, 80–99.

Braff, D. L. (1993). Information processing and attention dysfunctions in schizophrenia. *Schizophrenia Bulletin, 19*, 233–259.

Braunstein-Bercovitz, H. (2000). Is the attentional dysfunction in schizotypy related to anxiety? *Schizophrenia Research, 46*, 255–267.

Braunstein-Bercovitz, H., Dimentman-Ashkenazi, I., & Lubow, R. E. (2001). Stress affects the selection of relevant from irrelevant stimuli. *Emotion, 1*, 182–192.

Braunstein-Bercovitz, H., Hen, I., & Lubow, R. E. (2004). Masking task load modulates latent inhibition: support for a distraction model of irrelevant information processing by high schizotypal participants. *Cognition and Emotion, 18*, 1135–1144.

Braunstein-Bercovitz, H., & Lubow, R. E. (1998). Are high schizotypal normals distractible or limited in attentional resources? A study of latent inhibition as a function of masking task load and schizotypy. *Journal of Abnormal Psychology, 107*, 659–670.

Braunstein-Bercovitz, H., Rammsayer, T., Gibbons, H., & Lubow, R. E. (2002). Latent inhibition deficits in high schizotypal normals: symptom-specific or anxiety-related? A review. *Schizophrenia Research, 53*, 109–121.

Burch, G. S. J., Hemsley, D. R., & Joseph, M. H. (2004). Trials-to-criterion latent inhibition in humans as a function of stimulus pre-exposure and positive schizotypy. *British Journal of Psychology, 95*, 179–196.

Chapman, L. J., Edell, W. S., & Chapman, J. P. (1980). Physical anhedonia, perceptual aberration, and psychosis proneness. *Schizophrenia Bulletin, 6*, 639–653.

Claridge, G. S., & Broks, P. (1984). Schizotypy and hemisphere function-I: theoretical considerations and the measurement of schizotypy. *Personality and Individual Differences, 5*, 633–648.

Cohen, E., Sereni, N., Kaplan, O., Weizman, A., Kikinzon, L., Weiner, I., et al. (2004). The relation between latent inhibition and symptom-types in young schizophrenics. *Behavioural Brain Research, 149*, 113–122.

De la Casa, L. G. (1994). Latent inhibition and recall of irrelevant stimuli in type-A and type-B subjects. *Revista de Psicologia General y Aplicada, 47*, 289–300.

De la Casa, G., & Lubow, R. E. (2001). Latent inhibition with a response time measure from a within-subject design: effects of number of preexposures, masking task, context change, and delay. *Neuropsychology, 15*, 244–253.

Della Casa, V., Hoefer, I., Weiner, I., & Feldon, J. (1999). Effects of smoking status and schizotypy on latent inhibition. *Journal of Psychopharmacology, 13*, 362–368.

Dunn, L. A., Atwater, G., & Kilts, C. (1993). Effects of antipsychotic drugs on latent inhibition: sensitivity and specificity of an animal behavioral model of clinical drug action. *Psychopharmacology, 112*, 315–323.

Ellinwood, E. H. J. (1967). Amphetamine psychosis: I. Description of the individuals and process. *Journal of Nervous and Mental Disease, 144*, 273–283.

Escobar, M., Arcediano, F., & Miller, R. R. (2003). Latent inhibition in human adults without masking. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 29*, 1028–1040.

Evans, L. H., Gray, N. S., & Snowden, R. J. (2007). A new continuous within-participants latent inhibition task: examining associations with schizotypy dimensions, smoking status and gender. *Biological Psychology, 74*, 365–373.

Eysenck, M. W., Derakshan, N., Santos, R., & Calvo, M. G. (2007). Anxiety and cognitive performance: attentional control theory. *Emotion, 7*, 336–353.

Eysenck, H. J., & Eysenck, S. B. G. (1976). *Psychoticism as a dimension of personality*. London: Hodder and Stoughton.

Frith, C. D. (1979). Consciousness, information processing and schizophrenia. *The British Journal of Psychiatry, 134*, 225–235.

Ginton, A., Urca, G., & Lubow, R. E. (1975). The effects of preexposure to a nonattended stimulus on subsequent learning: latent inhibition in adults. *Bulletin of the Psychonomic Society, 5*, 5–8.

Gosselin, G., Oberling, P., & Di Scala, G. (1996). Antagonism of amphetamine-induced disruption of latent inhibition by the atypical antipsychotic olanzapine in rats. *Behavioural Pharmacology, 7*, 820–826.

Graham, S., & Mclaren, I. P. L. (1998). Retardation in human discrimination learning as a consequence of preexposure: latent inhibition or negative priming? *Quarterly Journal of Experimental Psychology, 51B*, 155–172.

Gray, N. S., Fernandez, M., Williams, J., Ruddle, R. A., & Snowden, R. J. (2002). Which schizotypal dimensions abolish latent inhibition? *British Journal of Clinical Psychology, 41*, 271–284.

Gray, N. S., Hemsley, D. R., & Gray, J. A. (1992). Abolition of latent inhibition in acute, but not chronic, schizophrenics. *Neurology, Psychiatry, and Brain Research, 1*, 83–89.

Gray, N. S., Pickering, A. D., Hemsley, D. R., Dawling, S., & Gray, J. A. (1992). Abolition of latent inhibition by a single 5 mg dose of d-amphetamine in man. *Psychopharmacology, 107*, 425–430.

Gray, N. S., Pilowsky, L. S., Gray, J. A., & Kerwin, R. W. (1995). Latent inhibition in drug naive schizophrenics: relationship to duration of illness and dopamine D2 binding using SPET. *Schizophrenia Research, 17*, 95–107.

Gray, N. S., Snowden, R. J., Peoples, M., Hemsley, D. R., & Gray, J. A. (2003). A demonstration of within-subjects latent inhibition in the human: limitations and advantages. *Behavioural Brain Research, 138*, 1–8.

Gray, N. S., Williams, J., Fernandez, M., Ruddle, R. A., Good, M. A., & Snowden, R. J. (2001). Context dependent latent inhibition in adult humans. *Quarterly Journal of Experimental Psychology, 54B*, 233–245.

Hall, G. (1991). *Perceptual and associative learning*. Oxford, England: Clarendon.

Head, D., Bolton, D., & Hymas, N. (1989). Deficit in cognitive shifting ability in patients with obsessive-compulsive disorder. *Biological Psychiatry, 25*, 929–937.

Hoefer, I., Della Casa, V., & Feldon, J. (1998). The interaction between schizotypy and latent inhibition: modulation by experimental parameters. *Personality and Individual Differences, 26*, 1075–1088.

Hoffmann, H., & Spear, N. E. (1989). Facilitation and impairment of conditioning in the preweanling rat after prior exposure to the conditioned stimulus. *Animal Learning and Behavior, 17*, 63–69.

Kaplan, O., Dar, R., Rosenthal, L., Hermesh, H., Fux, M., & Lubow, R. E. (2006). Obsessive-compulsive disorder patients display enhanced latent inhibition on a visual search task. *Behavior Research and Therapy, 44*, 1137–1145.

Kumari, V., Cotter, P. A., Mulligen, O. F., Checkley, S. A., Gray, N. S., Hemsley, D. R., et al. (1999). Effects of d-amphetamine and haloperidol on latent inhibition in healthy male volunteers. *Journal of Psychopharmacology, 13*, 398–405.

Leumann, L., Feldon, J., Vollenweider, F. X., & Ludewig, K. (2002). Effects of typical and atypical antipsychotics on prepulse inhibition and latent inhibition in chronic schizophrenia. *Biological Psychiatry, 52*, 729–739.

Lipp, O. V., Siddle, D. A. T., & Vaitl, D. (1992). Latent inhibition in humans: single cue conditioning revisited. *Journal of Experimental Psychology: Animal Behavior Processes, 18*, 115–125.

Lipp, O. V., & Vaitl, D. (1992). Latent inhibition in human Pavlovian differential conditioning: effects of additional stimulation after preexposure and relation to schizotypal traits. *Personality and Individual Differences, 13*, 1003–1012.

Lubow, R. E. (1973). Latent inhibition. *Psychological Bulletin, 79*, 398–407.

Lubow, R. E. (1989). *Latent inhibition and conditioned attention theory*. New-York: Cambridge University Press.

Lubow, R. E. (2005). Construct validity of the animal latent inhibition model of selective attention deficits in schizophrenia. *Schizophrenia Bulletin, 31*, 139–153.

Lubow, R. E., Braunstein-Bercovitz, H., Blumenthal, O., Kaplan, O., & Toren, P. (2005). Latent inhibition and asymmetrical visualspatial attention in children with ADHD. *Child Neuropsychology, 11*, 445–457.

Lubow, R. E., Caspy, T., & Schnur, P. (1982). Latent inhibition and learned helplessness in children: similarities and differences. *Journal of Experimental Child Psychology, 34*, 231–256.

Lubow, R. E., & De la Casa, L. G. (2005). There is a time and a place for everything: bidirectional modulations of latent inhibition by time-induced context differentiation. *Psychonomic Bulletin and Review, 12*, 806–821.

Lubow, R. E., Dressler, R., & Kaplan, O. (1999). Visual search and latent inhibition in de novo Parkinson patients. *Neuropsychology, 13*, 415–423.

Lubow, R. E., & Gewirtz, J. C. (1995). Latent inhibition in humans: data, theory, and implications for Schizophrenia. *Psychological Bulletin, 117*, 87–103.

Lubow, R. E., Ingberg-Sachs, Y., Zalstein-Orda, N., & Gewirtz, J. C. (1992). Disruption of latent inhibition in high psychotic-prone normal subjects. *Personality and Individual Differences, 13*, 563–572.

Lubow, R. E., & Josman, Z. E. (1993). Latent inhibition deficits in hyperactive children. *Journal of Child Psychology and Psychiatry, 84*, 859–875.

Lubow, R. E., & Kaplan, O. (2005). The visual search analog of latent inhibition: implications for theories of irrelevant stimulus processing in normal and schizophrenic groups. *Psychonomic Bulletin and Review, 12*, 224–243.

Lubow, R. E., Kaplan, O., Abramovich, P., Rudnick, A., & Laor, N. (2000). Visual search in schizophrenia: latent inhibition and novel popout effects. *Schizophrenia Research, 45*, 145–156.

Lubow, R. E., & Moore, A. U. (1959). Latent inhibition: the effect of non-reinforced pre-exposure to conditional stimulus. *Journal of Comparative and Physiological Psychology, 52*, 416–419.

Lubow, R. E., Toren, P., Laor, N., & Kaplan, O. (2000). The effects of target and distractor familiarity on visual search in anxious children: latent inhibition and novel pop-out. *Journal of Anxiety Disorders, 14*, 41–56.

Lubow, R. E., Weiner, I., Schlossberg, A., & Baruch, I. (1987). Latent inhibition and schizophrenia. *Bulletin of the Psychonomic Society, 25*, 464–467.

Mackintosh, N. J. (1975). A theory of attention: variations in the associability of stimuli with reinforcement. *Psychological Review, 82*, 276–284.

McCartan, D., Bell, R., Green, J. F., Campbell, C., Trimble, K., Pickering, A., et al. (2001). The differential effects of chlorpromazine and haloperidol on latent inhibition in healthy volunteers. *Journal of Psychopharmacology, 15*, 96–104.

McGhie, A., & Chapman, J. (1961). Disorders of attention and perception in early schizophrenia. *British Journal of Medical Psychology, 34*, 103–116.

Mednick, S. A., & McNeil, T. F. (1973). Current methodology in research on the etiology of schizophrenia: serious difficulties which suggest the use of the high-risk-group method. *Psychological Bulletin, 70*, 681–693.

Miller, R. R., Kasprow, W. J., & Schachtman, T. R. (1986). Retrieval variability: sources and consequences. *American Journal of Psychology, 99*, 145–218.

Mirsky, A. F., & Duncan, C. C. (1986). Etiology and expression of schizophrenia: neurobiological and social factors. *Annual Review of Psychology, 37*, 291–319.

Moran, P. M., Fischer, T. R., Hitchcock, J. M., & Moser, P. C. (1996). Effects of clozapine on latent inhibition in the rat. *Behavioural Pharmacology, 7*, 42–48.

Moser, P. C., Hitchcock, J. M., Lister, S., & Moran, P. M. (2000). The pharmacology of latent inhibition as an animal model of schizophrenia. *Brain Research Reviews, 33*, 275–307.

Nadal, R. (2001). Pharmacology of the atypical antipsychotic remoxipride, a dopamine D2 receptor antagonist. *CNS Drug Reviews, 7*, 265–282.

Nelson, J. B., & Sanjuan, M. D. C. (2006). A context-specific latent inhibition effect in a human conditioned suppression task. *Quarterly Journal of Experimental Psychology, 59*, 1003–1020.

Nuechterlein, K. H., Asarnow, R. F., Subotnik, K. L., Foelson, D. L., Payne, D. L., Kendler, K. S., et al. (2002). The structure of schizotypy: relationships between neurocognitve and personality disorder features in relatives of schizophrenic patients in the UCLA Family Study. *Schizophrenia Research, 54*, 1211–130.

Nuechterlein, K. H., & Dawson, M. E. (1984). Information processing and attentional functioning in the developmental course of schizophrenic disorders. *Schizophrenia Bulletin, 10*, 160–203.

Nutt, D. J., Bell, C. J., & Malizia, A. L. (1998). Brain mechanisms of social anxiety disorder. *Journal of Clinical Psychiatry, 12*, 31–38.

Ohman, A., Nordby, H., & d'Elia, G. (1986). Orienting and schizophrenia: stimulus significance, attention, and distraction in a signaled reaction time task. *Journal of Abnormal Psychology, 95*, 326–334.

Pearce, J. M., & Hall, G. (1980). A model of Pavlovian learning: variations in the effectiveness of conditioned but not of unconditioned stimuli. *Psychological Review, 87*, 532–553.

Peters, S. L., & Joseph, M. (1993). Haloperidol potentiation of latent inhibition in rats: evidence for a critical role at conditioning rather than pre-exposure. *Behavioural Pharmacology, 4*, 183–186.

Pineno, O., De la Casa, L. G., Lubow, R. E., & Miller, R. R. (2006). Some determinants of latent inhibition in human predictive learning. *Learning and Motivation, 37*, 42–65.

Prados, J. (2000). Effects of varying the amounts of preexposure to spatial cues on a subsequent navigational task. *Quarterly Journal of Experimental Psychology, 53B*, 139–148.

Raine, A. (1991). The SPQ: a scale for the assessment of schizotypal personality based on DSM-III-R criteria. *Schizophrenia Bulletin, 17*, 555–564.

Rascle, C., Mazas, O., Vaiva, G., Tournant, M., Raybois, O., Goudemond, N., et al. (2001). Clinical features of latent inhibition in schizophrenia. *Schizophrenia Research, 51*, 149–161.

Sato, M., Numachi, Y., & Hamamura, T. (1992). Relapse of paranoid psychotic state in methamphetamine model of schizophrenia. *Schizophrenia Bulletin, 18*, 115–122.

Serra, A. M., Jones, S. H., Toone, B., & Gray, J. A. (2001). Impaired associative learning in chronic schizophrenics and their first-degree relatives: a study of latent inhibition and the Kamin blocking effect. *Schizophrenia Research, 48*, 273–289.

Shadach, E., Feldon, J., & Weiner, I. (1999). Clozapineinduced potentiation of latent inhibition is due to its action in the conditioning stage: implications for the mechanism of action of antipsychotic drugs. *International Journal of Neuropsychopharmacology, 2*, 283–291.

Spielberger, C. D., Gorsuch, R. L., & Lushene, R. E. (1970). *Manual for the state-trait anxiety inventory (self-evaluation questionnaire)*. Palo Alto, CA: Consulting Psychologists Press.

Stefanatos, G. A., & Wasserstein, J. (2001). Attention/deficit hyperactivity disorder as a right hemisphere syndrome. *Annals of the New York Academy of Sciences, 931*, 172–195.

Swerdlow, N. R., Braff, D. L., Hartston, H., Perry, W., & Geyer, M. A. (1996). Latent inhibition in schizophrenia. *Schizophrenia Research, 20*, 91–103.

Swerdlow, N. R., Hartston, H. J., & Hartman, P. L. (1999). Enhanced visual latent inhibition in obsessive-compulsive disorder. *Biological Psychiatry, 45*, 482–488.

Swerdlow, N. R., Magulac, M., Filion, D., & Zinner, S. (1996). Visuospatial priming and latent inhibition in children and adults with Tourette's disorder. *Neuropsychology, 10*, 485–494.

Swerdlow, N. R., Stephany, N., Wasserman, L. C., Talledo, J., Sharp, R., & Auerbach, P. P. (2003). Dopamine agonists disrupt visual latent inhibition in normal males using a within-subject paradigm. *Psychopharmacology, 169*, 314–320.

Swerdlow, N. R., Stephany, N., Wasserman, L. C., Talledo, J., Sharp, R., Minassian, A., et al. (2005). Intact visual latent inhibition in schizophrenia patients in a within-subject paradigm. *Schizophrenia Research, 72*, 169–183.

Trimble, K. M., Bell, R., & King, D. J. (1997). Enhancement of latent inhibition in the rat by the atypical antipsychotic agent remoxipride. *Pharmacology, Biochemistry, and Behavior, 56*, 809–816.

Tzschentke, T. M. (2001). Pharmacology and behavioral pharmacology of the mesocortical dopamine system. *Progress in Neurobiology, 63*, 241–320.

Vaitl, D., Lipp, O., Bauer, U., Schuler, G., Stark, R., Zimmermann, M., et al. (2002). Latent inhibition and schizophrenia: Pavlovian conditioning of autonomic responses. *Schizophrenia Research, 55*, 147–158.

Weiner, I. (2003). The "two-headed" latent inhibition model of schizophrenia: modeling positive and negative symptoms and their treatment. *Psychopharmacology, 169*, 257–297.

Weiner, I., & Feldon, J. (1987). Facilitation of latent inhibition by haloperidol. *Psychopharmacology, 91*, 248–253.

Weiner, I., Lubow, R. E., & Feldon, J. (1984). Abolition of the expression but not the acquisition of latent inhibition by chronic amphetamine in rats. *Psychopharmacology, 83*, 194–199.

Weiner, I., Lubow, R. E., & Feldon, J. (1988). Disruption of latent inhibition by acute administration of low doses of amphetamine. *Pharmacology, Biochemistry and Behavior, 30*, 871–878.

Williams, J. H., Wellman, N. A., Geaney, D. P., Cowan, P. J., Feldon, J., & Rawlins, J. N. P. (1996). Anti-psychotic drug effects in a model of schizophrenic attentional disorder: a randomized controlled trial of the effects of haloperidol on latent inhibition in healthy people. *Biological Psychiatry, 40*, 1135–1143.

Williams, J. H., Wellman, N. A., Geaney, D. P., Cowen, P. J., Feldon, J., & Rawlins, J. N. P. (1998). Reduced latent inhibition in people with schizophrenia: an effect of psychosis or of its treatment. *British Journal of Psychiatry, 172*, 243–249.

Williams, J. H., Wellman, N. A., Geaney, D. P., Feldon, J., Cowen, P. J., & Rawlins, J. N. P. (1997). Haloperidol enhances latent inhibition in visual tasks in healthy people. *Psychopharmacology, 133*, 262–268.

Wuthrich, V., & Bates, T. C. (2001). Schizotypy and latent inhibition: non-linear linkage between psychometric and cognitive markers. *Personality and Individual Differences, 30*, 783–798.

Young, A. M. J., Moran, P. M., & Joseph, M. H. (2005). The role of dopamine in conditioning and latent inhibition: what, when, where and how? *Neuroscience and Biobehavioral Reviews, 29*, 963–976.

Zahn, T., Rappaport, J. L., & Thompson, C. L. (1981). Autonomic effects of dextroamphetamine in normal men: implications for hyperactivity and schizophrenia. *Psychiatry Research, 4*, 39–47.

Zalstein-Orda, N., & Lubow, R. E. (1995). Context control of negative transfer induced by preexposure to irrelevant stimuli: latent inhibition in humans. *Learning and Motivation, 26*, 11–28.