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An investigation into the drivers of avolition in schizophrenia

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ABSTRACT

Over a century of research has documented that avolition is a core symptom in schizophrenia. However, the drivers of avolition remain unclear. Conceptually, there are at least two potential mutually compatible drivers that could cause avolition in schizophrenia. First, people with schizophrenia might have differences in preferences that result in less goal-directed behavior than non-clinical populations (preference-differences). Second, people with schizophrenia might have difficulty translating their preferences into manifest behavior at rates similar to non-clinical populations (psychological-inertia). In the present work, we modified and validated a well-validated paradigm from the motivation/decision making literature to compare levels of preference-differences and psychological-inertia. To measure preference-differences, people with and without schizophrenia choose between a lower-valenced and higher-valenced image. We measured the rate at which the normatively lower-valenced image was preferred. To measure psychological-inertia, both groups were given the opportunity to volitionally switch from a lower-valenced image and view a higher-valenced image. Contrary to expectations, people with schizophrenia did not differ on either preference-differences or psychological-inertia. Statistical analysis revealed that the possibility of a Type II error for even a weak effect was small. The present data suggest new avenues for research investigating mechanisms underlying avolition and clinical interventions targeting avolition in schizophrenia.

1. Introduction

The very earliest writing on schizophrenia considered avolition – defined as a decrease in spontaneous, self-initiated and purposeful behaviors – to be a central symptom of the condition (Bleuler, 1911; Kraepelin, 1919; Trémeau et al., 2012). Describing people with schizophrenia, Bleuler (1950) noted a characteristic difficultly initiating goal-directed behavior. Modern schizophrenia researchers have repeatedly confirmed the prevalence of avolition and now conceive of it as being a fundamental underlying process that is central to the pathology (e.g., Foussias and Remington, 2010).

Despite the crucial role of avolition in schizophrenia, its underlying causes are not well understood. Prior avolition research has often focused on establishing the prevalence and functional outcomes of avolition, rather than elucidating its underlying causes. This research has often been conducted using structured clinical interviews and scales. For example, Andreasen's Scale for the Assessment of Negative Symptoms (SANS) (Andreasen, 1982) has a subscale for avolition/apathy that includes items related to grooming, non-persistence at work/school, level of asociality, and physical anergia. Other well-accepted rating scales include the Positive and Negative Syndrome Scale (PANSS) (Kay et al., 1987), the Brief Psychiatric Rating Scale (Overall and Gorham, 2004), and the Schedule for the Deficit Syndrome (SDS) (Kirkpatrick et al., 1989). All of these have included similar life-outcome measures to assess the degree of avolition in individuals with schizophrenia. Studies based on these scales have consistently shown that avolition (rated by clinicians) is correlated with lower levels of functioning (e.g. Kiang et al., 2003).

These scales along with structured clinical interviews have been invaluable in characterizing the every-day life consequences of avolition in schizophrenia. However, since these studies have (appropriately) focused on qualitative measures of life-outcomes, it is difficult to use them, or their methods, to examine the underlying drivers of avolition. Such assessments require laboratory studies with tightly controlled contexts.

Conceptually, there are at least two separable drivers that may underlie avolition. First, it is possible that people with schizophrenia have different preferences than individuals who do not have schizophrenia. For example, in some cases people with schizophrenia may prefer normatively negatively valenced images over normatively

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positively valenced images. Non-clinical populations largely prefer normatively positively valenced images over normatively negatively valenced images (Suri et al., 2013a, 2013b). Such affect-related *preference differences* between schizophrenia and non-clinical populations could drive avolition. Second, it is possible that people with schizophrenia are less able than individuals who do not have schizophrenia to translate preferences – based on anticipated rewards and punishments – into actions. They may have an increased tendency to persist with a current state even when they attach greater value to an option available via volitional action. This may result in these individuals with schizophrenia exhibiting higher levels of *psychological inertia* – defined as a tendency to remain in a current state of (in)action, even though they are inferior to other available options (Gal, 2006; Suri et al., 2013a, 2013b) – compared to non-clinical populations. Since psychological inertia may preclude action, its presence may drive avolition and, therefore, may be one cause of avolition. It is crucially important to understand the extent to which preference differences and psychological inertia are drivers of avolition or differentially contribute to clinical and nonclinical populations because of the current lack of knowledge concerning the causes of avolition.

The possibility of preference differences being a driver of avolition is supported by a meta-analysis (Cohen and Minor, 2010) that has shown that while the hedonic ratings of individuals with schizophrenia do not differ from healthy control participants (Gard et al., 2006), people with schizophrenia do report experiencing some aversion when processing stimuli considered by others to be positive or neutral. Such aversive reactions may lead to preference differences in schizophrenia that are manifested as avolition – specially in contexts involving approaching positive stimuli. Further, emerging evidence suggests that people with schizophrenia may demonstrate inconsistent and unstable preference judgments for affective and non-affective stimuli (Strauss et al., 2011), and people with schizophrenia may show the most discrepant preferences for low arousal or neutral stimuli (Strauss et al., 2017). This further implies that it is possible that preference differences, particularly for future rewards, could drive avolition despite intact hedonic emotional processing of experienced events in schizophrenia.

The possibility that psychological inertia is a driver of avolition is supported by studies that have noted abnormal cost-effort calculations in schizophrenia (Gold et al., 2013). People with schizophrenia were noted to have abnormalities in estimating the “cost” of effortful behavior, which could lead to increased psychological inertia and increased avolition. Other potential drivers for differences in psychological inertia include attention deficits and action-readiness deficits (Suri and Gross, 2015; Suri et al., 2015) which have been noted in schizophrenia (Heinrichs and Zakzanis, 1998).

It is unknown whether preference differences and psychological inertia are in-fact potential drivers of avolition and actually implicated in schizophrenia. To our knowledge, few such studies have been attempted, particularly studies that provide the option of moving away from negative stimuli and moving towards positive stimuli. A notable exception is a study by Heerey and Gold (2007) in which the researchers compared the extent to which people with schizophrenia (compared to controls) repeatedly pressed a button to increase the duration of viewing a positive image or to decrease the duration of viewing of a negative image. People with schizophrenia were found to make fewer button presses per second (in a five second response window) than comparison participants. While suggestive of an avolition deficit, the repeated-button-pressing-measure is not conclusive since differences in pressing rates could be, in part, ascribed to psychomotor slowing in schizophrenia (Brébion et al., 2000). Such psychomotor slowing is more likely to be present at higher rates of pressing (i.e. in the presence of valenced stimuli) than at lower rates of pressing (i.e. in the presence of neutral stimuli). Thus, the fact that people with schizophrenia pressed at an equivalent rate compared to controls for neutral stimuli, does not disprove a psychomotor attribution.

In the present work we sought to adapt a task used in basic science research with healthy individuals, focused on motivation and decision making (Suri et al., 2013a, 2013b, 2015; Suri and Gross, 2015) that can test for differences in levels of preference differences and for differences in levels of psychological inertia between individuals. In the first part of this experiment, individuals are asked to view images of differing valence for 1 s, and then asked to choose one image to view for a longer time (we will refer to this task as the Forced choice task). The percentage of time an individual selects the lower-valenced image for longer viewing is a measure of preference differences (relative to normative ratings). In this sense, preference differences refer to participants’ viewing preferences (whether they prefer lower valenced or higher valenced images). Low valence (negative) images generally depict aversive wounds and/or scenes of violence, neutral images often depict everyday items such as umbrellas, and high valence (positive) images usually depict beautiful scenes of nature.

In the second part of this experiment, participants start trials by viewing a default image. If they do nothing, they continue to view the default – but could view a better (i.e. higher valenced) image if they volitionally pressed a button (we will refer to this task as the Volitional choice task). The percentage of time an individual persists with viewing the (lower valenced) default image is a measure of psychological inertia.

In the Forced choice task, when asked to choose between viewing one of two stimuli, (non-clinical) participants reliably choose (~ 85% of all trials) to later view the more positive (or less negative) stimulus for a longer time. Comparing this rate to choice-rates in schizophrenia could indicate whether there are stable preference differences between the two groups. If so, preference differences may be a potential driver of avolition in schizophrenia.

In the Volitional choice task, (non-clinical) participants often persisted with viewing the lower valenced image and switched to the ‘better’ image infrequently (~ 30% of all trials), despite the presence of a caption underneath the default image reminding them that they had an option to switch (Fig. 1). This pattern of results has been replicated in multiple studies (Suri and Gross, 2015; Suri et al., 2015). The difference in outcomes between participant preferences in Forced choice trials and Volitional choice trials indicated the presence of psychological inertia, which involves remaining in a current state of (in)action despite this state being inferior to alternative options. Since discrepancies between the Forced choice and Volitional choice versions of this task reveal the presence of psychological inertia among non-clinical individuals, these tasks may also be suited to detect avolition, in the form of psychological inertia, in patients with schizophrenia.

Transdiagnostic approaches suggest that mental disorders are characterized by a dynamic set of biological and contextual variables that are reliably found – albeit at a subthreshold level – in the general population (van Os and Reininghaus, 2016). If this perspective is applicable in the case of psychological inertia, we might expect that people with schizophrenia would display higher levels of psychological inertia in this Volitional choice context compared to non-clinical

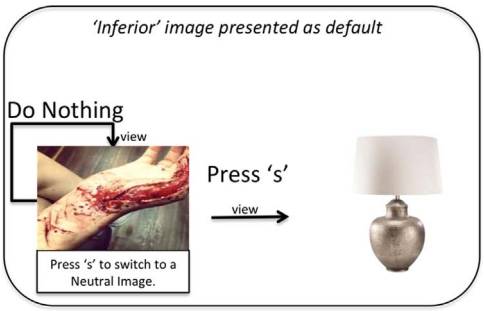

Fig. 1. In Volitional choice trials participants frequently failed to switch to a higher valenced image and persisted with the (lower valenced) defaults.

Fig. 2. The panel on the left illustrates a trial from the Forced Choice block in which participants are asked to select one out of two presented images for full screen viewing. The panel on the right illustrates a trial from the Volitional Choice block in which participants have the option of switching away from a lower valenced default to view a higher valenced image.

populations. In other words, if avolition is a key symptom of patients with schizophrenia, which is characterized as a decrease in self-initiated and purposeful behaviors, patients with schizophrenia may exhibit even greater levels of psychological inertia compared to non-clinical individuals as measured by these tasks. If so, psychological inertia may be a potential driver of avolition in schizophrenia.

The goal of the present studies was to compare levels of preference differences and psychological inertia in a non-clinical comparison group and a group consisting of individuals with schizophrenia in the image-viewing decision context described above. We sought to use Forced choice trials to measure preference differences and the difference between rates in Forced choice and Volitional choice trials to measure psychological inertia.

Given the value of within-subject conditions in clinical research, in Study 1, we tested a within-subjects variant of the task in a sample of non-clinical participants to validate this version of the task. Having validated this task in these participants, in Study 2, we compared preference differences and psychological inertia in people with schizophrenia and in a non-clinical comparison group. Thus, this is the first study to empirically investigate whether manifestations of avolition in schizophrenia can be detected using a within-subjects version of the current task, which has proven to be useful in detecting psychological inertia in non-clinical individuals when administered in its traditional format.

2. Study 1: Testing preference differences and psychological inertia within participants

The studies described above tested preference differences and psychological inertia in two different groups: the Forced choice group and the Volitional choice group. In these experiments, the forced choice preferences of one group are often not consistent with the volitional choice preferences of a second group – thereby indicating some level of psychological inertia. This between-subjects design allows each participant to complete exactly one condition (Forced choice or Volitional) – which precludes cross-condition interference effects. However, the between-subjects design has the disadvantage of requiring a greater number of participants since different participants are required for each condition. In contexts involving particular clinical populations, the requirement of a between-subjects design could make certain studies less valid (given the value of within subject design in clinical research) and harder to implement. The objective of Study 1 was to test whether preference levels (later used to measure preference differences between groups) and psychological inertia could be tested *within* subjects.

We specifically sought to test whether participants who undertook the Forced choice task and the Volitional choice task – in either order – would show a difference in choice outcomes between conditions (i.e. whether psychological inertia would be retained in a within choice context). We hypothesized that psychological inertia would be seen regardless of which task was completed first, but that greater levels of psychological inertia would be seen when the Volitional choice task was completed first. We reasoned that completing the Forced choice task first would increase participants' awareness of their preferences and thereby lead to increased levels of image-switching in the Volitional choice task.

2.1. Participants

A diverse sample of college students (n = 80; 55% female) completed the study and were randomized into the Forced choice first condition (n = 42) or the Volitional choice first condition (n = 38). They were then administered each block in accordance with their assigned condition.

2.2. Method

Study 1 consisted of two blocks: the Forced Choice block and the Volitional Choice block (corresponding to the tasks described above). Both blocks used three types of images: positive (nature scenes), neutral (everyday items such as an umbrella), and negative (aversive wounds and/or scenes of violence). The neutral and negative images were selected from the International Affective Picture System (IAPS) (Lang et al., 1999). IAPS image numbers representative of the negative stimuli used in the current study are available in the supplemental material. The positive images consisted of IAPS images, and similarly rated images (in initial pilot studies) collected from the Internet.

In the Forced choice block trials, participants sequentially glimpsed two images for 1 s each. Participants were then shown a thumbnail (3″ × 3″) of each of the two pictures placed on the left and right corner of a computer screen (Fig. 2). They were asked to select one of the two thumbnails (by pressing 'z' for the image on the left, and 'm' for the image on the right) in choice window (2 s). Their selection was then expanded into the full screen, and they viewed this expanded image for a period of 6 s. If participants did not make a selection (which did not happen for any trial across all participants), the computer randomly selected an image for longer viewing. The Forced choice block consisted of 50 trials. Half of these trials involved selections between negative and neutral images and the other half involved choices between neutral images and positive images.

In the Volitional choice block trials (after being sequentially shown both images constituting the trial for 500 ms), participants were shown a full screen view of one of the two images. Participants had a choice to press 's' to switch to an image from a different category. For example, for 25 trials, participants were shown a (default) neutral image and had the option to press 's' and switch to viewing a positive image (neutral-to-positive trials). In this case a caption that read "Press 's' to switch from the neutral picture to a positive picture," was placed under the default image (Fig. 2). If the participant pressed in such a trial, the default neutral image was replaced by a positive image. In 25 additional similarly structured trials, participants were shown a negative image and had the option to press 's' and switch to viewing a neutral image (negative-to-neutral trials).

This Volitional choice context was specifically designed to ensure that participant actions could not be attributed to value-based factors such as costs related to option evaluation, implied recommendations, or loss aversion. In particular, there were no effort-related costs involved

in leaving the default state – a mere button press was required. A successful cover story was used to minimize the influence of implied recommendations. Further, there were no losses (and only benefits) associated with leaving the default state; thus, loss aversion was unlikely to be a factor.

2.3. Results

In both the Forced choice first condition and the Volitional choice first condition, participants viewed higher valenced images at lower rates when they were completing trials in the Volitional choice block compared to when they were completing trials in the Forced Choice block. Thus, in both conditions, participants showed evidence of psychological inertia, demonstrating, for the first time, that psychological inertia was measurable in a within subject design.

Specifically, in the Volitional choice first condition, participants elected to switch from a neutral default to a positive image in 36.5% of trials, and elected to switch from a negative default to a neutral image in 40% of the trials (38.2% overall). In the Forced choice block, these same participants preferred positive images over neutral images in 82.9% of trials and neutral images over negative images in 85.4% of trials (84.2% overall) (Table 1). The viewing preference difference (Forced choice block – Volitional choice block, which represents how often participants are acting on their preferences) in the Volitional choice first condition was 46% (84.2-38.2). This difference was statistically significant, $t(41) = 7.34$, $p < 0.01$, indicating that individuals did not behave (Volitional Choice task) in congruence with their actual preferences (Forced Choice task).

In the Forced choice first condition, participants in the Forced choice block preferred positive images over neutral images in 78.7% of trials and neutral images over negative images in 79.9% of trials (79.3% overall). Then in the Volitional choice block, participants elected to switch from a neutral default to a positive image in 63.1% of trials, and elected to switch from a negative default to a neutral image in 68.7% of the trials (65.9% overall) (Table 1). The viewing preference difference (Forced Choice block – Volitional Choice block) in the Forced choice first condition was 13.4% (79.3–65.9). This difference was statistically significant, $t(37) = 2.4$, $p = 0.02$. As shown in Table 1, there were no differences between switching rates for 'negative to neutral' and 'neutral to positive' trial types.

2.4. Discussion

As predicted, the Volitional choice first condition displayed higher levels of psychological inertia than the Forced choice first condition. As shown in Table 1, this result occurred because in the Forced choice first condition, image switching in the Volitional block was more frequent than it was in the Volitional block for those completing the Volitional choice first condition – presumably because completing forced choice trials first heightened participants' attention towards their own preferences and engaged proactive behavior to press a key.

The Volitional choice first condition also allowed Volitional choice block measurements without interference effects from the (later occurring) Forced choice block. Further, the results in the Forced Choice Block were undistinguishable, $t(78) = 1.5$, $p = 0.14$, between the two conditions, suggesting that the pattern of results in the Forced choice Block in the Volitional choice first condition was not altered by the (earlier occurring) Volitional choice block.

Due to these factors, we elected to use the Volitional choice first condition in Study 2 in which we contrasted people with schizophrenia and a non-clinical comparison group.

3. Study 2: Preference difference and psychological inertia comparisons between people with and without schizophrenia

In Study 2 we sought to use the within-subjects design developed in Study 1 to test preference differences and differences in psychological inertia between people with schizophrenia and non-clinical controls. We planned to use differences in the Forced choice task to test for preference differences and to use the Volitional choice task to test for differences in levels of psychological inertia. The presence of one or both of these differences could illuminate the drivers of avolition in schizophrenia.

Prior schizophrenia research has nearly exclusively focused on motivation deficits in approaching positive outcomes – as opposed to motivation deficits in avoiding negative outcomes (for an exception to this trend, see Heerey and Gold, 2007). The Volitional task in Study 2 involved trials in which participants could switch away from a negative image and trials in which participants could switch towards a positive image. Differences in psychological inertia between these two types of trials could better characterize the nature of potential differences in psychological inertia between people with and without schizophrenia.

3.1. Participants

We recruited people with schizophrenia ($n = 20$) and non-clinical controls ($n = 22$) for participation in Study 2. People with schizophrenia were recruited from a larger study on motivation or cognitive impairment in schizophrenia, and were run in the present study as part of the baseline assessment battery, prior to their engagement in the larger study. Diagnoses, or lack of, for both groups were confirmed using the DSM-IV-Clinician Version (SCID: First et al., 1997). Exclusion criteria for all participants included a history of head trauma/loss of consciousness, neurological disorders, and non-fluency in English. People with schizophrenia were excluded if there were significant changes in medication or in dosage in the previous 30 days, or hospitalization in the previous 3 months. Non-clinical control participants were recruited through community postings and bulletin boards, and were excluded if they met criteria for any Axis I disorder on the SCID. Participants in both groups were matched on age, gender, and parents' education (Table 2). All participants were paid $10/hour for their time.

3.2. Method

Participants in both groups (people with and without schizophrneia) completed the tasks described in Study 1. They first completed a block

Table 1
Participant choice in volitional choice trials and forced choice trials.

	Volitional choice first condition						**Forced choice first condition**					
	Volitional choice block			Forced choice block			Forced choice block			Volitional choice block		
	Nu2P	Ne2Nu	Tot	P > Nu	Nu > Ne	Tot	P > Nu	Nu > Ne	Tot	Nu2P	Ne2Nu	Tot
%	36.5	40.0	**38.2**	82.9	85.4	**84.2**	78.7	79.9	**79.3**	63.1	68.7	**65.9**
95%CI	± 11.4	± 12.7	± 11.4	± 3.7	± 7.7	± 4.4	± 4.3	± 8.8	± 4.7	± 12.4	± 12.7	± 10.7

Note: Nu2P: Neutral default to Positive; Ne2Nu: Negative default to Neutral; Tot: Total across P/Nu and Nu/Ne trials; P > Nu: Positive image preferred over Neutral; Nu > Ne: Neutral image preferred over Negative; 95%CI: 95% Confidence Interval.

Table 2
Demographics among the schizophrenia and control samples.

	People with schizophrenia (n = 20, 2000 observations)	**Controls** (n = 22, 2200 observations)
Demographics		
Male, (%)	69.2%	54.5%
Age (years), *M* (*SD*)	45.38 (11.22)	41.09 (15.12)
Education, *M* (*SD*)	14.25 (3.11)	15.21 (2.65)
Mother's Education, *M* (*SD*)	14.67 (3.87)	13.33 (4.11)
Father's Education, *M* (*SD*)	12.25 (1.96)	13.13 (2.31)
Clinical variables Chlorpromazine Equiv. *M* (*SD*)	394.42 (177.52)	–
CAINS MAP, *M (SD)*	20.19 (5.96)	–
CAINS EXP, *M (SD)*	6.31 (4.45)	–
SANS Global Rating, Avolition/Apathy, *M (SD)*	2.61 (1.79)	–
SANS Global Rating, Anhedonia/Asociality, *M (SD)*	2.44 (1.76)	–

Note: CAINS: Clinical Assessment Interview of Negative Symptoms; MAP: Motivation and Pleasure subscale; EXP: Expression subscale; SANS: Scale for the Assessment of Negative Symptoms.

of 50 Volitional choice trials and then completed a block of 50 Forced choice trials. The 50 Volitional choice trials were equally divided into trials in which the participant could switch away from a neutral image to view a positive image, or they could switch away from a negative image to view a neutral image. The 50 Forced choice trials were equally divided into trials in which participants were asked to choose between a neutral and a positive image or between a negative and a neutral image (Fig. 2). Participants with schizophrenia also completed the Schedule for the Assessment of Negative Symptoms (SANS) and the Clinical Assessment Interview for Negative Symptoms (CAINS). The SANS is an interview based measure that assesses the degree to which various negative symptoms of schizophrenia are present. Among the negative symptoms captured by the SANS are avolition/apathy and anhedonia/asociality. The CAINS is also an interview based measure that assesses negative symptoms and expression deficits associated with schizophrenia. The CAINS is comprised of a motivation and pleasure (MAP) subscale, which has items related to avolition, and an expression (EXP) subscale. Since the current study is investigating the drivers of avolition and the SANS and CAINS both assess symptoms of avolition, these measures may be particularly related to the current task.

3.3. Results

Participant preferences in the Forced choice block were nearly identical: participants in the Schizophrenia Group selected positive images over neutral images in 76.2% of trials and neutral images over negative images in 75.4% of trials (75.8% overall). Participants in the Control Group selected positive images over neutral images in 82.0% of trials and neutral images over negative images in 83.8% of trials (82.7% overall). These rates are statistically equivalent, $t(40) = 1.32$, $p = 0.19$. This result suggested that there were no preference differences between the two groups.

In the Volitional choice block, participants in the Schizophrenia Group selected to switch away from neutral images to positive images in 37.2% of trials and away from negative images to neutral images in 58.4% of trials (47.8% overall). Participants in the Control Group selected positive images over neutral images in 33.0% of trials and neutral images over negative images in 50.7% of trials (41.9% overall). These statistically non-significant results are counter to our hypothesis that the schizophrenia group would display higher psychological inertia (i.e. lower rates of switching) than the control group. These results are also counter to our hypothesis that people with schizophrenia would display more psychological inertia for neutral to positive trials compared to negative to neutral trials.

To analyze the averages in detail, we ran a regression model that sought to predict switching rates based on group (schizophrenia vs. control), trial type and their interaction. The effect associated with group (schizophrenia = 1, control = 0) was not significant, Estimate 1.26, Standard Error 2.1, Z value = 0.60. The interaction term was also well below significance, Z value = 0.62. Thus, while both people with and without schizophrenia were more likely to switch away from negative images than they were to switch towards positive images, they did so at statistically equivalent rates.

3.4. Discussion

Importantly, the finding that rates of psychological inertia (as defined by the frequency of switches in the Volitional choice condition) were indistinguishable between people with and without schizophrenia, cannot easily be attributed to small sample sizes. The schizophrenia group was numerically *more* likely to switch away from lower valenced images (however, statistically, as described above, the groups had undistinguishable switching rates). This pattern of results suggests that the probability of Type II error – a false negative – is small: assuming even a weak Cohen's d of 0.2 (the conservative assumption), with the current sample size suggests a β of 0.02. In other words, the probability of not identifying a (potential) weak effect between the two populations is 2%; the probability of not identifying a (potential) stronger effects is even lower.

Finally, there was no correlation between measures of medication levels, motivation or negative symptoms in the schizophrenia group and levels of switching in the Volitional choice group. Overall, Study 2 demonstrated that neither preference differences nor psychological inertia (as measured in the present empirical context) appeared to be drivers of everyday avolition in our schizophrenia sample.

4. General discussion

Over a century of clinical research has confirmed that avolition is a core component of schizophrenia. Based on conceptual considerations, we proposed two potential drivers of avolition in schizophrenia, preference differences and psychological inertia. Contrary to expectations we found no preference differences and no differences in levels of psychological inertia between people with and without schizophrenia.

These findings offer something of a puzzle to the substantial literature that has documented broad and deep differences between people with and without schizophrenia related to avolition. How then might one explain the present lack of differences between the two groups?

We propose that an important potential reason for a lack of psychological inertia differences seen between groups is that the present study design requires little to no effort on the part of study participants. There is an emerging body of research that suggests that people with schizophrenia have difficulty with motivated behavior when effort levels are high (e.g., Gard et al., 2014; Gold et al., 2013; Green et al., 2015; McCarthy et al., 2016). In one study we found that people with schizophrenia were more likely to show motivated behavior when effort levels were low and reward salience was high, but much less likely to engage in motivated behavior if high levels of effort were required (Gard et al., 2014). Thus, psychological inertia may differ only for people with schizophrenia when there is a need to engage high levels of inertia. Future studies may need to increase the effort level of participants to show group differences. However, this increase in effort will have to be introduced in a manner that does not introduce new cognitive demands on the schizophrenia group.

There may be two other potential reasons for the null findings in

Study 2. First, since non-clinical individuals have demonstrated high levels of psychological inertia in both past studies (e.g., Suri and Gross, 2015; Suri et al., 2015) and in the current studies, the ability of the task to detect further impairments in individuals with schizophrenia may have contributed to the lack of significant findings. Although tempting, we do not believe that a floor effect contributed to the current findings because non-clinical controls still had a large number of trials in which they did not demonstrate psychological inertia in the Volitional Choice first group (just under 40%) in Study 1, meaning that there was likely enough room to observe a difference when compared to those with schizophrenia. Another reason for the lack of significant findings, and we thank an anonymous reviewer for bringing this to our attention, could be related the low levels of avolition present in our sample of individuals with schizophrenia according to their SANS and CAINS scores. Recruiting a sample of individuals with schizophrenia with higher levels of avolition according to these measures may help to identify differences in preference differences or psychological inertia in comparison to non-clinical individuals.

It is important to point out that the current data does not run counter to the recent finding that individuals with schizophrenia display reduced "positivity offset" (Strauss et al., 2017). Strauss et al. (2017) found that individuals with schizophrenia experienced lower levels of positive emotion than controls in response to low arousal stimuli despite in-tact capacities to experience comparable levels of positive emotion in response to high arousal stimuli. The images in the current study, whether positive or negative in valence, were of high arousal. In other words, the negative images were extremely negative whereas the positive images were extremely positive, which is in line with the vast majority of studies using IAPS images (Cohen and Minor, 2010). Thus, the current study likely did not create a situation in which the positivity offset could be observed.

If subsequent studies also do not show either preference differences or psychological inertia differences it is possible that cognitive deficits, not deficits related to affective or motivational processing, are the key causes of avolition in schizophrenia. A large number of studies have established that people with schizophrenia show deficits in the ability to actively maintain information over time (Lee and Park, 2005). If motivation involves the ability to actively represent information relevant to valued goals, then deficits in the ability to maintain such representations could contribute to motivational deficits (Barch, 2005). This hypothesis is consistent with studies that have established connectivity impairments in the dorso-lateral pre-frontal cortex (dlPFC) in people with schizophrenia (e.g., Glahn et al., 2005).

The fact that the above studies report a null finding with a modest sample size underlines the need for cautious interpretations. Nevertheless, as discussed above, the statistical trends in Study 2 suggest that the probability of a Type II error – for even a weak effect – is relatively small ($p = 0.02$). Given the paucity of traits that are conserved in schizophrenia, we therefore believe that the pattern of results described here warrants further consideration by the field.

One limitation of the present work is that our stimuli consisted of images rather than stimuli that may be more akin to primary reinforcers (e.g. those involving food or smells). Some studies have suggested that preference differences are more likely in such contexts (Berlin et al., 1998). A second limitation is that our studies have relied on choice and volitional action as dependent variables and have not investigated other response channels, such as functional brain activation or peripheral physiology. A third limitation of our study is that it did not assess participant beliefs in relationship to avolition. A growing literature supports the proposition that defeatist beliefs are a mediator of negative symptoms in schizophrenia (Grant and Beck, 2009). Finally, our study did not emphasize the measurements of cognitive variables that may be related to avolition. As suggested above, cognitive deficits may be integrally involved in avolition.

The present work presents a new, within-subjects tool to measure motivation in clinical contexts that does not depend on self-report measures. It is easy to administer and indicates the rates at which people work towards desirable goals or away from undesirable goals. It measures psychological inertia – which is known to be present in non-clinical populations (Suri et al., 2013a, 2013b) and therefore offers a comparison point with clinical populations. As mentioned above, the current task may not have been cognitively demanding enough to reveal differences in psychological inertia between patients with schizophrenia and non-clinical individuals. However, we think one to way to increase the cognitive demands of the task would involve having participants click 5 times instead once for each trial. This task modification would make the task similar to that of Brébion et al. (2000) in which clinical and non-clinical individuals were required to press a button repeatedly to increase the duration of a positive image or to decrease the duration of a negative image (within a 5 s response window). However, pressing a button repeatedly may add an additional level of demand to some clinical populations, such as those with schizophrenia or with particular symptoms (e.g., psychomotor slowing), and confound any differences that might be observed whereas pressing a button *only* 5 times may not. Future research administering the current task with these kinds of instructions may help to elucidate the appropriate degree of difficulty that can be administered to various clinical populations while still allowing any observed differences in psychological inertia between clinical and non-clinical individuals to be meaningful. It might also be useful for future studies to utilize measures of physiology to investigate avolition and psychological inertia in schizophrenia. We believe that the lack of the expected difference in preferences and psychological inertia between people with and without schizophrenia in the present context has important implications related to the nature of avolition in schizophrenia and to clinical interventions related to avolition. It suggests that avolition may not occur in contexts involving limited cognitive complexity and/or temporal distance. This in turn suggests that clinical interventions seeking to overcome avolition in schizophrenia would be well served in breaking complex tasks requiring volitional action sequences into smaller sub-steps, each of which are relatively straight-forward and are associated with tangible and temporally proximal intermediate milestones of success.

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