Schizotypal personality and latent inhibition: exploring the role of working memory

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Table of Contents

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

The following list outlines abbreviations used in this thesis.

Inter-stimulus interval	…….....	ISI
Latent inhibition	…….....	LI
Negative schizotypy	…….....	SPQ-
Non-pre-exposed	…….....	NPE
Pre-exposed	…….....	PE
Positive schizotypy	…….....	SPQ+
Reaction time	…….....	RT
Working memory	…….....	WM

ABSTRACT

A recently developed within-subject measure of latent inhibition has found an association between highly schizotypal individuals and abnormal learning of pre-exposed stimuli, suggesting that these individuals do not down-regulate their attention to irrelevant stimuli. Subsequent studies that have replicated the design have reported varying results – this may be a result of failing to consider potential mediators. In the present study, we explored the role of working memory, schizotypy and latent inhibition using the aforementioned within-subject design. Notably, the design was corrected for potentially confounding instructions. Participants (N = 62) completed a latent inhibition task in which reaction time responses to pre-exposed and non-pre-exposed cues were measured. Participants also completed two working memory tasks and a schizotypal personality questionnaire. Results revealed mixed support for our predictions. Regression analysis confirmed that there was enhanced learning about pre-exposed cues associated with schizotypy, however there was no significant association found with working memory. Unexpectedly, results also indicated a relation with enhanced learning about non-pre-exposed stimuli, suggesting the potential influence of other executive functions that may facilitate the processing of excess stimuli. Findings from this study further validate this new latent inhibition design and provide implications for understanding schizotypal personality and schizophrenia.

Word count: 197

DECLARATION

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CHAPTER 1: INTRODUCTION

Schizophrenia is a psychiatric condition that severely impedes on an individual's psychological function and can lead to a deteriorated conception of reality (Ettinger et al., 2014). Symptoms have typically been classified into three categories: the positive symptoms consisting of perceptual aberrations, hallucinations and delusions, the negative symptoms constituting reduced emotional and social function coupled with anhedonia, and the disorganised symptoms relating to eccentric and odd behaviour. (Reynolds et al., 2000; Tsuang, Stone, Tarbox & Faraone, 2002). In addition to the symptomology, patients with schizophrenia also exhibit a number of cognitive deficits including: impairments in attention (Barnett & Mundtt, 1992; Baruch, Hemsley & Gray, 1998a), difficulties in language production and communication (Barnett & Mundt, 1992; Ettinger et al., 2014; Gold, Queern, Iannone & Buchanan, 1999) and deficits in a series of associative learning tasks – such as blocking, negative priming and prepulse inhibition (Gold et al., 2008; Hemsley, 1996; Jones, Hemsley & Gray, 1992b; Waltz, Frank & Robinson, 2008). Abnormal latent inhibition, a phenomenon that reflects learning-driven changes in attention, is consistently reported to be diminished in patients with schizophrenia, to such an extent that it has been proposed that it may be used as a diagnostic tool for schizophrenia (Baruch et al., 1998a; Hall & Honey, 1989; Hemsley, 1996; Lubow & Moore, 1959; Williams et al., 1998).

1.1 Latent Inhibition and Schizophrenia

A typical latent inhibition (LI) task begins with the pre-exposure phase where a stimulus is repeatedly presented on its own, followed by a test phase in which the same stimulus now predicts an outcome. Healthy individuals show reduced learning about the pre-exposed (PE) stimulus, compared to a novel, non-pre-exposed (NPE) stimulus. That is, they typically learn to a

lesser extent that the PE stimulus signals the outcome compared to the NPE stimulus (Lubow & Moore, 1959; Lubow, 2012). The task provides an index of whether individuals can successfully ignore irrelevant, non-predictive stimuli, as this effect is thought to be due to a down-regulation of attention to the PE stimulus during the pre-exposure phase, which might then slow down subsequent learning (Gray & Snowdon, 2005; Lubow, 2012). The LI effect has been argued to be an adaptive advantage – ignoring irrelevant stimuli allows for more focus on other important information in the environment (Lubow & De la Casa, 2002; Lubow, 2012). It is important to note that abnormalities in LI may actually indicate enhancements in learning as it reflects a greater propensity to process more information (Gray & Snowdon, 2003).

Although there are strong associations between individuals with schizophrenia and abnormalities in LI, there are numerous confounds that complicate this relationship. A common finding is that although LI deficits are expressed in patients with acute schizophrenia, these abnormalities do not appear in chronic patients (Baruch et al., 1998a; Hemsley, 1996; Lubow, 2012). A possible explanation for these contradictory results could be ascribed to the confounds of medication. Numerous studies provide evidence for the role of the dopaminergic system in the expression of LI (Baruch et al., 1998a; Hemsley, 1996; Lubow, 2012). Studies with healthy individuals and animals have demonstrated a reduction in LI following the administration of dopamine agonists, such as amphetamines, while subsequent administrations of dopamine antagonists or antipsychotics, such as haloperidol, can reverse these effects (Baurch et al., 1998a; Hemsley, 1996; Koychev, El-Deredy, Haenschel & Deakin, 2010; Williams et al., 1998). Individuals with schizophrenia are often treated with antipsychotic medication which may act as a significant confound in understanding this relationship. Additional confounds of repeated hospitalisation and reduced compliance with experimental procedure can further obscure the

study of LI within individuals with schizophrenia (Gray et al., 2002; Gray & Snowden, 2015; Koychev et al., 2010).

1.2 Schizotypy and Schizophrenia

Schizotypy is a personality construct that captures the subclinical levels of schizophrenic symptomology in the general population, including the positive, negative and disorganised facets, and it can offer an alternate avenue of study that circumvents many of the confounds that are present in studies on schizophrenia patients (Chun, Minor & Cohen, 2013; Ettinger et al., 2015; Koychev et al., 2010; Steffens et al., 2018). Degree of schizotypal personality is determined via psychometric self-reports that show high correlations with ratings from clinical interviews (Ettinger et al., 2014). There is a wide range of schizotypy scores in the population, which has led some researchers to propose a continuum between schizotypy and schizophrenia – individuals with higher scores of schizotypy have been shown to have an increased susceptibility to schizophrenia (Chun et al., 2013; Koychev et al., 2010; Nelson, Seal, Pantelis & Phillips, 2013; Nettle, 2006). Evidence for this continuum also comes from studies that report considerable overlap in genetic variation and brain structure for schizotypy and schizophrenia (Calkins, Curtis, Grove & Iacono, 2004; Van Os, Kenis & Rutten, 2010). It is important to note that high levels of schizotypy do not signify the eventual development of schizophrenia – rather, there appears to be many social and biological protective factors that have yet to be fully elucidated (Ettinger et al., 2015; Koychev et al., 2010; Lenzenweger, 2006; Meehl, 1989). What is apparent in individuals with high schizotypy, however, are changes in psychological and cognitive functioning. Similar to schizophrenia, high levels of schizotypy are also associated with a number of cognitive deficits including impairments in attention (De la Casa, Ruiz & Lubow, 1993; Ettinger et al., 2015; Gray et al., 1991), language and communication (Ettinger et

al., 2015; Lenzenweger, 2006; Morrison, Brown & Cohen, 2013) flexible adaptation (Volter et al., 2012) and visual processing (Koychev et al., 2010), although such deficits are much less severe compared to those observed in schizophrenia (Gray et al., 2002; Lenzenweger, 2006; Steffens et al., 2018).

Beyond sharing similar symptomology and cognitive deficits with schizophrenia, studying schizotypy also provides a number of additional benefits. Most evidently, there are no confounds of long-term medication or chronic hospitalisation as high schizotypal individuals are usually not diagnosed or treated for a disorder (Ettinger et al., 2015; Koychev et al, 2010). Consequently, participants with varying levels of schizotypal personality are readily accessible from the local community and can be reliably assessed using psychometric questionnaires (Davidson, Hoffman & Spaulding, 2016; Chmura Kraemer, Noda & O'Hara, 2004). Studies involving individuals with high schizotypy therefore have enhanced statistical power compared to experiments with small populations of non-medicated individuals with acute schizophrenia (Gray et al. 2002; Chmura Kraemer, Noda & O'Hara, 2004). Chapman and colleagues (1994) have further proposed that studying schizotypy within university students is of particular benefit as this is the peak age of schizophrenia onset and allows for a more refined exploration.

1.3 Schizotypy and Latent Inhibition

Similar to patients with schizophrenia, individuals with high levels of schizotypy also exhibit abnormal levels of latent inhibition, and these findings are not confounded by antipsychotic medication or repeated hospitalisation. Past studies, however, have found that the relationship between high levels of schizotypy and LI is considerably variable. A large proportion of the literature reports abnormal LI effects, whether that be reduced (Allan et al., 1995; Baruch, Hemsley & Gray, 1988b; Gray et al., 2003) or enhanced (De la Casa & Lubow,

2002; Evans, Gray & Snowden, 2007; Granger, Moran, Bucley & Haselgrove, 2016) LI effects, while others report no association between schizotypy and LI (Claridge & Broks, 1984; Lipp, Siddle & Arnold, 1994). Furthermore, there is considerable variation regarding whether LI abnormalities are related to any specific schizotypal symptomology – some studies report a greater association with positive symptoms (Allan et al., 1995; Gray et al., 2002, Gray & Snowden, 2005), while others report an association with negative symptoms (Barnett & Mundt, 1996; Gal et al., 2009; O'Leary et al., 2000). Despite these contrasts, it is important to note that facets of schizotypy exhibit covariation – the positive symptoms of schizotypy are not strictly independent from the negative symptoms (Linscott, 2013; Shira & Tsakanikos, 2009)

The relationship between schizotypal personality and LI appears somewhat complex and this is of considerable theoretical concern, as it limits its usefulness for understanding cognitive dysfunction in schizophrenia. In order to better understand these variable findings, it is important to examine previous experimental designs and explore the underlying theories of LI.

1.3.1 Past experimental designs of schizotypy and latent inhibition

Despite larger sample sizes, previous studies of schizotypy and LI have a number of drawbacks that severely limit their statistical power. One prominent concern is the allocation of individuals to categorical measures of schizotypy – namely, either high or low schizotypy groups based on various schizotypy questionnaires. Although there have been some methodological differences in determining the cut-off point between these groups, such as referencing past findings or proposed norms (Chun, Minor & Cohen, 2013; Koychev et al., 2010), a large proportion of past studies have employed a median split analysis (De la Casa, Ruiz & Lubow, 1993; Gray et al. 2002; Lubow & De la Casa, 2002; Williams et al., 1998). These methods of categorical allocation have been critiqued for their severe restrictions on statistical power, as well

as how they may produce contradictory findings by merely shifting the cut-off point away from the median (Chmura Kraemer, Noda & O'Hara, 2004; Cohen, 1983; MacCallum, Zhang, Preacher & Rucker, 2002; Veiel, 1998). In contrast, studies employing continuous classifications of schizotypy are often ideal for hypothesis testing as they provide a greater specificity in scoring, whilst also enhancing statistical power (Chmura Kraemer et al., 2004; Cohen, 1983).

In a related sense, there have also been concerns regarding the scoring of LI and the strengths of capturing continuous data. Previous studies have compared the number of correct responses for PE and NPE cues as a measure of LI (De la Casa, Ruiz & Lubow, 1993; Gray et al., 2002; Gray & Snowden, 2003; Williams et al., 1998). Eventually, measuring reaction time (RT) was introduced as an alternative proxy, with larger differences in RT representing a greater magnitude of LI. Although both methods have been validated as measures of LI, the use of RT offers a number of benefits; namely it is a more sensitive measure of learning that can detect subtle differences, particularly if the learning tasks are demanding (Evans et al., 2007; Lubow & De la Casa, 2002).

1.3.1.1 The new within-subject latent inhibition design

The enhanced specificity afforded by RT has led to the development of a robust within-subject design that enables the study of LI magnitude based on individual differences in schizotypal personality (De la Casa & Lubow, 2001; Granger et al., 2016; Lubow & De la Casa, 2002). This design is described in Granger et al. (2016), who used a variation of Evans et al.'s (2007) design. In the pre-exposure phase, all participants are asked to repeat a series of letters as they appear on a computer screen, one of which is a PE cue that will later be used in the test phase. During the test phase, participants are asked to respond to the appearance of a target stimulus by pressing the spacebar on their keyboard – prior to starting the test phase however,

participants are also informed to look for any cues that they believe may predict the target stimulus (Evans et al., 2007; Granger et al. 2012; Granger et al., 2016; Schmidt-Hansen et al., 2009). The target stimulus in the test phase is always preceded by a predictive cue from the pre-exposure phase, or by a novel, non-pre-exposed cue – scores for LI are derived by comparing RT to the target cue when it is preceded by a PE cue versus when it is preceded by a NPE cue.

It is important to note that although this within-subject design captures subtle differences in LI, there still appears to be substantial variation in findings. Evans et al. (2007) and Granger et al. (2012) found positive symptoms of schizotypy to be associated with faster learning about PE stimuli (i.e. reduced LI effect), while Schmidt-Hansen et al. (2009) only found a relation between positive symptoms and faster learning about PE stimuli when the pre-exposure phase was short. Conversely, Granger et al (2016) found that positive symptoms of schizotypy are associated with slower learning about PE stimuli, indicating enhanced LI. It is concerning that even within a new and robust measure of within-subject LI, there appears to be considerable variation in results.

One potential drawback of this new LI design is that the participants are instructed to look for potentially predictive cues within the test phase. Participants are encouraged to respond faster, often prematurely, to stimuli that they suspect to predict the target stimulus – responses that correctly anticipate the occurrence of the target stimuli, while the predictive stimuli are still displayed, are regarded as correct responses and provide an additional indicator of learning (Evans et al., 2007; Granger et al., 2016). The instructions to predict the target stimulus appear to be preserved from past studies that have used correct responses as proxies for learning, and as such their inclusion is non-essential when using a reaction time measure as learning is instead inferred from the time taken for participants to respond. In addition to this however, instructions to be weary of potential predictors may lead to participants observing effects that they otherwise

would not have recognised. Consequently, the observed effects from these studies may not solely constitute LI, in which attenuated learning is due only to pre-exposure. Instructing participants to look for predictive cues introduces additional confounds – studies have suggested that performance from high schizotypal individuals can be influenced by providing explicit instructions (Partos, Cropper & Rawlings, 2016; Polner, Simor & Kéri, 2018). Informing participants with high schizotypy to look for predictive cues may be inflating the observed differences between the PE and NPE stimuli and thus may not strictly be capturing a LI effect. By omitting these instructions, any effects observed are more likely attributed to non-conscious learning processes and are less likely due to any instructional confounds. Our first aim was therefore to study the relationship between schizotypy and LI using an adaptation of Granger et al.'s (2016) design but omitting the potentially confounding instructions.

1.3.2 Theories of latent inhibition

In returning to a previous point, to better understand the variability in results between LI and schizotypy, it is important to clarify the mechanisms that may be involved in LI as this may provide indications regarding the origins of the deficits within high schizotypy.

The most prominent explanation for LI involves a reduction in attention to the PE stimulus (Lubow, 1993; Mackintosh, 1975). Healthy participants might down-regulate their attention to the PE stimulus during the pre-exposure phase as it does not appear to be predictive of any outcome. This downregulation in attention leads to slower learning about the PE stimulus in the test phase – comparatively, attention to the novel, NPE cue is unaffected and participants are able to quickly learn its association with the outcome (Gray, 2002; Lubow, 2012). Abnormal LI in high schizotypal individuals may be therefore attributed to attention deficits – findings have

suggested that individuals with high schizotypy continue to attend to PE stimuli following the pre-exposure phase resulting in faster learning (De la Casa & Lubow, 2001; Gray & Snowden, 2005; Lubow, 2012).

Alternately, other proponents explain the attenuated LI effect in high schizotypal individuals in regard to hyperactive switching, a process in which there is an enhanced tendency to respond based on the directly available information (Hemsley, 1993; Salzinger, 1983; Weiner, 1990). Healthy participants learn that PE stimuli are associated with no outcome in the pre-exposure phase and this is retained in the test phase, resulting in a large LI effect (Hemsley, 1993; Gray & Snowden, 2005). Conversely, schizotypal individuals are argued to more readily respond based on immediately available factors, irrespective of past context, and as a result they attend to stimuli that has previously been established as irrelevant (Salizinger, 1983; Weiner, 1990). Highly schizotypal individuals, therefore, inhibit the information learned about in the pre-exposure phase and respond only to the available information in the test phase – this leads to equal learning about the PE and NPE stimuli, and hence a reduced LI effect (Gray & Snowden, 2005; Weiner, 2003).

Although it is currently unclear what processes are involved in LI, attentional and switching theories of LI are both commonly underlined by processes involving inhibition (Gray & Snowden., 2005). High schizotypal individuals may be suggested as having inhibitory deficits, whether that be insufficiencies in inhibiting attention, or inhibiting information previously learnt, particularly in regard to less salient associations. From a general standpoint, inhibition is understood as the ability to deliberately resist interference or override internal predispositions in order to do what is more appropriate – more general inhibition deficits therefore may underlie reduced LI and high schizotypy (Diamond; 2013; Gray & Snowden, 2005; Steffens et al. 2018).

1.3.2.1 Inhibition and executive function

Inhibition as a general construct is one of the three core facets of executive functioning – the others include working memory (WM), the ability to maintain information in mind after such information can no longer be perceived, whilst simultaneously performing complex tasks (Baddeley, 2010; Barouillet, Bernadin & Camos, 2004; Sasaki, 2009), and cognitive flexibility, the ability to switch between different perspectives and to perceive information in a way that has not previously been considered (Diamond, 2013; Steffans et al., 2018). These three core executive functions are intricately related and provide the basis for higher-order executive functions such as reasoning, problem-solving and planning (Collin et al., 2014; Diamond, 2013; Goldberg, 2001).

Of particular interest is the interrelated nature of inhibition and WM – in the past, some have even proposed that these facets actually represent one factor (Hasher & Zacks, 1988; Miyake et al., 2000; Miyake & Friedman, 2012), although they are still commonly reported as separate facets (Baddeley, 2010; Diamond, 2013; Engle & Kane, 2004). WM is integral in comprehending information that unfolds over time as it allows relationships to form between past events and current experiences (Baddeley, 2010; Diamond, 2013). The formation of associations in WM is significantly influenced by what information is, and what information is not, inhibited. A greater level of inhibitory control can prevent the WM workspace from getting cluttered with extraneous thoughts and irrelevant information – and this is particularly important considering the limited capacity of WM (Baddeley, 2010; Baruch et al., 1998a; Diamond, 2013). The relationship between inhibition and WM is further strengthened by findings that show how improvements in inhibitory control can lead to improvements in WM (Awh, Vogel & Oh., 2006; Chun, 2011; Gazzaley & Nobre, 2011).

The intertwined nature of executive functions would propose that deficits in one area are likely to have subsequent impacts on other areas – this is an important consideration that directly applies to the relationship between schizotypy and LI (Ettinger et al., 2015; Park & Mctigue, 1997). Previous studies of schizotypy and LI have not considered the potential mediating factors of other executive functions, particularly WM. A study by Collins et al. (2014) has emphasised the role of WM in the formation of associations for individuals with schizophrenia. Through the use of computational modelling, the study claims that associative learning deficits in schizophrenia are strongly related to impairments in WM capacity and WM decay. Although such results highlight the importance of considering the mediation role of WM, the study estimated WM capacity based on computational modelling of performance in a learning task, rather than measuring it directly. It is therefore important to explore the role of WM as a mediator between schizotypy and LI whilst using independent measures of WM – so far, this area of research has received minimal focus and has never been tested using a LI design.

1.4 The Current Study

This study investigates the role of WM as a potential mediator between high schizotypy and abnormal LI using a variation of a newly developed within-subjects design.

Examination of past literature reveals significant variation in the findings between schizotypy and LI which led to the refinement of more precise measures. The new method of measuring within-subjects LI using RT has been implemented in very few studies, but even still there is substantial variation in results. The first aim of this study is to replicate, and improve upon, this within-subjects LI design – specifically by removing the confounds of alerting participants to potentially predictive cues during the test phase. The second aim of this study is to

examine the relationship between WM in LI given the interconnected nature of executive functions.

CHAPTER 2: METHOD

2.1 Participants

A total of $N = 64$ participants (58% female) took part in the experiment, ranging from 18 to 52 years of age ($M = 24.0$, SD = 7.6). Two participants were excluded from the sample due to incomplete data. The sample was made of up first-year psychology students, who received course credit for their participation ($n = 22$), and volunteers recruited from personal contacts of the researchers ($n = 42$). The project was approved by the University of Adelaide Human Research Ethics Committee.

The following criteria was required for eligibility for participation in the experiment: aged 18-60 years; not suffering from a neurological disorder; not suffering from a drug or alcohol dependency, either current or previous; not smoking more than 5 cigarettes per day; not using medication that affects neurological function (e.g. antidepressants, sedatives, antipsychotics; see Appendix A).

2.2 Materials

2.2.1 Latent inhibition task. Participants were asked to complete a task similar to the one presented by Granger et al. (2016), which was a variation on the Evans et al. (2007) study. The task was composed of two phases: the pre-exposure phase and the test phase. Both phases involved a sequence of letters appearing on the screen for 1000ms with a 50ms inter-stimulus interval (ISI) between each letter. Each phase required the participants to respond to the letters in a different way as explained in more detail below. The letters were presented in the centre of the screen in white text, size 12 Arial font, against a black background.

Table 1 provides a summary of the LI task design separated into the two phases. The latent inhibition task took approximately 16 minutes to complete.

Table 1

Summary of Latent Inhibition Task Design

Pre-exposure phase	Test phase	
Pre-exposed cue	*Pre-exposed cue*	
M (25)	M -> X (30)	
	Non-pre-exposed cue	
	E -> X (30)	
	Control cues	
	O -> X (4)	O (24)
	I - > X (4)	I (24)
	J -> X (4)	J (24)
	L -> X (4)	L (24)
	N -> X (4)	N (24)
Filler letters	*Filler letters*	
S (25)	S (30)	
T (15)	P (30)	
A (15)	T (24)	
U (15)	A (24)	
Q (15)	U (24)	
H (15)	Q (24)	
	H (24)	
	Y (24)	
	G (24)	
	F (24)	
	V (24)	
	D (24)	
	R (24)	
	B (24)	
	W (24)	
	C (24)	
	K (24)	

Note. The letters denoting the predictive cues were randomly assigned to each participant from the pool of M, E, S or P. Some filler letters appeared the same number of times as the predictive cues in both the pre-exposure and test phase so that the PE and NPE letters were not the only most frequently presented letters. *X* was used as the target stimulus for all participants in the test phase. The number in brackets refers to the number of times the letters appeared in the sequence. A LI effect occurs if responses to the target letter X are faster when it is preceded by the NPE cue than when it is preceded by the PE cue.

2.2.1.1 Pre-exposure phase. Participants completed a masking task in which they were instructed to mouth all the letters that appeared on screen. Participants were presented with the following instructions:

> *"In this task, you'll see a sequence of letters appearing on the screen. Your task is to say each letter under your breath. The task will last about three minutes. When it ends, you'll be given a new set of instructions. Click the 'Begin' button when you're ready to start"*

The inclusion of the masking task is important as it diverts attention from the pre-exposed stimulus which would promote subsequent LI effects (Lubow & De La Casa, 2002).

The sequence in the pre-exposure phase consisted of seven distinct letters: one would act as pre-exposed cue in the test phase, while the remaining letters were filler letters. The pre-exposed cue was presented 25 times, intermixed with filler letters (Table 1). All participants observed the same fixed pseudo-random order sequence in the pre-exposure phase (Figure 1). The pre-exposure phase lasted approximately 3 minutes. Participants were immediately directed to the test phase following completion.

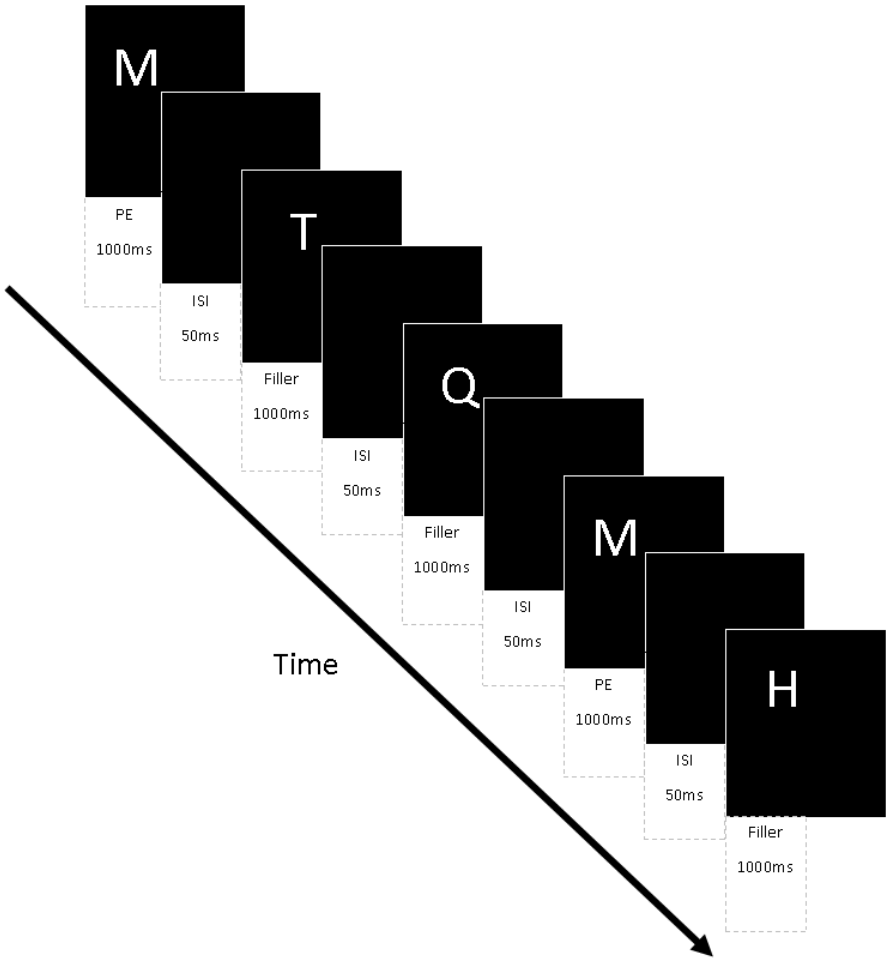

Figure 1: A partial example of the pre-exposure sequence. Each stimulus was presented for 1000ms followed by a 50ms inter-stimulus interval (ISI). Participants were asked to mouth each of the letters as they appeared on screen. The pre-exposed (PE) cue was relevant to the test phase.

2.2.1.2 Test phase. In the test phase, participants were asked to respond as quickly as possible to the target letter *X* by clicking on a red button on screen using the computer mouse. Participants were presented with the following instructions:

> *"Perfect! This time, you'll see another sequence of letters appearing on the screen. Your task is to respond to the X. When you see the X, you'll need to press the red button as quickly as possible. Please try to be as accurate as you can, but don't worry too much if you make the occasional error."*

It is important to highlight that in contrast to past designs, this study does not inform participants to anticipate the target letter X – effects can therefore be reliably attributed to LI whilst avoiding potential instructional confounds that suggest that X can be anticipated.

The sequence in the pre-exposure phase consisted of 24 distinct letters (Table 1). Two of these letters were cues that would always predict the X; one had been PE while the other was a novel, NPE cue. Each cue was presented 30 times and would predict the X immediately after – the RT relative to the onset of the X were recorded.

There were also five control cues that would only occasionally predict the X. Each control cue appeared a total of 24 times, but would only be followed immediately by the X on four instances (Table 1). RT to the X when it was preceded by control cues were used to determine the participants' baseline speed of responding when they could not anticipate the letter X.

Finally, there were also 17 filler letters that did not predict the X. Similar to the pre-exposure phase, all participants observed the same fixed pseudo-random order sequence in the test phase (Figure 2). The test phase lasted for approximately 13-minutes.

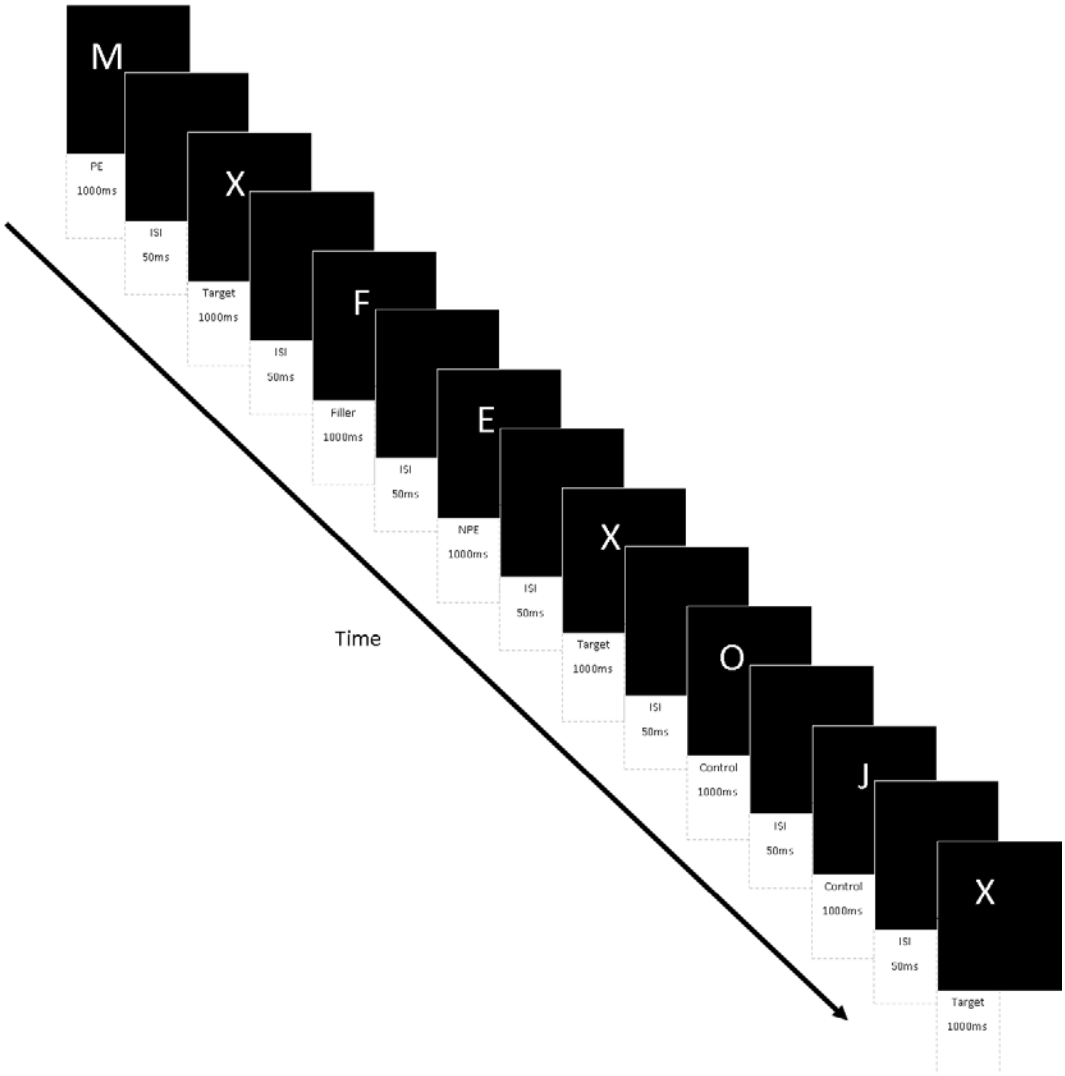

Figure 2: An example of the test sequence. Each stimulus was presented for 1000ms followed by a 50ms inter-stimulus interval (ISI). Participants were asked to quickly respond to the appearance of the X on the screen. Reaction times in response to the X were recorded from the onset of the X. PE = pre-exposed cue. NPE = non-pre-exposed cue.

***2.2.1.3 Data scoring*.** RT was used as a measure of learning performance as it reflects the amount of time taken for the participants to respond following the appearance of the X, which could be predicted when the PE and NPE cues preceded it. In regard to the control cue reaction times, these scores indicate the participant's ability to respond to the X when it is not well predicted by the preceding cue. These scores reflect the participant's baseline level of performance (i.e. how fast they can react to an unpredictable X) that can be compared to RT to X

when it is predictable (i.e. when it is preceded by a PE or NPE cue). Therefore, we assessed the amount of learning in each condition by subtracting each participant's RT to X when it was preceded by a PE or NPE cue from their RT to X when it was preceded by a control cue:

NPE learning score = Control RT – NPE RT

PE learning score = Control RT – PE RT

At the end of the latent inhibition task, participants completed two additional learning tasks, unrelated to the current study, before completing two measures of working memory capacity.

2.2.2 Measures of working memory capacity. WM capacity was measured using a complex span task and a verbal n-back task.

2.2.2.1 Dot-matrix. The dot-matrix is a complex span task that measures visuospatial WM capacity. The task was first introduced by Law, Morrin & Pellegrino (1995), but was revised by Miyake, Friedman, Rettinger, Shah and Hetagry (2001). The objective of the task is to memorise and recall the locations of various dots presented on a 5x5 grid, whilst simultaneously completing various matrix equations (Figure 3).

Participants are initially given 4000ms to verify a matrix equation as being either "TRUE" or "FALSE." An on-screen warning appears if they do not respond in this time. If participants respond incorrectly, they are shown an error message and are given the opportunity to try again. Following the correct verification, participants are presented with a 5x5grid for 1500ms with one of the squares containing a blue dot – this is then followed by another matrix equation. After the presentation of all the dots, and the simultaneous completion of the matrix equations, participants are presented with a blank 5x5 grid and are asked to indicate the locations

of the previously presented dots in any order. Participants are able to select fewer dots than were presented, but not more, using the computer mouse. Recall of the dots is not restricted by any time limit.

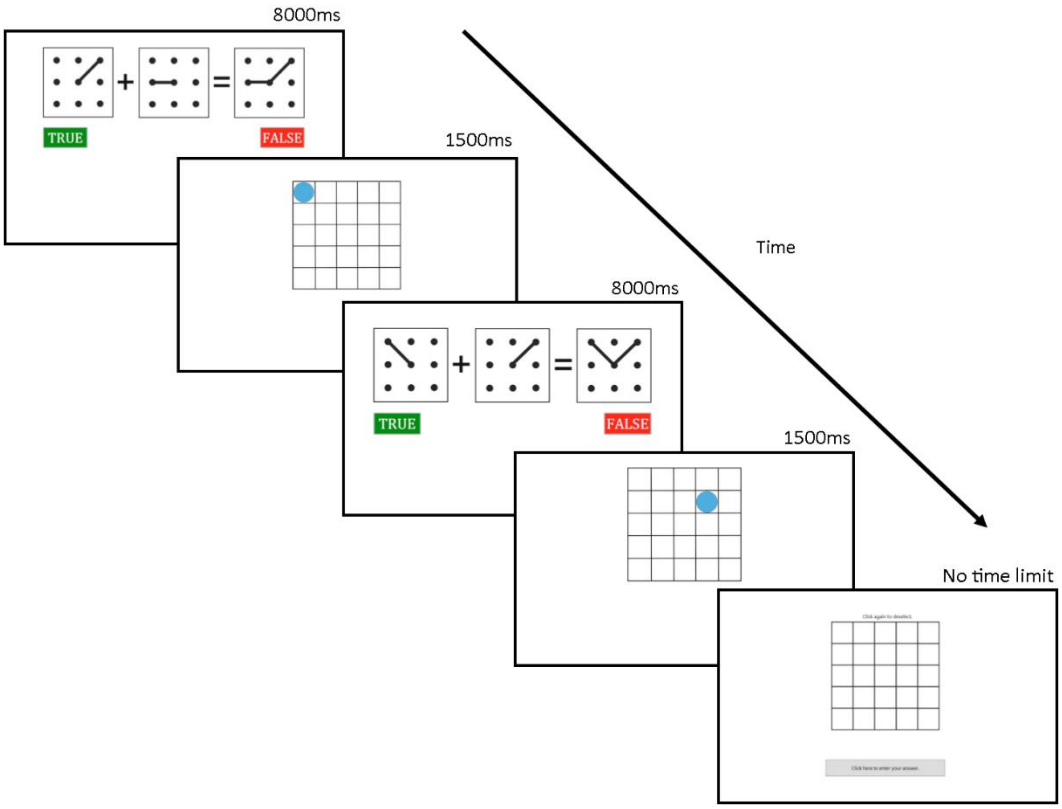

Figure 3: A practice trial example from the dot-matrix task at load-level 2. Participants alternate between verifying simple matrix equations and remembering the locations of various dots on a 5x5 grid. Following presentation of all the dots, the participants use the mouse to select the locations of the previously observed dots.

There are 4 load-levels that reflect the number of dots that need to be memorised, ranging from two dots to five dots. There are 4 questions at each load-level, equating to a total of 16 items. The number of dot locations correctly recalled and selected is recorded, with a total of 56 potential correct answers. The task takes approximately 9-minutes to complete and is reported as having high internal reliability (Cronbach's $\alpha = .79$; Miyake et al., 2001).

2.2.2.2 Verbal n-back. The verbal 1-back was utilised by Wilhelm, Hidebrant and Oberauer (2013) as an assessment of the recall component of WM. The objective of the task is to recall the letters presented in empty boxes that are continuously being updated (Figure 4).

Initially a number of empty boxes, ranging from one to three depending on load-level, are shown on screen for 2000ms. A lowercase letter then appears in each of the boxes for either 2500ms (load-level 1), 3000ms (load-level 2) or 3500ms (load-level 3) followed by a 1000ms ISI in which the boxes appear empty. Next, a new letter appears in one of the boxes with the duration of appearance depending on the load-level. Participants are asked to recall the letter that had previously appeared in that box by selecting the appropriate letter on the keyboard. Responses need to be completed whilst the new letter remains on the screen, otherwise this is recorded as an error. Following an input from the participant, each of the boxes continually update with a new letter, separated by an ISI.

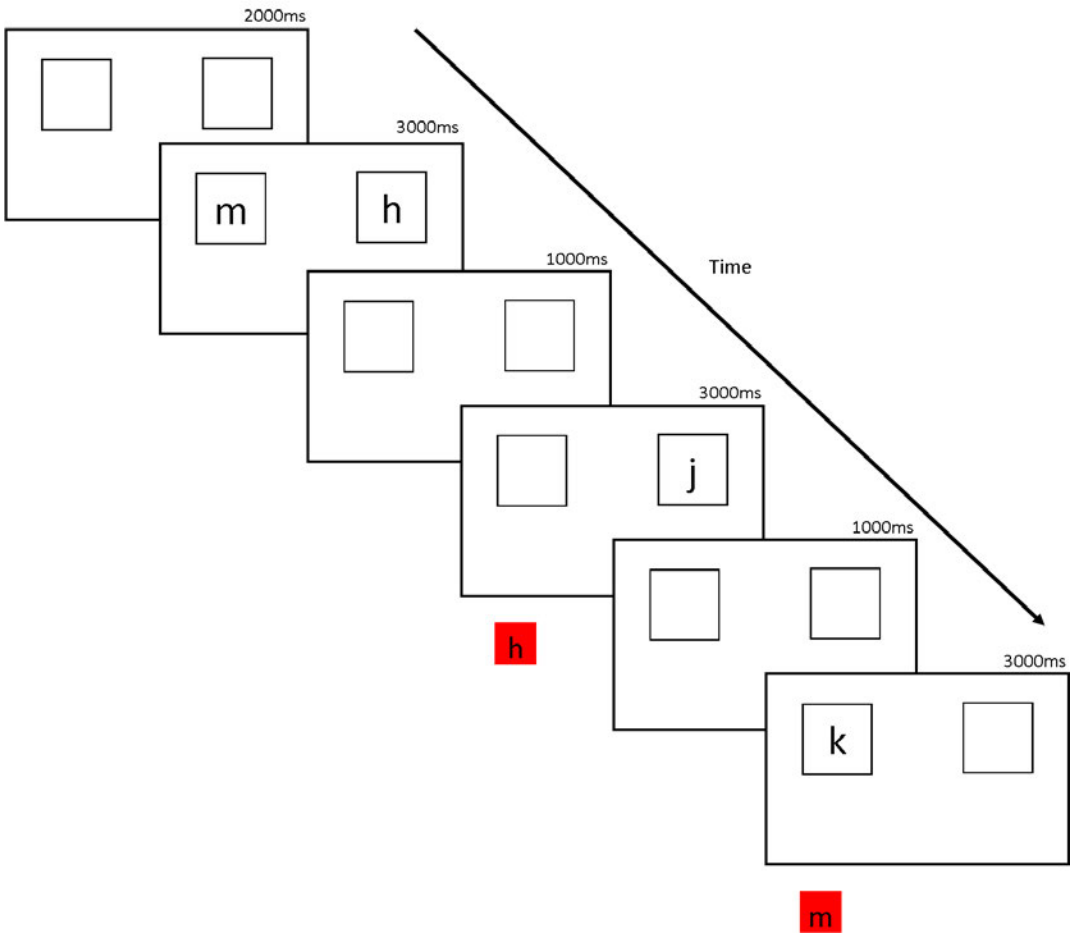

Figure 4: A practice trial example from the verbal 1-back at load-level 2. Participants are presented with two boxes that show a series of single lowercase letters one at a time. Participants press the key on the keyboard that corresponds to the letter that appeared in the box in the prior presentation. The red boxes represent the correct response at each stage. Note that the duration of the letters varies between the load levels, however the 1000ms inter-stimulus interval remains constant.

There is a total of 12 trials in total: two load-level 1, five load-level 2, and five load-level 3. All participants completed the same pseudo-random order across all load-levels. Prior to commencing the task, participants completed 3 practice trials, one at each of the load-levels. The proportion of correct responses was recorded. The task takes approximately 10-minutes to complete and is reported as having high internal reliability (Cronbach's $\alpha = .94$; Wilhelm et al., 2013)

Following the completion of the two WM tasks, participants were directed to two sets of personality questionnaires. Only the Schizotypal Personality Questionnaire - Brief Revised (Updated) was relevant to the current study.

2.2.3 Schizotypal Personality Questionnaire - Brief Revised (Updated)

Levels of schizotypal personality were assessed using the Schizotypal Personality Questionnaire – Brief Revised (Updated) (SPQ-BRU; Davidson et al., 2016). The SPQ-BRU consists of 32 items and assesses three-factors underlying schizotypal personality. The cognitive-perceptual factor measures unusual perceptions and magical thinking which is thought to reflect the positive symptomology (e.g. "I believe in telepathy (mind-reading)."). The interpersonal factor measures social anxiety and constricted affect which is thought to reflect the negative symptomology (e.g. "I find it hard to be emotionally close to other people."). Finally, the disorganised factor measures eccentric behaviour and odd speech and is thought to reflect the disruptions in attention and concentration (e.g. "I am an odd and unusual person."). Participants provide self-reported responses to a series of statements on a 5-point Likert scale ranging from 'Strongly Disagree' to 'Strongly Agree.' SPQ-BRU scores were calculated at the overall level, as well as at the levels of the three-factors, with higher scores indicating higher levels of schizotypal personality traits. Davidson et al. (2016) reports that the SPQ-BRU demonstrates high reliability, as well as convergent and discriminant validity.

There is currently minimal data surrounding the reliability of the SPQ-BRU given that it has only recently been developed. Previous revisions, such as the Schizotypal Personality Questionnaire-Brief Revised (SPQ-BR; Cohen et al., 2010), report high levels of internal reliability (Cronbach's $\alpha = .96$; Chan et al., 2015). Since the SPQ-BRU involves only minor

changes to wording, it is likely that it would have comparable levels of reliability as previous iterations.

2.3 Procedure.

Participants were first given a short debrief of the experiment before providing informed consent (Appendix B). This study was part of a collaboration with two other projects, consisting of three associative learning tasks, two working memory tasks and two personality questionnaires. Only the LI task, the WM tasks and the SPQ-BRU were relevant for the purposes of this study. The experiment was programmed on Xojo software (Xojo Inc., Austin, Texas) and was completed on a 21-inch Apple iMac computer with an HP corded mouse and keyboard. The experiment was completed in a single session lasting approximately 1.5 hours. Progress through each task was self-directed, and so any breaks in between tasks was at the discretion of the participant.

CHAPTER 3: RESULTS

3.1 Latent Inhibition

Table 2 presents the descriptive statistics for age, learning scores, working memory tasks and the schizotypy questionnaire.

Figure 5 shows that group level mean reaction time scores are larger for the NPE condition than for the PE condition, indicating more learning about NPE cues. A paired samples t-test comparing NPE learning to PE learning, revealed a significant difference (t (61) = 2.38, p = 0.02) – this represents a LI effect at the group level.

Table 2

Descriptive Statistics for Latent Inhibition Scores, Working Memory Tasks and Schizotypal Personality Questionnaire

Variable	M (SD)	Min	Max	Skew	Kurtosis
Age (years)	24.0 (7.6)	18.0	51.0	0.05	-1.24
PE Learning (ms)	31.0 (48.0)	-69.2	147.9	0.61	-0.22
NPE Learning (ms)	43.0 (51.4)	-78.1	186.8	0.38	0.61
Dot-Matrix	38.0 (9.5)	17.0	56.0	-0.19	-0.86
Verbal *n*-back	0.64 (0.24)	0.00	0.98	-0.99	-0.10
SPQ-BRU	88.0 (18.3)	53.0	129.0	0.10	-0.26

Note: PE = pre-exposed, NPE = non-pre-exposed, SPQ-BRU = Schizotypal Personality Questionnaire – Brief Revised (Updated). The Dot-Matrix is scored out of a total of 56. The Verbal *n*-back is scored as a proportion of correct responses. PE learning and NPE learning are calculated based on mean reaction times in the last third of the experiment (for analysis that considers average reaction times for the overall experiment, see Appendix C)

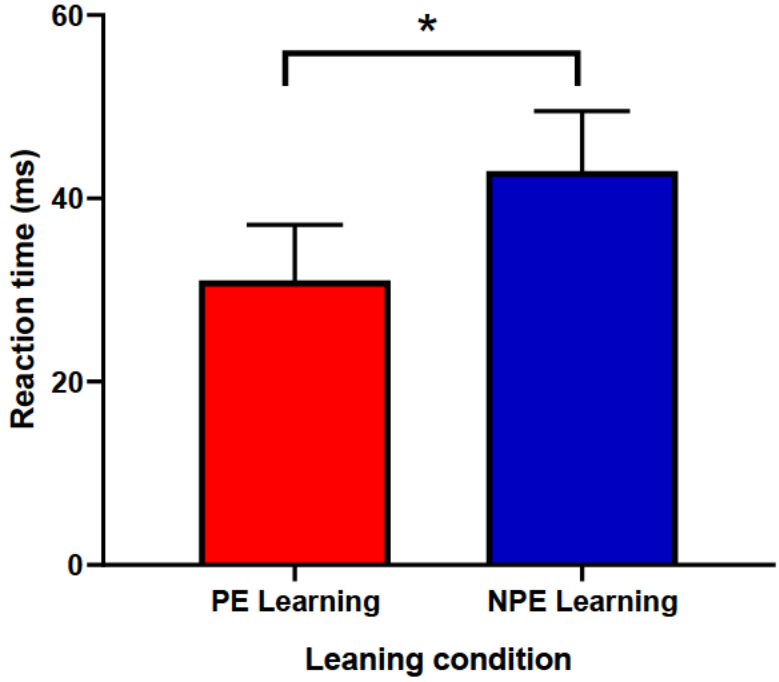

Figure 5: The mean reaction time difference scores for the pre-exposed and non-pre-exposed cues. Error bars represent the standard error of the mean.

3.2 Principal Component Analysis for Working Memory

Previous studies suggest that the dot-matrix and the verbal *n*-back capture the same underlying concept of WM (Schmiedek et al., 2009; Shelton, Metzger & Elliot, 2007; although see Appendix D for further analysis). Given this presumed underlying relationship, a principal component analysis (PCA; Jolife, 2002) was conducted to derive a single estimate of WM from these two tasks. The PCA solution for the first unrotated component indicates that the component has an eigen value of 1.18 and accounted for 59% of the total variance – each working memory measure had a loading of .77. The scores derived from the PCA were used as a measure of WM, hereafter referred to as WM scores.

3.3 Latent Inhibition, Schizotypy and Working Memory

We performed multiple regression analyses to predict two facets of the SPQ-BRU. Table 3 shows the results of the regression models for the cognitive-perceptual facet that is thought to reflect positive symptomology (SPQ+), and Table 4 shows the results of the regression models for the interpersonal facet that is thought to reflect negative symptomology (SPQ-). In both regression analyses, model 1 includes only age and gender as predictor variables and provides a baseline model of comparison, model 2 includes PE learning and NPE learning as additional predictors, and finally model 3 also includes WM to determine whether it has any mediating effects (for analysis that examines LI scores, rather than PE learning and NPE learning, see Appendix E)

The analysis of the SPQ+ scores revealed that model 1 was statistically significant (F (2, 59) = 3.66, p = .03) and captured 11.0% of the variance. Model 2 was also statistically significant (F (5, 56) = 4.08, p = .003) but captured 26.7% of the variance – this was a significant improvement relative to model 1 (F (2,57) = 6.06, p = .004). This indicates that including the learning scores significantly improve the amount of explained variance in SPQ+ scores. Adding the WM predictor in model 3, however, did not significantly increase the amount of variance explained (F (1, 56) = 0.067, p = .797).

The analysis of the SPQ- scores revealed that model 1 was statistically significant (F (2, 59) = 5.48, p = .007) and captured 15.7% of the variance. Model 2 was also statistically significant (F (5, 56) = 4.515, p = .001) but captured 28.7% of the variance – this was a significant improvement relative to model 1 (F (2, 57) = 3.28, p = .0448). This indicates that adding the learning scores significantly improved the amount of explained variance in SPQ-

scores. Adding the WM predictor in model 3, however, did not significantly increase the amount of variance explained (F (1,56) = 3.43, p = .0692).

WM was not a significant predictor of positive schizotypy (B = -0.291, p = .797), although it was a marginal, non-significant predictor of negative schizotypy (B = 1.868, p = .069). These results suggest that there are no mediating effects of WM for positive schizotypy, although it appears that higher WM scores are somewhat predictive of higher negative schizotypy (see Appendix D for analyses that consider the two WM measures separately, but note that the results are similar to those reported here).

Results from these regression models are summarised using a relative importance regression analysis that regressed positive and negative schizotypy on age, gender, PE learning, NPE learning and WM. Figure 6 provides a visual representation of the relative contributions of each predictor variable to the overall variance captured by the regression model. The figure emphasises the role of PE learning in predicting positive symptoms as it accounted for 45.5% of the explained variance. Similarly, PE learning is emphasised as a predictor in regard to negative symptoms, accounting for 33.2% of the explained variance.

Table 3

Regression Models Predicting Positive Schizotypy

	R^2	*F*	*p*	B	SE B	*p*
Model 1	0.110	3.66 (2,59)	.033			
Intercept				43.96	3.714	< .001
Age				**-0.390**	**0.145**	**.009**
Gender (male)				-0.191	2.22	.931
Model 2	0.266	5.14 (4,57)	.001			
Intercept				40.65	3.748	< .001
Age				**-0.336**	**0.137**	**.017**
Gender (male)				-0.555	2.051	.788
PE Learning				**0.079**	**0.029**	**.008**
NPE Learning				-0.007	0.027	.801
Model 3	0.267	4.08 (5, 56)	.003			
Intercept				40.80	3.827	< .001
Age				**-0.345**	**0.142**	**.019**
Gender (male)				-0.384	2.171	.860
PE Learning				**0.077**	**0.030**	**.012**
NPE Learning				-0.006	0.027	.824
WM scores				-0.291	1.124	.797

Note. PE = pre-exposed, NPE = non-pre-exposed, WM = working memory.

Table 4

Regression Models Predicting Negative Schizotypy

	R^2	*F*	*p*	B	SE B	*p*
Model 1	0.157	5.48 (2, 59)	.007			
Intercept				35.57	3.289	< .001
Age				**-0.382**	**0.128**	**.004**
Gender (male)				3.223	1.962	.106
Model 2	0.244	4.59 (4, 57)	.003			
Intercept				33.61	3.460	< .001
Age				**-0.351**	**0.126**	**.007**
Gender (male)				2.973	1.893	.123
PE Learning				**0.058**	**0.027**	**.035**
NPE Learning				-0.011	0.026	.656
Model 3	0.287	4.52 (5, 56)	.002			
Intercept				32.61	3.431	< .001
Age				**-0.294**	**0.127**	**.025**
Gender (male)				1.873	1.947	.339
PE Learning				**0.068**	**0.027**	**.014**
NPE Learning				-0.016	0.025	.528
WM scores				1.868	1.008	.069

Note. PE = pre-exposed, NPE = non-pre-exposed, WM = working memory.

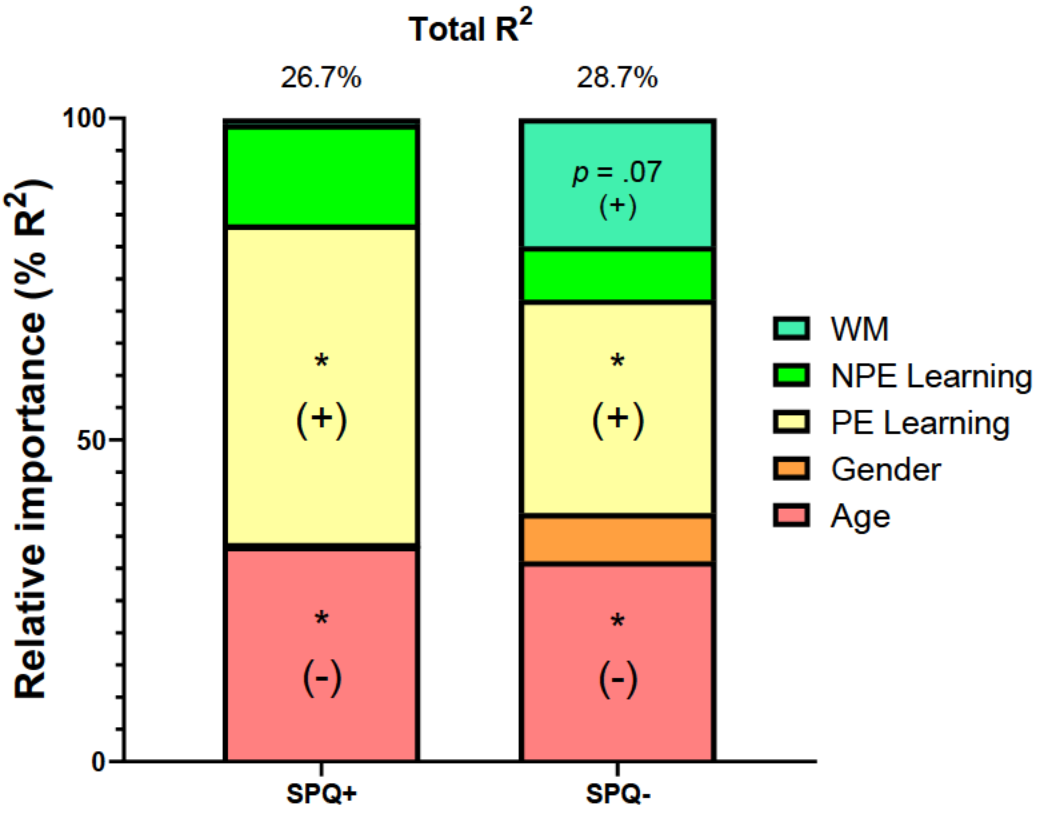

Figure 6: The relative importance of each predictor for models of positive and negative schizotypy. The total amount of variance explained by each regression model is displayed above each bar. * denotes significant regression coefficients. The direction of a relationship is indicated with either + for a positive relationship, or – for a negative relationship.

3.4 Schizotypal Symptoms and Latent Inhibition

Table 7 shows that PE learning scores is a significant predictor of SPQ+ scores (B = 0.077, p = .012), and likewise Table 4 indicates that it is also a significant predictor of SPQ- scores (B = 0.068, p = .014). Figure 6 confirms that PE learning is a large predictor of both SPQ+ and SPQ-.

A Pearson's correlation analysis was conducted as it has previously been suggested that positive and negative symptoms of schizotypy covary (Linscott, 2013; Shira & Tsakanikos, 2009). The results reveal a significant relationship (r = 0.523, p = < .0001) and provides further

evidence of covariation between schizotypal symptoms. Figure 7 illustrates the correlation between positive and negative schizotypy and confirms the positive association.

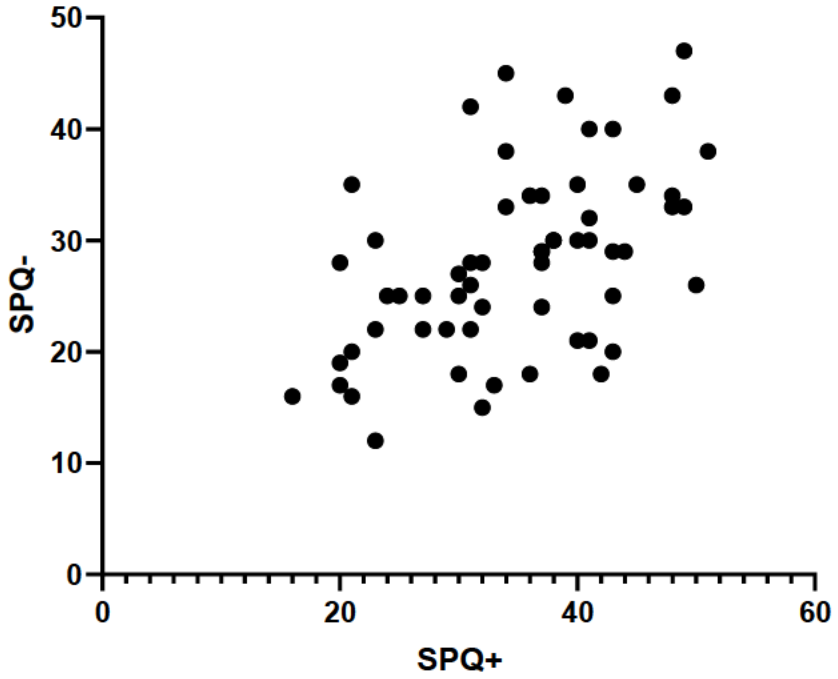

Figure 7: A plot between scores for positive and negative schizotypy

The relationship between one schizotypal symptom and PE learning may potentially be accounted for by the covariation with the other schizotypy dimension. In order to better understand the relationship between schizotypal symptoms and LI, a regression analysis was conducted predicting PE learning based on age, gender, SPQ+ and SPQ- scores (Table 5). This allowed us to test whether SPQ+ is associated with PE learning above and beyond its covariation with SPQ-, and vice versa. The model was statistically significant (F (4,57) = 3.72, p = .009) and captured 20.7% of the variance. The only significant predictor in the model was SPQ+ (B =

1.935, p = .013) – a relative importance regression analysis reveals that the positive symptoms account for 65.5% of the explained variance (Figure 8).

Because SPQ+ is a significant predictor of PE learning and accounts for a large proportion of the explained variance, even after including SPQ- as a predictor, this suggests that the underlying relationship between schizotypy and LI can be attributed to the positive symptoms. Scores for SPQ- is not a significant predictor of PE learning after accounting for SPQ+ scores, suggesting that negative symptoms of schizotypy may only be related to LI because of covariation with the positive symptoms.

Table 5

Regression Model Predicting Pre-Exposed Learning

	R^2	F	p	B	SE B	p
	0.207	3.72 (4,57)	.009			
Intercept				-71.22	37.91	.065
Age				0.321	0.810	.693
Gender (male)				2.068	11.71	.860
SPQ+				**1.935**	**0.758**	**.013**
SPQ-				0.966	0.856	.264

Note. SPQ+ = positive schizotypy, SPQ- = negative schizotypy.

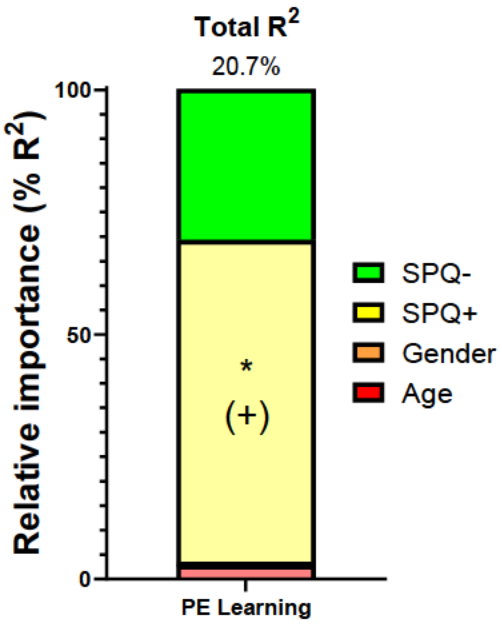

Figure 8: The relative importance of each predictor for pre-exposed learning scores. The total variance explained by the model is displayed above the bar. * denotes significant regression coefficients. + indicates a positive relationship with pre-exposed learning scores.

3.5 Schizotypy and Learning

Our results so far suggest that the underlying relationship between schizotypy and LI relates predominately to the positive symptoms. Figure 9 plots the changes in PE learning and NPE learning in relation to SPQ+ (for analysis that considers LI scores, see Appendix E). Visual inspection of the figure confirms that there are larger differences between PE learning and NPE learning at low levels of SPQ+, reflecting a LI effect, while there are only very small differences at high levels of SPQ+, suggesting an attenuated LI effect.

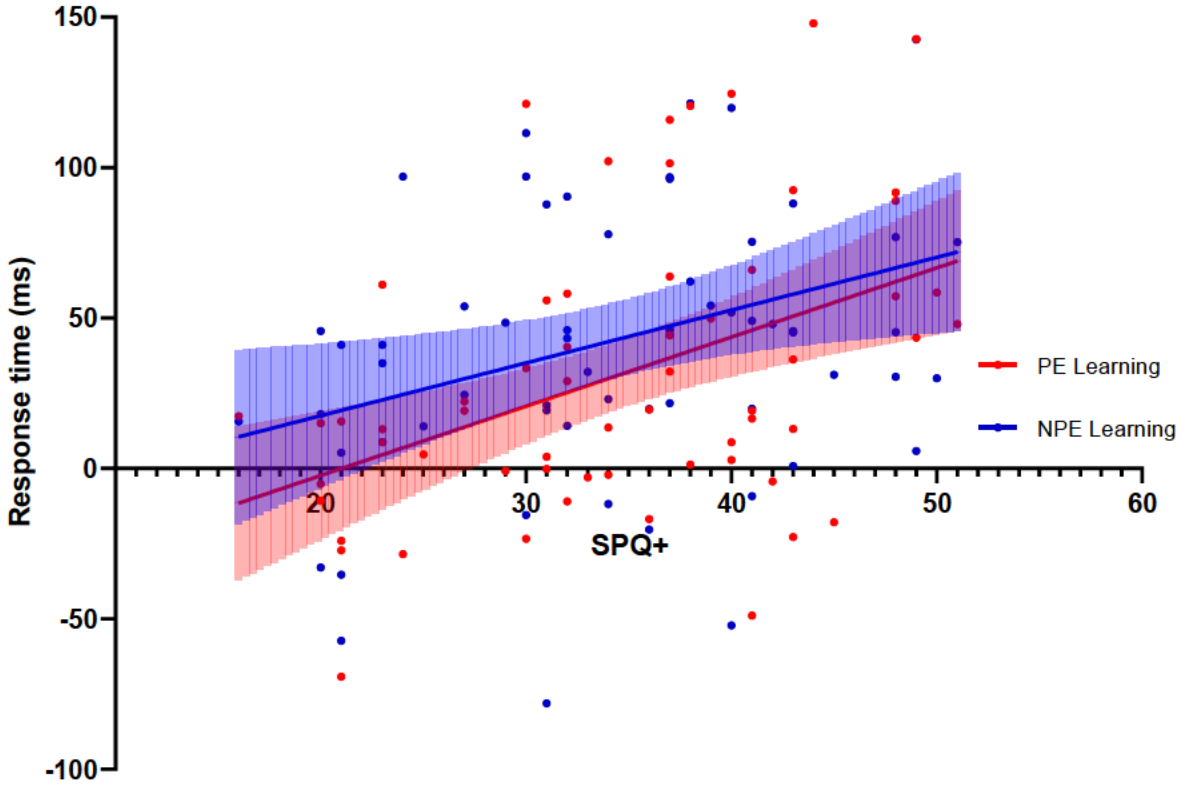

Figure 9: A plot of individual scores for pre-exposed and non-pre-exposed learning against positive schizotypy scores. Linear regression models are shown for each learning condition. Error bars represent the standard error of the mean.

As previously established PE learning is a significant predictor of SPQ+ scores (Table 3) which suggests more learning about irrelevant stimuli with increases in positive schizotypy. Visual inspection of Figure 5 however also indicates that NPE learning increases with scores on SPQ+. To explore this unexpected result further, we conducted a regression analysis predicting SPQ+ scores with age, gender and NPE learning as predictors. Table 6 indicates that the model is a significant in predicting SPQ+ (F (3,58) = 3.99, p = .019) and captures 17.1% of the variance. Without considering PE learning scores, NPE learning is a significant predictor of SPQ+ (B = 0.044, p = .044), suggesting that individuals with high positive schizotypy are also more likely to

learn about relevant stimuli. The learning effects for relevant stimuli appear to be masked by the enhanced learning about irrelevant stimuli (the PE learning scores).

For the sake of completeness, a regression analysis was also conducted predicting SPQ- using only NPE learning scores – results from Table 6 reveal that NPE learning was not a significant predictor ($B = 0.026$, $p = .185$)

Table 6

Regression Model Predicting Positive and Negative Schizotypy Using Only Non-Pre-Exposed Learning

	R^2	*F*	*p*	B	SE B	*p*
SPQ+	0.171	3.99 (3,58)	.019			
Intercept				40.69	3.949	< .001
Age				**-0.331**	**0.144**	**.025**
Gender (male)				-0.307	2.149	.888
NPE learning				**0.044**	**0.021**	**.044**
SPQ-	0.182	4.31 (3,58)	.008			
Intercept				33.64	3.567	< .001
Age				**-0.347**	**0.130**	**.009**
Gender (male)				3.155	1.950	.111
NPE learning				0.026	0.019	.185

Note. NPE = non-pre-exposed.

CHAPTER 4: DISCUSSION

This study aimed to extend the current literature in two regards. First, we attempted to replicate past findings that used a newly developed within-subject designs, whilst also improving upon the design by removing potentially confounding instructions. We also considered the high covariation between positive and negative schizotypy in order to better specify the underlying relationship. Secondly, we explored the role of WM as a potential mediator between schizotypy and LI. Claims from previous research, as well as the interrelated nature of WM and inhibition, suggested a strong association between WM in LI, however minimal research has clarified this relation

4.1 Schizotypy and Latent Inhibition

4.1.1 The new within-subject latent inhibition design. Using a variation of the design in Granger et al. (2016), the study was successful in replicating reports of an attenuated LI effect in individuals with high schizotypal personality (Evans et al., 2007; Granger et al., 2012). Notably, these results are inconsistent with the reports from Granger et al. (2016) who reported an enhanced LI effect associated with high schizotypy. Similar to past studies that implemented this design, an association was only found between high schizotypy and increased learning about PE stimuli (Evans et al., 2007; Granger et al. 2012; Granger et al., 2016; Schmidt-Hansen et al., 2009). Supplementary analysis from Appendix E reveals that using LI scores, i.e. calculating the differences between PE and NPE learning scores, indicates no significant association with schizotypy. Such findings are somewhat unexpected given that calculating LI scores should nonetheless reflect the same concept as learning about the PE stimuli.

A possible explanation for this result can be attributed to the RT measure which, in comparison to studies that used correct responses, provide a greater degree of specificity as a

proxy for learning. The consequence of this enhanced specificity is that the measure captures a greater degree of noise. Because RT was recorded in milliseconds, there was a large degree of variability in participant scores for both PE and NPE learning conditions (Figure 9). The additional noise captured by measuring RT compounds when calculating LI difference scores and thus could mask the observed learning effects. Consequently, although this new within-subject design affords greater specificity, it does so at the cost of capturing highly variable data. This is an important consideration for future studies that may use a similar design, particularly if the effect of interest is only subtle like the effects of pre-exposure on learning.

Although the use of LI scores was less viable for our analysis, we were still able to account for PE and NPE learning conditions by including both measures in the regression model (Table 3, Table 4). By controlling for scores of NPE learning, we are more confident in concluding that high schizotypy is associated with increased learning about irrelevant stimuli, above and beyond what is accounted for by learning about relevant stimuli – this reflects an attenuation in LI.

In addition to replicating the findings from Granger et al., (2016), we also aimed to improve upon the design in a number of respects. Most evidently, we removed the potentially confounding instructions in which participants were informed to anticipate the target stimulus prior during the test phase. Such a confound is likely to influence results, particularly within highly schizotypal individuals who have been shown to interpret instructions in abnormal ways (Partos et al., 2016, Polner et al. 2018).

We observed much smaller LI effects in comparison to Granger et al. (2016), notably as learning effects for PE and NPE conditions only appeared in the final third of the experiment (see Appendix C). In contrast, past studies that have included the potentially confounding

instructions observed stable learning effects much earlier in their task whilst simultaneously using fewer pairings between the cues and target stimulus. Many of the past papers have observed learning effects when averaging results from the entire test phase (Evans et al., 2007; Granger et al., 2016) in contrast to this study that only observed effects in the final third of the experiment. The larger effects reported in past studies can be attributed to the instructional confounds in which participants are primed to anticipate the target stimulus at the beginning of the test phase. Removing these instructional confounds has likely resulted in much smaller observed effects as any learning that occurs is incidental – effects can therefore more reliably be attributed to LI in which only pre-exposure leads to differences in learning.

Furthermore, this study was also able to enhance the ecological validity of this new within-subject LI design. Participants were exposed to a wide array of letter stimuli across the pre-exposure and test phase, more so than have been used previously. Furthermore, the target stimulus was preceded by many different cues – whether they be part of the PE, NPE or control condition – leading to greater task difficulty and a reduced likelihood that effects can be attributed to cue familiarity (De la Casa & Lubow, 2001; Schmidt-Hansen et al., 2009). The enhanced difficulty of the task mimics experiences in the real world in which individuals must constantly process, regulate and ignore a wide range of stimuli in their environment (Medin & Heit, 1999). The ability to discern relevant and irrelevant cues when overwhelmed with a wide array of stimuli is better represented in this design, more so than past studies.

4.1.2 Schizotypal symptoms and latent inhibition. The results indicate a group level LI effect as demonstrated by the significant differences between PE and NPE learning (Figure 5). Although such findings validate this design as an effective means of studying the LI effect, this study was more concerned with the influence of schizotypal personality on LI. Our results

indicate that PE learning was a significant predictor of both positive and negative schizotypy. In recognizing the covariation of positive and negative schizotypy, we analysed these findings further using a regression analysis. Our results reveal that the underlying relationship between schizotypy and LI is a result of the positive symptoms – the relationship between PE learning and negative symptoms, therefore, may have occurred due to covariation with positive symptoms. The consideration of covariation of positive and negative symptoms draws into question the previous claims that have failed to account for these effects (as they only performed correlational analyses that failed to control for covariation between types of symptom) and may therefore erroneously ascribe a relationship between negative symptoms and learning deficits (Cornblatt et al., 1985; Gal et al., 2009; O'Leary et al., 2000).

Many researchers have proposed that the positive symptoms of schizotypy, and to some degree schizophrenia, are a direct result of reduced LI (Gray et al., 1991; Hemsley, 1996; Lubow & De la Casa, 2002). A reduction in LI reflects a greater propensity to learn about irrelevant stimuli, which are typically ignored by healthy individuals. Greater awareness of irrelevant stimuli may allow subsequent associations and connections that form with these irrelevant stimuli, which may lead to the development of deluded thoughts and beliefs in attempt to explain these connections that other individuals are not aware of (Granger et al., 2016; Harrow & Silverstein, 1991; Hemsley, 1996; Lubow, 2012). Larger reductions in LI would subsequently lead to even more learning about irrelevant stimuli – this may then lead to a sensory overload which may have broader implications on everyday activities and executive functioning (Baruch et al., 1998a; Diamond, 2013). This framework emphasises that deficits in LI lead to the expression of positive symptomology in both schizotypal personality and schizophrenia. Positive symptoms should therefore be understood as a consequence of reduced LI, rather than the

common suggestion that schizotypal personality leads to deficits in LI (Gray et al., 2002; Gray et al., 2003; Lubow, 2002).

4.2 Working Memory and Executive Function

4.2.1 The role of working memory. A study conducted by Collins et al. (2014) suggested that the role of WM was integral in the formation of associations in individuals with schizophrenia. The strong claims from this finding are undermined by the fact that the study estimated WM based on computational modelling of performance in a learning task. In contrast, in our study WM was measured independently of the learning task and we did not find WM to be a mediator in the relationship between schizotypy and LI, nor was it a significant predictor of positive or negative schizotypy. WM was only found to be a marginal, non-significant predictor of negative schizotypy (Figure 6). Post-hoc correlation analyses indicate no associations between WM and positive schizotypy (r = -0.034, p = .793) and only a weak correlation with negative schizotypy (r = 0.262, p = .039). The findings from this study are therefore inconsistent with the claims made by Collins et al. (2014).

The fact that WM was not a mediator between schizotypy, particularly the positive symptoms, and LI is nonetheless unexpected. Reductions in LI can be suggested to be a result of defective inhibitory mechanisms, whether they be related to attention or switching capacities. Reduced inhibitory control, therefore, leads to more learning about irrelevant stimuli that should clutter and overwhelm the limited capacity of WM (Harsher & Zacks, 1998; Hemsley, 1996; Matussek, 1992). Ultimately, the reduced inhibitory capacity of high schizotypal individuals, as reflected by attenuated LI, was expected to have subsequent impacts on performance on WM tasks. This was not supported by the findings from this study and there a number of potential explanations.

4.2.1.1 The measures of working memory. The analysis in Appendix D reveals that the dot-matrix and the verbal *n*-back, although are both commonly regarded as measures of WM, seem to show weak correlations with each other and furthermore, are not predicted by the same facets. These findings emphasise the broad and multifaceted nature of WM – encompassing processes of recall, inhibition, encoding and maintenance amongst others (Diamond, 2013). Critically, the regression analysis of the dot-matrix reveals that it was more strongly linked to learning about irrelevant stimuli, although the relation was still marginally non-significant. This relationship between the dot-matrix and irrelevant stimuli can be attributed to how processing irrelevant, distractive stimuli is embedded into the dot-matrix task (Miyake et al., 2001), while the verbal *n*-back task establishes all information as task relevant through continuous updating (Wilhelm et al., 2013).

Nonetheless, a separate regression analysis using only the dot-matrix as a WM measure reveals that it remains as a non-significant predictor of schizotypal personality. Our results therefore suggest that although schizotypal individuals display deficits in inhibition, this does not then also lead to deficits in WM. Such findings may allude to the existence of some compensatory mechanisms that allow schizotypal individuals to accommodate the increased learning about irrelevant stimuli, without impacting on WM processing.

4.2.1.2 The processes involved in latent inhibition. Another important clarification is to consider the processes involved in LI. Although performance on a LI task is dependent on the ability to inhibit learning about irrelevant stimuli, the task also captures many other processes aside from inhibition. Fundamentally, LI is a learning task and is influenced, not only by the ability to inhibit irrelevant information but also, by the ability to learn and process relevant information. The trends observed in Figure 9 and the regression analysis from Table 6 reveals

that there is enhanced learning about NPE relevant stimuli with increases in positive schizotypy when considered independently of PE learning. These results provide evidence that individuals with high positive schizotypy are better learners in general – and this may offer some explanation for the lack of relationship between positive schizotypy and WM. Although they may express deficits in inhibition, this does not then result in subsequent impacts on WM as they exhibit a greater propensity to learn and process information in general, be it relevant or irrelevant.

4.2.2 Cognitive flexibility and creativity. So far, this study has considered the relationship between two executive functions, namely inhibition and WM, by examining the association between schizotypy and LI. It is important to note, however, that there is another executive function commonly described in the literature – that being cognitive flexibility, the ability to consider a number of different perspectives and adjust to changes in demands (Diamond, 2013; Steffens et al., 2018). As an executive function, it is also strongly intertwined with inhibitory and WM processes – it is sometimes even regarded as the culmination of WM and inhibition functioning in tandem (Braem & Egner, 2018; Diamond, 2013). Reduced inhibition leads to the processing of more irrelevant stimuli – while this may typically lead to deficits in WM due to sensory overload, the function of cognitive flexibility may act as a compensatory mechanism by allowing better processing of irrelevant stimuli (Braem & Egner, 2018; Crump & Logan, 2010). Some studies have suggested that there is a greater reliance on cognitive flexibility functions, rather than WM, when tasks are difficult or require processing of many different stimuli (Ávila et al., 2015, Bouazzoui et al., 2013). Despite the deficits in inhibition, highly schizotypal individuals may be engaging cognitive flexibility functions to accommodate for the increased stimulus input, rather than relying solely on their WM capacity.

Cognitive flexibility is shown to have large overlaps with creativity, and as such is often examined using measures of set-shifting or task-switching (Eysenck, 1993; Kiesel et al., 2010; Crump & Logan, 2010). Given that some researchers characterize LI as involving shifting or switching mechanisms, this may be considered further evidence for the abnormal switching mechanisms in schizotypal individuals (Abu-Akel et al., 2018; Yogev, Sirota, Gutman & Hadar, 2004)

There have been a number of studies that have shown decreases in LI to be associated with increases in creativity and cognitive flexibility using a number of different measures (Carson, Peterson & Higgins, 2003; Peterson, Smith & Carson, 2002). In addition to this, there have been several papers that suggest a strong relationship between schizotypy and creativity, with some studies suggesting similar biological underpinnings (Eysenck, 1993; Fink et al., 2014; Folley & Park, 2005; Weinstein & Graves, 2002), while others have demonstrated an association through psychometric assessment (Partos et al., 2016; Polner et al., 2018). Although not explicitly measured in this study, it would be important for future research to examine the interrelated nature of all three executive functions and how this may influence the attenuated LI effects in schizotypal individuals. Previous studies that have found links between schizotypy and creativity, as well as between creativity and reduced LI, offer a strong foundation for future research that may help to provide a holistic conception of the processes that underpin schizotypy and LI.

4.3 Research implications and limitations

4.3.1 Schizotypy, not schizophrenia. Studying schizotypy has a number of benefits in that it allows for enhanced statistical power by studying members from the general population, as well as providing a model for studying the symptoms and cognitive deficits typically found in

schizophrenia, without confounds of medication or hospitalization (Ettinger et al., 2014; Meehl, 1989; Steffens et al., 2018). Nonetheless there are important distinctions between schizotypy and schizophrenia – most notably is that schizotypy describes a broad personality trait developed for theoretical purposes, while schizophrenia encompasses definitive clinical symptoms with important practical relevance (Lenzenweger, 2006). Although schizotypy is not regarded as a precursor for the development of schizophrenia, high schizotypal individuals are nonetheless more likely to develop schizophrenia at some point in the future (Davidson et al., 2016; Nelson et al., 2013; Nettle, 2006). Rather than perceiving schizotypy as a prelude to schizophrenia, it is more appropriate to consider it as a risk factor that leads to increased susceptibility in developing schizophrenia. With this conception, the findings from this study support the use of LI measures as an indicator of schizotypy – coupled with other cognitive measures and schizotypal personality questionnaires, vulnerability to schizophrenia may one day be evaluated by examining cognitive deficits and using personality assessments (Hall & Honey, 1989; Rascale et al., 2001; Williams et al., 1998).

4.3.2 Implications of latent inhibition deficits in a practical setting. One problem of using LI as an indicator of cognitive deficit is that the same LI paradigm cannot be re-administered after the outcome is known (Gray & Snowden, 2005). A good LI design should measure incidental learning, similar to real world situations, rather than learning under instructions. If the paradigm were to be re-administered, participants would no longer be naïve once they realise that the PE cue is subsequently useful despite it being irrelevant in the PE phase. Thus, the influence of the pre-exposure phase on subsequent learning will no longer be effective if people have prior awareness that the PE cue will eventually be useful. Due to this limitation, the LI task has restricted application as a diagnostic tool to capture changes in

cognitive ability over time, and as such it may not be appropriate to use to assess the effectiveness of any therapeutic interventions (Gray & Snowden, 2005).

4.4 Conclusions – future directions

This study has successfully demonstrated LI using a new within-subject design and has examined the role of WM as a potential mediator. Although findings did not confirm our initial predictions regarding WM, the results reveal the variability of WM measures and how they may be capturing opposing facets. One potential direction for future research could involve using a battery of measures in order to examine the multifaceted nature of WM in relation to LI. Furthermore, the interrelated nature of executive functions may posit future research to consider all three executive functions in tandem, particularly focusing on the role of cognitive flexibility. Although not directly examined in this study, past literature has clearly demonstrated the potential role of creativity and cognitive flexibility in LI.

An important conclusion from this analysis is considering the understanding of schizotypy and what it may represent. What appears evident from the results is that schizotypy should not be considered solely in regard to the associated deficits. Schizotypal personality reflects broad changes in cognitive functioning, some of which may allude to improvements in ability. Briefly considered was the enhanced creativity of highly schizotypal individuals, potentially due to increased tendency to learn about irrelevant stimuli. In fact, deficits in LI themselves reflect a higher propensity to learn about information – and the results from this study provide further evidence that schizotypal individuals appear to better learners in general. As further research has broadened the understanding of schizotypal personality, it should no longer be considered as merely a reflection of cognitive deficits and symptomology – rather, these changes in personality should be perceived in a more creative manner. In order to develop a

more flexible interpretation of schizotypal characteristics, we just need to learn more about this type of personality.

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APPENDIX A: Information Sheet

THE UNIVERSITY of ADELAIDE

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Information Sheet

Study Title

Relationship between individual differences in personality and working memory on learning

Investigators

XXXX XXXX

XXXX XXXX

XXXX XXXX

XXXX XXXX

Purpose of the Study

This project investigates how people learn to associate stimuli based on individual differences. Associative learning is fundamental as it enables people to predict future events and ignore irrelevant stimuli. Although everyone is capable of such learning, there are known differences in the way people learn to associate stimuli. Working memory, defined as the ability to maintain information in an active state, is one particular factor that is known to influence the formation and strength of associations, and this is an individual difference that is often highly variable between people. By studying the role of working memory and personality in associative learning, a more holistic understanding can be developed of how people are able to learn. Specifically, prior conceptions of associative learning tend to only briefly consider the role of working memory, thus results from this study may provide preliminary evidence that future research of associative learning will require more focus on the role of working memory.

What Happens During the Study

To investigate the learning process, participants are asked to complete computerised tasks that will involve responding to and making predictions about various types of stimuli. One task will involve quickly responding to a sequence of randomised letters, while other tasks will involve making predictions about a series of visual stimuli.

Additionally, the study will also explore the relationship between personality and learning. Measures of personality will be captured through a number of self-reported questionnaires.

Finally, participants will be asked to perform several tests that assess working memory. Because learning ability might depend on working memory, we will test whether these cognitive functions mediate the relationship between associative learning and personality.

Location

The study takes place in the Hughes building room 240, School of Psychology, University of Adelaide, North Terrace Campus.

Who Can Participate

- Volunteers will be eligible for inclusion in this study only if all of the following apply:
- Aged 18-60 years
- Not suffering from a neurological disorder and no history of brain injury
- Not suffering from a drug or alcohol dependency, either a current or previous condition
- Not smoking more than 5 cigarettes per day
- Not using medication that affects neurological function (e.g., antidepressants, sedatives, antipsychotics)

Safety and Ethical Issues

The Human Ethics Committee of The University of Adelaide has approved this study (ethics approval number H201974). All potential participants will provide their written informed consent before commencing the study. The risks of this study are considered minimal. Every effort will be made to ensure that the discomfort levels are kept to a minimum.

Leaving the Study

You are free to withdraw from the study at any time and for any reason. You are not required to explain your reasons to the study staff. You may also decide to withdraw any collected data. In this case, none of your data will be used for research purposes. Withdrawal from the study will not affect your involvement in any future research programs that you may wish to participate in.

Duration

The study lasts approximately 1.5 hours.

Confidentiality

All information collected about you from the study is completely confidential. Your results in this experiment will not be associated with your personal information at any point in time (e.g., in publications or presentations). Number codes rather than names will be used to assign identification.

Contact Information

If you have any questions about the study please feel free to contact XXXX (XXXX), XXXX (XXXX), XXXX (XXXX), or XXXX (XXXX). Please see the attached independent complaints form if you have any concerns regarding the ethics of this research, or would like to speak to someone independent of the project.

The University of Adelaide

Human Research Ethics Committee (HREC)

This document is for people who are participants in a research project.

CONTACTS FOR INFORMATION ON PROJECT AND INDEPENDENT COMPLAINTS PROCEDURE

The following study has been reviewed and approved by the University of Adelaide Human Research Ethics Committee:

Project Title:	**Relationship between individual differences in personality and working memory on learning**
Approval Number:	[redacted]

The Human Research Ethics Committee monitors all the research projects which it has approved. The committee considers it important that people participating in approved projects have an independent and confidential reporting mechanism which they can use if they have any worries or complaints about that research.

This research project will be conducted according to the NHMRC National Statement on Ethical Conduct in Human Research (see http://www.nhmrc.gov.au/publications/synopses/e72syn.htm)

1. If you have questions or problems associated with the practical aspects of your participation in the project, or wish to raise a concern or complaint about the project, then you should consult the project co-ordinator:

Name:	XXXX
Phone:	XXXX

2. If you wish to discuss with an independent person matters related to:

- making a complaint, or
- raising concerns on the conduct of the project, or
- the University policy on research involving human participants, or
- your rights as a participant,

contact the Human Research Ethics Committee's Secretariat on phone (08) 8313 6028 or by email to hrec@adelaide.edu.au

APPENDIX B: Consent form

1. I have read the attached Information Sheet and agree to take part in the following research project:

Title:	Individual differences in learning, schizotypy and impulsivity
Ethics Approval Number:	[redacted]

2. I have had the project, so far as it affects me, and the potential risks and burdens fully explained to my satisfaction by the research worker. I have had the opportunity to ask any questions I may have about the project and my participation. My consent is given freely.

3. Although I understand the purpose of the research project, it has also been explained that my involvement may not be of any benefit to me.

4. I agree to participate in the activities outlined in the participant information sheet.

5. I understand that I am free to withdraw from the project at any time and that this will not affect my study at the University, now or in the future.

6. I have been informed that the information gained in the project may be published in a journal article, thesis or in conference presentations.

7. I have been informed that in the published materials I will not be identified and my personal results will not be divulged.

8. I understand my information will only be disclosed according to the consent provided, except where disclosure is required by law.

9. I am aware that I should keep a copy of this Consent Form, when completed, and the attached Information Sheet.

Participant to complete:

Name: _____ Signature: _____ Date: _____

Researcher to complete:

I have described the nature of the research to _____

(print name of participant)

and in my opinion she/he understood the explanation.

Signature: _____ Position: _____ Date: _____

APPENDIX C: Overall Mean Reaction Time Analysis

Table C1

Overall Mean Reaction Times for Pre-Exposed Learning and Non-Pre-Exposed Learning

Variable	M (SD)	Min	Max
Overall PE Learning (ms)	15.3 (30.3)	-54.9	110.6
Overall NPE Learning (ms)	15.6 (29.9)	-43.2	96.9

Table A1 indicates no differences in overall mean reaction time for PE learning and NPE learning, suggesting no LI effect at the group level. Due to the contrary nature of the results, we inspected the raw scores for the PE, NPE and control cues over the course of the experiment to examine if learning effects had been masked by calculating the overall mean scores (Figure A1). We anticipated that responses to all three cues would be similar at the beginning of the experiment and that differences between cue types would only appear over the course of the task. The test phase of the LI design was separated into 6 blocks of trials and changes in reaction time for PE, NPE and control cues were plotted (Figure A1). Contrary to expectations, responses to PE and NPE conditions were faster than control conditions even at the beginning of the experiment.

It is important to note that the control cues were predictive of the target stimulus, although much less reliable in comparison to the PE and NPE cues, and this is reflected in Figure A1. The differences between the control conditions and the PE and NPE conditions become much larger over the course of the test phase, reflecting how participants incidentally learn the differences in predictability with adequate exposure. Such results emphasise the importance of

including control conditions in studies examining LI as learning about PE and NPE is now less likely attributed to individual differences in learning.

Although PE and NPE conditions both reliably predict the target stimulus, there are subtle differences in RT in the final two blocks of the experiment – these differences can be attributed to the effects of pre-exposure. Figure A1 reveals that in general, changes in reaction time across all conditions only appear stable by the final two blocks of the experiment. The effects of pre-exposure on learning appear subtle and only manifest once participants have had adequate exposure to the task and have reached a level of stable learning. These subtle effects are masked when calculating the overall mean reaction time for the test phase. Mean reaction times for the final two blocks of the task were calculated as scores for PE learning and NPE learning and are reported in the main Results section.

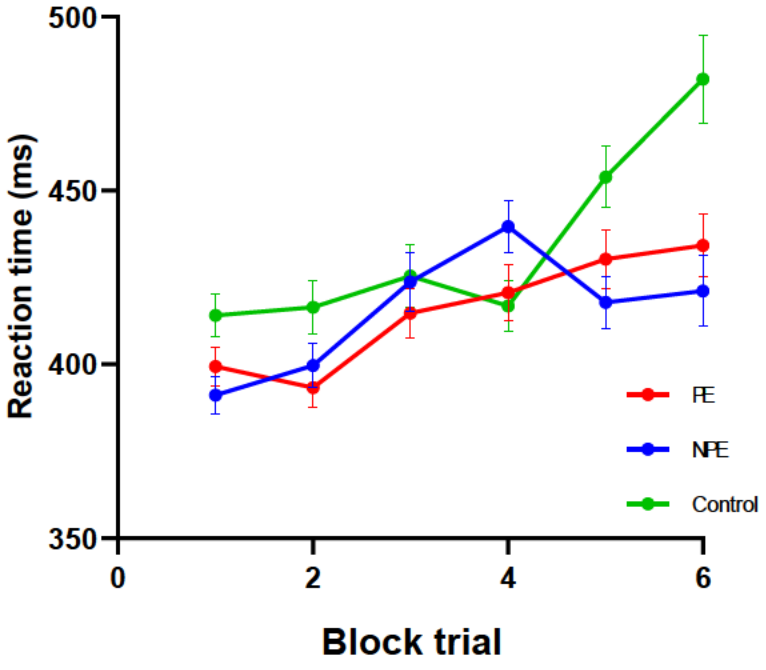

Figure C1: Mean reaction times in the pre-exposed, non-pre-exposed and control conditions across the experiment, separated into 6 blocks. Error bars represent standard error of the mean. Visual inspection indicates stable learning effects within the final two blocks of the experiment.

APPENDIX D: Working Memory Measures

Pearson's correlation analysis reveals weak, non-significant relations between the dot-matrix and the verbal *n*-back ($r = 0.175$, $p = .173$) which is confirmed by Figure 1B. This result is surprising given that both tasks are presumed to measure the same construct of WM, as well as how both tasks have adequate loadings on the PCA analysis.

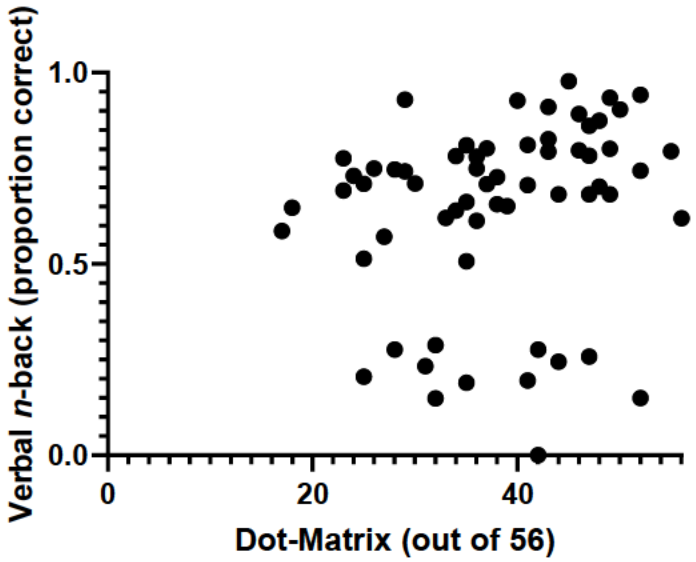

Figure D1: A plot of dot-matrix scores against verbal *n*-back scores.

The lack of correlation between the two tasks has been found in a number of past studies (Jaeggi, Buschkuehl, Perrig & Meier, 2010; Kane, Conway, Miura & Colflesh, 2007; Oberauer, 2005). Furthermore, there is also strong evidence to suggest that improved performance on n-back tasks do not transfer to performance on complex-span tasks (Chooi & Thompson, 2012; Jaeggi et al., 2010) – such findings emphasise that these tasks should not be considered interchangeable (Redick & Lindsey, 2013).

Complex span tasks are frequently used in studies of individual differences and are reported as having high reliability (Barouillet, Bernadin & Camos, 2004; Kane et al., 2007; Redick et al., 2012). On the contrary, *n*-back tasks are commonly used in studies of cognitive neuroscience that attempt to outline the processes involved in WM – consequently, *n*-backs have received minimal psychometric verification as measures of WM (Jaeggi et al., 2010; Kane et al., 2007; Redick & Lindsey 2013). The WM tasks appear to be distinct and capturing different facets of WM, despite the underlying assumptions.

Additional exploratory analysis was conducted to examine the differences between these two tasks. According to the interrelated nature of executive functions, we would expect that measures of WM would be related to inhibitory processes. We used a multiple regression analysis to test this idea – scores for dot-matrix and verbal *n*-back tasks were predicted based on age, gender, PE learning and NPE learning. Because scores for PE learning reflect the ability to inhibit irrelevant information, and we expected this to be a significant predictor for measures of WM.

Table B1 reveals that the overall model predicting the dot-matrix was significant, with age and gender being significant predictors. Such findings concur with previous literature that indicate age and gender differences for visuospatial tasks of WM (Lawton & Hatcher, 2005; Pauls, Petermann & Lepach, 2013). Critically, PE learning was a marginal, non-significant predictor indicating that ignoring irrelevant stimuli is somewhat predictive of better performance on the dot-matrix.

In contrast, the overall regression model predicting verbal *n*-back scores was not significant.

Table D1

Regression Models Predicting Scores for the Dot-Matrix and Verbal n-back

	R^2	*F (p)*	B	SE B	*p*
Dot-Matrix	0.229	4.23 (0.005)			
Intercept			43.24	4.064	< .001
Age			**-0.313**	**0.148**	**.0396**
Gender (male)			**7.066**	**2.224**	**.0024**
PE Learning			-0.060	0.0317	.0621
NPE Learning			0.025	0.0300	.3987
Verbal n-back	0.020	0.293 (0.88)			
Intercept			0.710	0.116	< .001
Age			-0.003	0.004	.442
Gender (male)			0.0387	0.063	.545
PE Learning			-0.0004	0.0009	.603
NPE Learning			0.0002	0.0008	.774

Note. PE = pre-exposed, NPE = non-pre-exposed.

The dot-matrix is a complex span task that requires participants to memorise the locations of various dots, whilst simultaneously completing a number of matrix equations – critically, the matrix equations are irrelevant, and act as distractions, in memorising the location of the dots (Barouillet et al., 2004). In contrast, the verbal *n*-back task used in this study required participants to recall letters that were presented in empty boxes, whilst the boxes were continuously updated. All information presented in this task was relevant and needed to be stored – there was no requirement to down-regulate attention to any stimuli in the task (Wilhelm, Hildebrandt & Oberauer, 2013).

Both tasks are suggested to involve maintaining information, whether it be a dot location or letters presented in a box, whilst also avoiding interference from recently presented stimuli, whether that be a matrix equation or letters that are presented in separate boxes. The important difference between the two tasks, however, is the relevance of the interfering stimuli – the dot-matrix involves matrix-equations that are irrelevant to performance on the task, while the *n*-back presents interfering letters that remain relevant for later performance on the task.

Although non-significant, results from the regression model indicate that the dot matrix task and LI are underlined by similar processes, namely the inhibitory processing of irrelevant stimuli. Notably, inhibition of irrelevant information would enhance performance on the dot-matrix, whilst this same process would lead to reduced learning about PE stimuli and thus produce a larger LI effect. These results are in contrast to the verbal *n*-back regression model in which PE learning is not predictive.

The exploratory analysis reveals the distinction between WM tasks despite the underlying presumption that they capture the same fundamental construct. Measures of WM each include their own task-specific variance which may not necessarily relate to the construct of interest

(Wilhelm et al., 2013). This, in part, may be due to the multifaceted nature of WM that involve multiple processes – including encoding, maintenance, recall, inhibition and many others (Redick & Lindsey, 2013). Future studies that aim to examine the role of WM should therefore use a battery of WM tasks that measure a broad range of facets in order to enhance the construct validity of WM (Wilhelm et al., 2013).

Given the apparent distinctions between the WM measures, we performed additional analysis to determine whether results differed when using our PCA measure, or when considering each WM measure independently. We re-ran all relevant analysis twice using participants' scores on the dot-matrix (Table B2) and verbal *n*-back (Table B3). Both sets of analyses returned a similar pattern of results to those originally reported.

Table D2

Regression Models Predicting Positive Schizotypy Using Dot-Matrix and Verbal n-back scores

	R^2	*F*	*p*	B	SE B	*p*
	0.268	4.09 (5,56)	.003			
Intercept				42.29	6.529	< .001
Age				**-0.348**	**0.143**	**.018**
Gender (male)				-0.286	2.243	.090
PE Learning				**0.077**	**0.030**	**.014**
NPE Learning				-0.006	0.028	.831
Dot-Matrix				-0.038	0.123	.758
	0.266	4.07 (5,56)	.003			
Intercept				40.93	4.867	< .001
Age				**-0.337**	**0.139**	**.018**
Gender (male)				-0.540	2.076	.796
PE Learning				**0.079**	**0.029**	**.009**
NPE Learning				-0.007	0.027	.806
Verbal *n*-back				-0.401	4.318	.926

Note. PE = pre-exposed, NPE = non-pre-exposed.

Table D3

Regression Models Predicting Negative Schizotypy Using Dot-Matrix and Verbal n-back scores

	R^2	F	p	B	SE B	p
	0.283	4.43 (5,56)	.002			
Intercept				25.17	5.871	< .001
Age				**-0.290**	**0.128**	**.028**
Gender (male)				1.593	2.017	.433
PE Learning				**0.070**	**0.027**	**.013**
NPE Learning				-0.016	0.025	.518
Dot-Matrix				0.195	0.111	.083
	0.258	3.89 (5,56)	.004			
Intercept				30.69	4.451	< .001
Age				**-0.337**	**0.127**	**.010**
Gender (male)				2.814	1.898	.144
PE Learning				**0.060**	**0.027**	**.030**
NPE Learning				-0.012	0.026	.628
Verbal *n*-back				4.102	3.948	.303

Note. PE = pre-exposed, NPE = non-pre-exposed.

APPENDIX E: Latent Inhibition Score Analysis

Calculating LI scores involves subtracting average reaction times for PE conditions from NPE conditions, with higher scores representing a larger LI effect. Table C1 and C2 include the recalculated regression models for positive and negative schizotypy respectively using LI scores rather than PE learning and NPE learning. The important finding from this analysis is that LI scores are not significant in predicting either positive or negative schizotypy, although the beta coefficients are in the right direction. This is in contrast to the original analysis reported in the Results section that found PE learning to be a significant predictor for both schizotypal facets, even after controlling for NPE learning. Figure C1 illustrates the linear regression models for PE learning, NPE learning and LI scores. There are large differences between PE learning and NPE learning at low levels of SPQ+, reflecting large LI effects, and these differences are reduced at high levels of SPQ+, reflecting a reducing in LI.

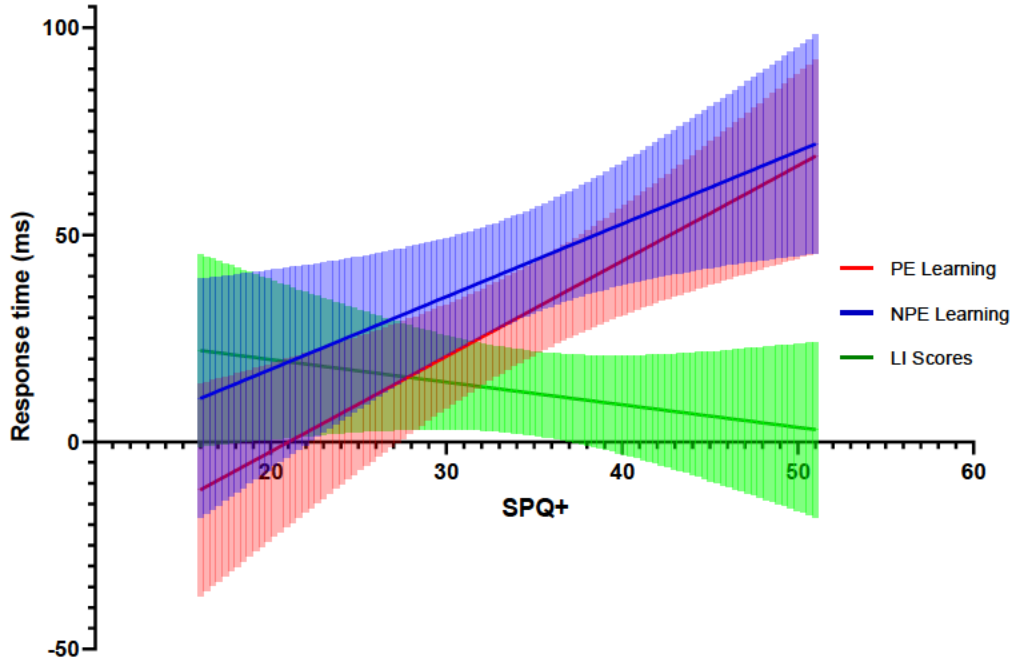

Figure E1: Linear regression models for pre-exposed learning, non-pre-exposed learning and latent inhibition scores. Error bars represent standard error of the mean.

Table E1

Regression Models Predicting Positive Schizotypy Using Latent Inhibition Scores

	R^2	*F*	*p*	B	SE B	*p*
Model 1	0.136	3.05 (3,58)	.036			
Intercept				44.93	3.762	< .001
Age				**-0.411**	**0.145**	**.006**
Gender (male)				-0.272	2.203	.902
LI scores				-0.039	0.028	.192
Model 2	0.143	2.38 (4,57)	.063			
Intercept				45.21	3.804	< .001
Age				**-0.432**	**0.149**	**.005**
Gender (male)				0.186	2.319	.936
LI scores				-0.034	0.028	.236
WM scores				-0.793	1.192	.509

Note. LI = latent inhibition, WM = working memory.

Table E2

Regression Models Predicting Negative Schizotypy Using Latent Inhibition Scores

	R^2	*F*	*p*	B	SE B	*p*
Model 1	0.178	4.20 (3,58)	.009			
Intercept				36.37	3.336	< .001
Age				**-0.399**	**0.129**	**.003**
Gender (male)				3.156	1.954	.118
LI scores				-0.031	0.025	.220
Model 2	0.207	3.72 (4, 57)	.009			
Intercept				35.82	3.327	< .001
Age				**-0.358**	**0.131**	**.008**
Gender (male)				2.290	2.028	.263
LI scores				-0.036	0.025	.151
WM scores				1.501	1.043	.155

Note. LI = latent inhibition, WM = working memory.