The simulation heuristic, paranoia, and social anxiety in a non-clinical sample

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Abstract

Background and objectives: Quality of reasoning within non-clinical paranoia and mental simulation of future paranoia themed events was investigated by use of a simulation task to determine whether paranoid individuals would be restricted or more adept at reasoning about paranoia relevant material in comparison to a social anxiety group and a group with low paranoia and social anxiety. Method: Participants (N = 63) were divided into the three groups based on paranoia and social anxiety scores. They were presented with the beginning and end of an imaginary situation and were asked to describe, step-by-step, what they imagined would happen between those two points. They were also administered a beads task to evaluate the jumping to conclusion decision making bias. Results: The prediction of more adept reasoning was not supported for paranoia. However, the social anxiety comparison group on average better simulated a scenario with congruent (socially anxious) thematic content compared to ones with non-congruent content. Further, in an exploratory analysis, jumping to conclusions bias was found to be positively related to goodness of simulation for paranoia themed scenarios within the paranoia group. Limitations: Study groups were relatively small and so power was an issue. Conclusion: The results are discussed in the context of the sometimes paradoxical findings in the area of cognitive biases and paranoia.

Keywords: Paranoia, social anxiety, reasoning biases, decision making heuristics

Clinical paranoia typically refers to the persecutory delusions found in psychosis. However, paranoia in its broader sense is common within non-clinical populations (e.g., Bebbington et al., 2013; Ellett, Lopes, & Chadwick, 2003; Freeman, Garety, McGuire, & Kuipers, 2005), and research into processes along the paranoia continuum has made use of non-clinical samples to help inform the understanding of clinical paranoia (e.g., Freeman, McManus, Brugha, Melzer, Jenkins, & Bebbington, 2011; Johns, Cannon, Singleton, Murray, Farrell, Brugha, et al., 2004). Anxiety is proposed to play a key role in paranoia across the continuum, and so knowledge of the mechanisms that give rise to anxiety, particularly social anxiety, is potentially central to the understanding of paranoia. It is notable that both paranoia and social anxiety involve the expectation of negative responses from others (Tone, Goulding, & Compton, 2011) and that similar reasoning patterns, such as the failure to consider or generate alternative explanations for aversive social experiences, are viewed as key features of both persecutory ideation and social anxiety (Clark & Wells, 1995; Freeman et al., 2004; Schutters et al., 2012).

The presence of reasoning biases such as jumping to conclusions (JTC; Garety, Hemsley, & Wessely, 1991; Huq, Garety, & Hemsley, 1988) is well established in paranoia. These biases are hypothesized to lead to rapid acceptance of beliefs despite limited supporting evidence and to preclude consideration of alternative explanations for troubling experiences, thus maintaining paranoid beliefs (Freeman, 2007). However, findings to date have mainly been based on laboratory tasks, and a clear delineation of how these phenomena contribute to real world reasoning is still being established. One approach to addressing this gap has examined the potential role of decision making heuristics. For example, Corcoran, et al. (2006) compared people with persecutory delusion to controls on a series of heuristic decision making tasks. They found a correlation between estimates of future threat and the rate of recollection of similar past events. The authors took this to reflect the operation of the availability heuristic (Tversky & Kahneman, 1973; 1982), according to which probability estimates of a future event increase when past instances of similar events can be brought to mind. Kahneman and Tversky (1982) described a corresponding reasoning tendency for

anticipated rather than recalled events. According to the simulation heuristic, the subjective probability of a given outcome depends upon the fluency of the mentally constructed model of the hypothetical situation. The concerns of individuals with delusions are frequently about imagined events that have never occurred before and, indeed, are likely to be viewed by others as being implausible. Therefore, the simulation heuristic is arguably a better fit to paranoia than the availability heuristic. In this connection, Corcoran (2010) argued that difficulty in mentally projecting oneself into a hypothetical future is the common thread underlying social cognition irregularities in psychosis.

An established methodology that has been used to capture the simulation heuristic involves providing the start and end of a scenario and requiring participants to mentally simulate the missing middle part of the scenario (Brown, MacLeod, Tata, & Goddard, 2002). Brown et al. (2002) asked participants (pregnant women) to imagine going into labour and reaching the hospital in time. "Goodness of simulation" (GOS) of the narrative connecting the beginning with the ending was shown to be associated with increased subjective probability of a positive outcome and a reduction in worry. In a subsequent study of individuals with OCD symptoms, simulations of scenarios related to personally relevant obsessive fears were judged to be more coherent and were regarded by participants as more likely to occur than non-personal OCD scenarios (Keen, Brown, & Wheatley, 2008). The general premise that individuals with emotional problems are more adept at reasoning about themes consistent in content with their difficulties is the basis of the Hyper Emotion Theory of psychological illnesses (HET; Johnson-Laird, Mancini, & Gangemi, 2006), which offers an account of how this tendency develops. The theory proposes that efforts to make sense of intense emotional experiences serve to elaborate and perpetuate these experiences, resulting in enhanced reasoning abilities on topics relevant to the problem. Explicit tests of the theory have been supportive (e.g., Gangemi, Mancini, & Johnson-Laird, 2013). Gangemi et al. found that individuals with depression and anxiety reasoned more validly and with fewer logical biases than controls, particularly with regard to affect congruent stimuli.

In an extension of the simulation approach to paranoia, Huddy, Brown, Boyd, and Wykes (2014) found that individuals with clinical paranoia produced less coherent simulations overall than matched controls (a finding recently replicated by Huddy, Drake, and Wykes, 2016) and did not, as predicted, produce more coherent simulations for scenarios that featured the negative intentions of others. Instead, those with paranoia were less able than controls to produce more coherent responses for scenarios that featured the *positive* intentions of others. However, as Huddy et al. (2014) noted, scenarios were not matched to individuals' specific concerns, as was the case in the Keen et al. (2008) study on OCD symptoms, and so the results did not necessarily contradict the predictions of the HET with regard to enhanced reasoning about paranoia themes. Further, the results may have been confounded with general cognitive deficits or the effects of medication. Finally, the absence of a symptomatic control group limited the conclusions that could be drawn about the specificity of observed reasoning patterns to paranoia.

To address these methodological issues, the current study employed the simulation task in a non-clinical analogue paranoia sample. The main question was whether paranoid individuals would be restricted in reasoning or whether they would be more adept reasoners in line with the HET (Johnson-Laird et al., 2006), as reflected in better simulations when the situation related to personal fears and concerns. Participants with high levels of paranoia were compared to socially anxious participants without high paranoia and a control group low on both paranoia and social anxiety with regard to their mental simulations of paranoia and social anxiety themed scenarios to determine if the symptomatic groups (paranoia and social anxiety) were more adept reasoners about content related to their symptoms compared to neutral content. It was also predicted, in line with the assumptions of the simulation heuristic, that the ease with which a scenario could be simulated (i.e., "goodness of simulation") would relate to increased subjective probability for that situation occurring, which would, in turn, be associated with greater worry about the simulated outcome. A final consideration was whether the pattern of reasoning about personally relevant topics might be associated with, or moderated by, the presence of reasoning biases such as the JTC bias. JTC bias

was among the irregularities that Corcoran (2010) argued stemmed from an underlying difficulty in mentally projecting oneself across time in order to reason hypothetically; it should therefore be associated with worse simulations, contradicting the predictions of HET. It was hoped that this apparent contradiction could be investigated empirically through exploratory analyses of the relationship between JTC and goodness of simulation.

Method

Participants

Participants were 63 undergraduate psychology students from a British university who participated for course credit. Fifty-four (85.7%) participants were female, nine (14.3%) were male; the mean age of the overall sample was 19.9 years (SD = 5.1; range = 17 – 48 years). They were divided into groups of high paranoia, high social anxiety, and low paranoia/social anxiety based on their scores on the Paranoia Scale (PS; Fenigstein & Vanable, 1992; see below), a measure of sub-clinical paranoia, and the Social Phobia Inventory (SPIN; Connor et al., 2000; see below), a measure of social anxiety. Eighteen participants showed elevated scores on the PS (≥ 53; +1 SD) and formed the high paranoia group; normative data from the student sample reported by Fenigstein and Vanable (1992) were used to identify the cut off score for determining paranoia group membership, consistent with previous studies (e.g., Combs, Michael, & Penn, 2006; Combs & Penn, 2004; Combs et al., 2007). Additionally, individuals scoring at or above this cut-off on the PS have been reported to show similar social, cognitive, and behavioural biases to those found in individuals with persecutory delusions (e.g., Combs & Penn, 2004; Combs et al., 2007). Note that this group was not required to be low in social anxiety, as research in representative populations suggests social anxiety is intrinsic to paranoia (e.g., Bebbington et al, 2013).

Connor et al. (2000) reported that a score of 19 on the SPIN distinguished between participants with and without social phobia. Participants in the current study who scored $\geq$19 on the SPIN but <53 on the PS formed the social anxiety (SA) group (*n* = 22). Participants below both cut-offs formed the "low" paranoia/social anxiety comparison group (*n* = 23). There were no differences

between groups for age (H (2) = 4.36, p = 0.11), gender (Fisher's exact test, p = 0.73), ethnicity (χ^2 (2) = 1.17, p = 0.56), English as a first language (N = 41 of 63 overall, χ^2 (2) = 3.24, p = 0.20), or experience of a mental health problem (Fisher's exact test, p = 0.27).

Materials & Measures

The simulation task. The simulation task was based on the procedure employed by Brown et al. (2002), which was modelled on the Means-Ends Problem Solving approach (Platt & Spivack, 1977). Participants were presented with the beginning and end of an imaginary situation and were asked to describe, step-by-step, what they imagined would happen between those two points (see Appendix 1 for all scenarios). Standardized task instructions and prompts were used for the task, and participant responses to scenarios were audio-recorded and transcribed verbatim.

Two paranoia themed scenarios ("Friend" and "Job") were developed from student narratives from a non-clinical study of paranoid experiences (Allen-Crooks & Ellett, 2014). Narratives were examined to identify frequently occurring themes and experiences; these narratives were then used to inform the construction of the start and end points of paranoia-evoking scenarios used in the current study. A further paranoia scenario ("Public Place") was taken from Huddy et al. (2014), developed from a qualitative clinical study of individuals experiencing persecutory paranoia (Boyd & Gumley, 2007). The scenario was found by Huddy et al. (2014) to be the most successful in evoking hostile content in responses. Hostility was used as an indicator of paranoia in responses as it was presumed to capture the two main features of paranoia as defined by Freeman and Garety (2000)--the presence of a persecutor and the threat or intention of harm. Presence of hostility in responses was rated post-hoc by two independent raters (see below).

Instructions for the "Friend" scenario differed to the other scenarios in that participant responses were directed toward two possible outcomes of the scenario; the scenario was presented twice with differing ending instructions, once requesting a response in which a friend had betrayed their trust and once where respondents were asked to give a response in which a friend had remained loyal. Order of the loyal and disloyal endings was counterbalanced. A social anxiety

scenario ("Speech") was constructed that described a social evaluation situation that ended with scrutiny by others. The scenario of unexpectedly having to stand up and speak is extensively used as a social anxiety manipulation and so was thought to be face valid as a relevant stimulus for social anxiety. Finally, a neutral non-paranoia evoking scenario ("Shop") was taken from Huddy (2008) that included content intended to omit any threat or intention of harm. It was found by Huddy et al. (2014) to produce responses with minimal hostility content. Following presentation of each scenario, consistent with previous studies using the simulation task methodology (i.e., Huddy et al., 2014, Keen et al., 2008), participants made ratings of ease of imagining, subjective probability of the situation, distress relating to thinking about the situation, and distress relating to the outcome of the situation on a Likert scale from 1 (*not at all*) to 7 (*very much*). A subjective potency (SP) variable (range 2-14) was then constructed by combining scores from the two post-scenario questions relating to ease of imagining and subjective probability , following the approach taken by Huddy et al. (2014). A worry variable was constructed from the two post-scenario questions relating to distress (range 2-14).

Scenario coding. The coding system for determining goodness of simulation (GOS) was based on Brown et al. (2002). Simulation responses to each scenario were rated according to six criteria: *logical sequencing, temporal ordering, minimization of uncertainty, level of detail, ease of imagining,* and *smooth flow.* Responses were also rated for hostility as defined by the judged presence of negative intent directed towards the respondent. All GOS criteria and hostility were rated on a 3-point scale (range 1-3) of the extent to which the aspect was present. Total score for GOS ranged from 6-18, with higher scores indicating better simulation. Following training and practice with example responses, two independent raters assigned scores for each GOS criterion and for presence of hostility for all scenarios from all participants. Scenario responses were presented to raters in a random order.

Event Ranking Questionnaire (ERQ; Keen et al., 2008). Participants were presented with nine brief statements, including statements describing the three paranoia and one social anxiety

scenarios; remaining statements were distracter items. Participants were asked to rank the statements in order of most to least upsetting from 1-9, to rate their degree of upset on a 4-point scale from "not at all" to "extremely" upsetting, and to rank statements in order of similarity to typical personal worries. This resulted in an overall score from which the most personally relevant scenario could be identified. A brief distracter questionnaire of five questions about the European Union was administered after the ERQ in order to discourage priming on the simulation task.

Probabilistic Reasoning Task ("Beads Task"; Huq et al., 1988). This task assessed data gathering reasoning style and JTC. Participants were shown a card containing a picture of two jars that each contained 100 red and blue coloured beads in proportions of 60 red and 40 blue beads in Jar 1, and 60 blue and 40 red in Jar 2 (60:40 ratio; Dudley, John, Young, & Over, 1997*)*. Participants were told that one jar had been randomly selected and were shown pictures of beads drawn from the selected jar and asked to decide which jar had been selected based on the beads drawn. The primary measure was number of bead draws requested prior to making a decision.

The Paranoia Scale (PS; Fenigstein & Vanable, 1992). The PS contains 20 items with responses given on a 5-point scale ranging from 1 (*not at all applicable to me*) to 5 (*extremely applicable to me*). Higher scores indicate greater levels of paranoia. Good levels of internal consistency (α = .84) and test-retest reliability (r = .70) have been reported within non-clinical student samples (Fenigstein & Vanable, 1992) and has been validated as a measure of paranoid ideation within clinically diagnosed groups (Smári, Stefánsson, & Thorgilsson, 1994).

The Social Phobia Inventory (SPIN; Connor et al., 2000). The SPIN comprises 17 items rated on a 5-point scale from 0 (*not at all*) to 4 (*extremely*), based on presence of symptoms over the past week. Total scores range from 0 to 68 with higher scores indicating greater distress. The SPIN has been reported as a reliable and valid measure of social anxiety within non-clinical student populations. Radomsky et al. (2006) reported the SPIN total score to exhibit excellent internal consistency (α = .93), excellent test-retest reliability (r = .86) and good convergent validity within a sample of 202 undergraduate students.

Hospital Anxiety and Depression Scale (HADS; Zigmond & Snaith, 1983). The HADS is a 14-item self-report questionnaire consisting of seven anxiety and seven depression related questions rated on a 4-point scale from 0 to 3, and based on symptoms observed in the past week. The HADS is a widely used measure and good levels of internal consistency on both the depression and anxiety scales (α = .76 and .80 respectively) have been reported (Mykletun, Stordal, & Dahl, 2001). It was included in the present study to help characterize the participants making up the analogue sample of the present study.

Procedure

Participants were administered the procedure singly by an experimenter in a quiet room. Measures and study tasks were presented in the following order: The ERQ and ERQ distracter task, the Probabilistic Reasoning Task, and then the simulation task followed by post-scenario ratings. The procedure for the simulation task followed the method of Brown et al. (2002) and Huddy et al. (2014). The neutral (Shop) scenario was presented first and the "Friend" scenario where participants were directly asked to simulate a response where someone had betrayed their trust last. The remaining scenarios were presented in random order. The PS, SPIN and HADs were completed following the simulation task. The simulation task took 40 minutes to complete on average, and the entire procedure took about 70 minutes.

Results

Sample characteristics

Scores on symptoms measures and JTC are presented in Table 1. Differences on the PS and SPIN reflect the group assignment procedure. There were no differences on beads task, (F(2, 60) =0.75, p = 0.48). The paranoia and SA group did not differ on anxiety (HAD-A) and depression (HAD-D) but both were significantly more anxious and depressed than the control group (t(24.83) = 4.79, p < 0.001), and t(43) = 4.55, p < 0.001, respectively for HAD-A and t(39) = 3.26, p = 0.002), and t(34.82) = 3.11, p = 0.004, respectively, for HAD-D). Furthermore, as a check on whether the highly female gender make-up of the sample was likely to distort the results, both point-biserial correlations of

gender with the full set of variables used in subsequent analyses and Mann-Whitney U group comparisons were carried out. The only significant difference was for females to have lower Loyal Friend scenario GOS scores (U = 129, p = .025). This variable did not ultimately figure prominently in the subsequent analyses, and so there is no compelling evidence for the possibility that gender significantly distorted the results reported in the rest of this section.

Table 1

Mood, social anxiety, paranoia and data gathering scores by group

	Paranoia (n=18)		Social Anxiety (n = 22)		Low on both (n = 23)	
Measure	M	SD	M	SD	M	SD
SPIN	22.89	12.75	27.59	8.28	9.65	5.73
PS	60.44	7.77	38.09	6.28	30.74	6.69
Beads Task	8.50	3.62	9.64	4.40	10.17	4.89
HAD-A	10.50	4.42	9.14	3.64	4.96	2.42
HAD-D	4.06	2.75	3.73	2.39	1.87	1.49

Note. SPIN = Social Phobia Inventory. PS = Paranoia Scale; HAD-A and HAD-D, Hospital Anxiety Scale Anxiety and Depression Scales.

Inter-rater agreement

A total of 378 scenario responses were rated (63 participants and 6 scenario types). Overall agreement on ratings within one point rating was 97.3% across all scenarios. The intra-class correlation (ICC) coefficient between raters ranged from 0.70 to 0.84 across GOS criteria and hostility. The overall Cronbach's α calculated on the six GOS dimensions from both raters was 0.86; rating dimension scores were therefore combined to calculate a total GOS score (range 6-18), taking the average GOS of the two raters.

Tests of the main hypotheses

Facility vs. restriction in reasoning. Mean GOS scores for each scenario by group are shown in Table 2. A series of analyses was carried out testing various hypotheses regarding facilitation of reasoning following from the HET using different ways of aggregating the GOS scores. The GOS score for the affect-neutral shop scenario, which was included as a point of reference for general GOS performance, did not differ by group ($F(2, 60) = 0.41$, $p = 0.67$). In the first analysis, the loyal/disloyal friend scenario GOS scores were compared. The predicted Group x Scenario interaction (with the paranoia group having relatively higher GOS scores for the disloyal scenario according to the facilitation prediction of the HET) was not found; in fact, the observed mean differences were in the opposite direction, with the paranoia group having the highest positive disparity between loyal and disloyal scenarios. The loyal friend scenario was not analyzed further following this contradictory result.

Next, the paranoia scenario was identified for each participant that had the highest rank on the ERQ, and its GOS score was compared to the average GOS of the remaining (nonpersonal) paranoia scenarios for each person. A mixed (Group x Personal Scenario Type) ANOVA did not find the predicted interaction, $F(2, 60) = .092$, $p = .91$. Thus, the main hypothesis with regard to facilitation in reasoning for matched paranoia content was not supported. The third HET hypothesis was that facilitation would be evident between groups, with the symptomatic groups being highest on GOS for content congruent with their main problem. An average paranoia GOS score was computed for the three paranoia scenarios, which was compared to the social anxiety scenario. There was a significant Group x Scenario interaction [$F(4,120) = 2.67$, $p = .038$, sphericity assumed]. Follow up planned contrasts confirmed, as is indicated in Table 2, that the source of the interaction was the elevation on the social anxiety scenario for the high social anxiety group compared to the paranoia group ($p = .01$) and the control group ($p = .018$), which did not differ from each other. Likewise, within the social anxiety group, the social anxiety scenario GOS was significantly elevated relative to the average GOS of the paranoia scenarios ($p = .022$).

Table 2

GOS scores (M, SD) by Scenario Type and Group

	Paranoia (n=18)		SA (n = 22)		Low (n = 23)	
Scenario	M	SD	M	SD	M	SD
Shop	16.25	1.60	16.24	1.71	15.85	1.68
Social anxiety	13.87	2.34	15.67	1.73	14.12	2.32
Public place	14.56	1.73	14.56	1.86	14.22	1.86
Job	13.94	2.15	14.36	1.89	14.89	1.74
Loyal Friend	14.69	2.30	14.96	2.30	15.17	2.26
Disloyal Friend	14.08	2.70	14.76	1.53	14.96	1.57
Personal paranoia	14.22	2.43	14.43	1.88	14.74	1.57
Non-personal paranoia	14.18	1.93	14.62	1.31	14.67	1.13

Note. SA = Social Anxiety

Relationship between GOS, Subjective Potency (SP) and Worry. Spearman's correlations (as within group correlations were planned and groups were relatively small) were calculated to examine whether GOS would be associated with increased SP, and that SP would, in turn, be associated with worry (see Table 3). On the highest ranking ERQ scenario in the overall sample there were significant positive correlations found between GOS and SP ($r(61) = 0.22$, $p = 0.04$), and between SP and worry ($r(61) = 0.31$, $p = 0.006$). There were no significant associations between GOS and SP for the average of the remaining lower-ranked scenarios and a significant negative correlation between GOS and worry for the combined sample ($r(61) = -0.26$, $p = 0.02$). On the social

anxiety scenario, there were no significant correlations between any of the post-scenario ratings and GOS. There was, however, a trend towards significance between subjective potency and GOS for the SA group ($r(20) = 0.35$, $p = 0.055$).

Table 3

Spearman Correlations of GOS, Worry and Subjective Potency, by Group and Scenario Type

Scenario	Group			
	Paranoia	Social Anxiety	Low Paranoia/Anxiety	Overall
Personal Paranoia				
GOS-SP	.33^	-.17	.61**	.22*
SP-Worry	.12	.44*	.32^	.31**
GOS-Worry	-.09	.02	.07	.07
Non-personal				
GOS-SP	.08	-.05	.01	.08
SP-Worry	-.38^	-.02	-.21	-.23
GOS-Worry	-.06	-.02	-.56	-.26
Social Anxiety				
GOS-SP	-.05	.35^	.07	.12
SP-Worry	.29	.25	-.21	.12
GOS-Worry	-.13	.08	-.03	-.01

Note. Paranoia group n = 18, df = 16, SA group n = 22, df = 20, low group n = 23, df =21, combined n = 63, df = 61; WR, scenario worry rating; SP, scenario subjective potency rating; ^ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$.

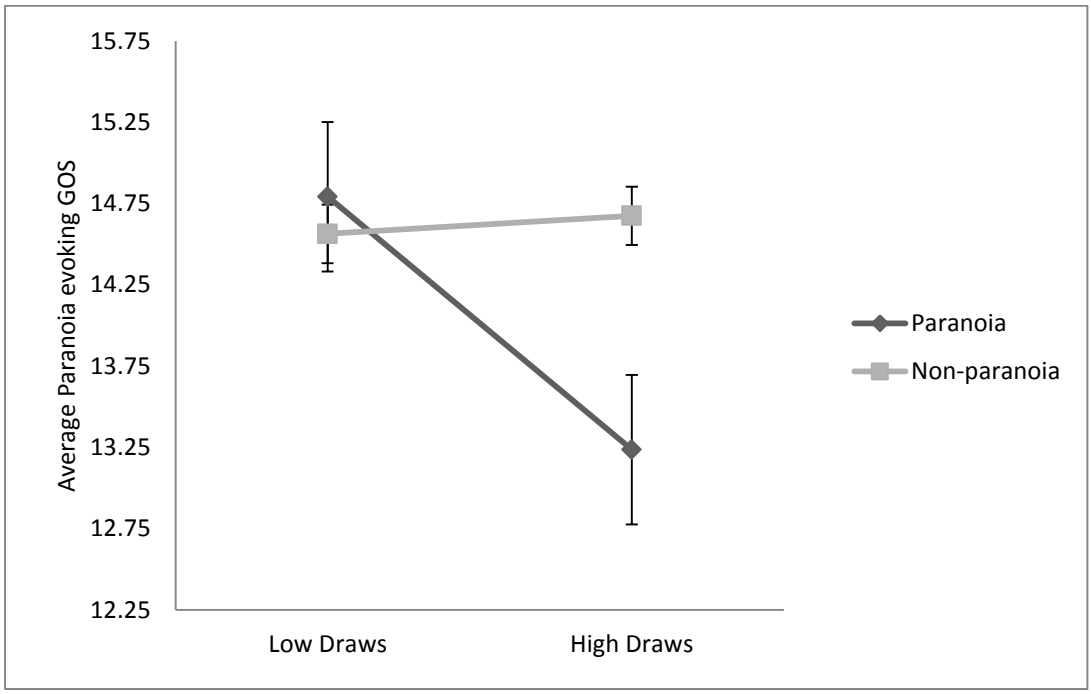
Exploratory analysis of GOS and JTC.

It was not possible to make an a priori prediction regarding the expected relationship between GOS and JTC. JTC as a reflection of disjointed reasoning would be expected to be associated with low GOS, but, according to the HET, the well-established association of JTC and

paranoia would predict greater facility, and a higher GOS score, for paranoia evoking content. The average paranoia GOS score was regressed on beads draws to decision and group membership (SA and control groups were combined for the present analysis given no differential prediction between these groups). Group was entered in the first step, followed by bead draws and the interaction term. There was no effect for group [$F(1,61)=1.50$, $p = .23$) or beads draws [$F(1,60) = .41$, $p = .53$]. However, the ΔR^2 for the interaction term was .05, and this was significant [$F(1,59) = 4.27$, $p = .043$]. As shown in Figure 1, there was no association between number of bead draws in the non-paranoia group and a negative relationship in the paranoia group—fewer draws to decision (i.e., greater JTC bias) was associated with *higher* GOS.

Figure 1

Relationship between bead draws and goodness of simulation by group (Paranoia versus Non-paranoia) for average paranoia scenario



Discussion

The main aim of this study was to investigate reasoning within non-clinical paranoia by use of a simulation task (Brown et al., 2002), following on from a similar study of clinical paranoia (Huddy

et al., 2014), while addressing some of the methodological issues raised in the earlier study. The central prediction, in line with Hyper Emotion Theory (HET; Johnson-Laird et al., 2006) was that paranoid and socially anxious individuals would be adept reasoners about content matching their areas of concern and that this would be reflected in good mental simulations of relevant scenarios. As was the case in the Huddy et al. (2014) study, the prediction was not supported for paranoia. However, the social anxiety comparison group on average better simulated a scenario with congruent thematic content compared to one with non-congruent content. Partial support was also found for the prediction, based on the putative operation of the simulation heuristic, that better simulations would be associated with greater worry, which would in turn be associated with higher subjective probabilities. Finally, in an exploratory analysis, jumping to conclusions bias was found to be *positively* related to goodness of simulation for paranoia themed scenarios within the paranoia group.

The finding that the social anxiety group provided better simulations on average for a scenario with congruent content parallels Keen et al.'s (2008) findings in a group with OCD symptoms. Johnson-Laird et al. (2006) suggest a number of reasoning processes that likely contribute to the development of enhanced reasoning for content congruent with a disorder, including confirmatory and emotional reasoning (Arntz, Rauner, & van den Hout, 1995) and repetitive elaboration of anticipated outcomes, which has been shown to raise subjective probabilities for those outcomes (Tversky & Koehler, 1994). A number of consistent effects have been reported in the social anxiety literature. Thus, Wild (2009) found that rehearsal of negative imagery within social anxiety increased its familiarity and was associated with increased belief in a negative self-image, and Morrison, Amir and Taylor (2011) similarly suggested that imagery may be generated more efficiently as a result of over-practice.

It is not immediately apparent that paranoia would be any worse a fit to HET than OCD, social anxiety, or any of the several other emotional problems included in the Johnson-Laird et al. (2006) paper in which the theory is set out. Elaboration of potential outcomes (Tversky & Koehler,

1994) and confirmatory and emotional reasoning appear to be equally implicated in the phenomenology of paranoia. However, HET crucially proposes that individuals are only adept reasoners within their area of preoccupation. Huddy et al. (2014) suggested with regard to their clinical sample that the scenarios they used, although constructed around themes systematically identified by Boyd and Gumley (2007) within a clinical paranoia sample, may not have been relevant enough to individuals' idiosyncratic concerns. The present study likewise used scenarios based on narratives of paranoia experiences from a student population comparable to the sample of the present study (Allen-Crooks & Ellett, 2014), along with the best performing scenario from Huddy et al. (2014), but these still might not have corresponded, for a sufficient portion of the sample, to their own paranoia evoking ideation. Keen et al. (2008), for example, reported that when scenarios were not relevant to an individual's OCD related concerns, even if still OCD themed, GOS was reduced and inversely related to worry. It may very well be that the method employed in the current study is only suited to phenomena like OCD and social anxiety that are more faithfully captured by prototypical scenarios that are more likely to resonate with a given member of the symptom group. This may not be achievable for paranoia, where the concerns are more particularized to an individual's circumstances.

An alternative possibility is that the lack of evidence of enhanced facility with prototypical paranoia content in the format in which it is presented in the present study may be a substantive difference between paranoia and anxiety disorders, and, particularly, may form part of the basis on which paranoia may be discriminated from social anxiety, to which it is tied conceptually in theories of paranoia (e.g., Freeman et al., 2004). The simulation paradigm presumes that reasoning about hypothetical scenarios makes use of imagery (e.g., Raune, MacLeod, & Holmes, 2005), and the anticipatory nature of anxiety problems like social anxiety, OCD, and worry, for which evidence has been found for a role for simulation, may promote rehearsal of disorder relevant imagery content. In contrast, it may be that paranoia is most marked as people reason following present time perceptions (e.g., a glance or a snatch of conversation) that is less anticipatory, less evocative of

imagery, and so less addressable by the current task where verbal statements are intended to elicit image-based reasoning process. Paranoia, instead (still potentially consistent with the HET), may be more characterized, on balance, by the type of post-event ruminative processing also found in social anxiety. Further research that can dissociate anticipatory, real-time, and poct hoc processes could shed light on this question.

In an exploratory finding, JTC appeared to moderate the relationship between paranoia and GOS, with lower GOS found in the paranoia group for those with *greater* draws to decision (i.e., with a relative *lack* of JTC bias). Were this finding to replicate, further research would be necessary to clarify the basis for the relationship. A plausible account consistent with existing findings in this area would start with liberal acceptance of potentially unusual logical inferences made by those with JTC bias (Corcoran, 2010; Woodward, Moritz, Cuttler, & Whitman, 2006) that is not subjected to disconfirmatory evaluation (e.g., Freeman, 2007; Woodward et al., 2006). The relevant lines of reasoning would subsequently be reinforced through the mechanisms proposed by HET, giving rise to greater ease of simulation for the content with repeated engagement. This highlights the fact that the HET is in essence a developmental theory that can only be conclusively supported through longitudinal research.

Confirmatory evidence that JTC bias was functionally related to higher GOS would not be atypical of the paradoxical and contradictory nature of the current findings in the area of cognitive biases and paranoia. The introduction to a recent special journal issue devoted to the area was entitled “Cognition and delusions: What do we know, what do we guess, what do we perhaps falsely believe?” (Balzan & Moritz, 2017). Indeed, there appears to be an emerging understanding that phenomena regarded as potentially maladaptive biases may be situationally adaptive. A recent meta-analysis of JTC and delusional thinking (Dudley, Taylor, Wickham, & Hutton, 2015) found that, although those with psychosis had higher odds of extreme JTC responding compared to controls, a substantial minority of the comparison participants (29% of non-clinical controls and 38% of clinical controls) met the conventional criterion of 1-2 draws considered to reflect extreme JTC. Similarly,

van Leer, Hartig, Goldmanis, and McKay (2015) employed an incentivized version of the standard JTC task to establish, for the first time, an optimum number of draws relative to which it could be judged whether respondents were jumping to a conclusion. They found that non-clinical participants who were relatively more delusion-prone showed the usual fewer draws on average than the non-delusion prone comparison group; however, both they and the comparison groups, on average, "jumped" before the optimum decision point.

That putatively extreme or at least suboptimal responding on bias tasks is relatively commonplace suggests that these biases are likely to be adaptively motivated and may be relied upon because they do not inevitably produce adverse consequences. Gangemi and Cardella (2014) reviewed a range of investigations into reasoning in psychosis in which initial adverse effects are no longer found when moderators such as intelligence are accounted for, and other situations in which a putative bias or reasoning error is ultimately advantageous. They suggest, for example, where real danger is perceived to be possible, jumping to conclusions could be viewed as being consistent with a "better safe than sorry" conservative safety seeking strategy that over-responds to potential dangers so as not to delay reacting to real dangers when they occur. Summarizing the relevant research, Gangemi and Cardella conclude that "in some cases, schizophrenics are more logical than healthy people, they are able to judge the validity of a syllogism without being distracted by its content, they falsify conditional rules without being diverted by heuristic traps and they are usually less sensitive to a number of reasoning biases" (p. 109). This is also consistent with the conceptualization of paranoia, from an evolutionary perspective, as a trait that was selected due to its adaptive value in allowing detection of threat to self by others (Ellett, Lopes, & Chadwick, , 2003).

There are clear limitations of the current study that should be clearly acknowledged. First of all, despite general support of the continuum approach to paranoia in the literature, paranoia within the current sample is a non-clinical analogue of a clinical phenomenon. Moreover, the sample was overwhelmingly female. Whereas analyses checking for readily apparent distortion of results due to

gender composition provided some assurance in this regard, the results need to be regarded as provisional until repeated in a demographically more representative sample.

In summary, the present study was unsuccessful in its main aim of demonstrating the operation of the simulation heuristic within paranoia. However, the heuristic appeared to operate as predicted within social anxiety, therefore extending previous findings in relation to worry and obsessive compulsive symptoms. Possible reasons for the negative findings with regard to paranoia include the need to match content more idiographically to individual concerns or the potential mediating and moderating effects of cognitive style factors that may produce contradictory effects under different circumstances. These factors should be investigated further in future research.

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Appendix 1 – Simulation task scenarios

1. Shop (neutral): At the beginning of the scenario, you are returning items to a shop. The cashier tells you that their policy does not allow you to do so without a receipt.
At the end of the situation, you leave the shop with your refund.

2. Speech (social anxiety): At the beginning of the situation, you are at a gathering at which, unexpectedly, each person attending has been told they will be asked to stand up in front of the group to give a short speech about themselves.
At the end of the situation, the meeting has been interrupted and a crowd of people has gathered around you looking concerned.

3. Job: At the beginning of the situation, you have arrived home after a job interview. During the course of the evening, you receive several phone calls from unidentified numbers, and each time you answer the phone the person on the other end of the line hangs up. At the end of the situation, it is the next day and you receive a call from the potential employer informing you that they have been unable to arrive at a decision and will be interviewing other candidates.

4. Public Place: At the beginning of the situation, you are sitting in a public place and an older man sits down next to you and starts speaking to you. He is very keen to talk and asks you about yourself.
At the end of the situation, you are making your way home when you see the man speaking on his mobile phone.

5. Friend (loyal and disloyal): At the beginning of the situation you have just introduced a good friend to someone you are acquainted with but do not know very well. The three of you end up discussing your weekend plans.
At the end of the situation, it is the next Monday, and you log onto Facebook and see pictures of your friend and the other person together at a party you were not invited to.

- **i)** (But) on this occasion I want you to provide a response in which your friend has *betrayed your trust*
- **ii)** (but now) I'd like you to provide a response in which your friend has *stayed completely loyal*