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Persecutory delusions: Effects of cognitive bias modification for interpretation and the Maudsley Review Training Programme on social anxiety, jumping to conclusions, belief inflexibility and paranoia

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Persecutory delusions: effects of Cognitive Bias Modification for Interpretation and the Maudsley Review Training Programme on social anxiety, jumping to conclusions, belief inflexibility and paranoia.

Abstract

Background and Objectives: The Threat Anticipation Model (Freeman, 2007) implicates social anxiety, jumping to conclusions (JTC) and belief inflexibility in persecutory delusions. We investigated whether Cognitive Bias Modification for Interpretation (CBM-I; Turner et al., 2011) improves social anxiety by targeting negative interpretation bias of ambiguous social information. We determined whether the Maudsley Review Training Programme (MRTP; Waller et al., 2011) improves JTC, belief inflexibility and paranoia. We also explored effects of CBM-I on JTC/belief inflexibility and paranoia, as well as the MRTP on social anxiety.

Methods: Twelve participants from Early Intervention and Recovery Services in East Anglia completed measures of social anxiety, paranoia, JTC and belief inflexibility. A concurrent multiple baseline case series design was used.

Results: Three of twelve participants improved in social anxiety following CBM-I, paranoia improved in 6/12 cases. CBM-I had no effect on JTC/belief inflexibility. The MRTP improved JTC and/or belief inflexibility in 9/12 cases, while improving paranoia for 6/12 individuals. The MRTP improved social anxiety in one case.

Limitations: The small sample size and large effects necessary for single case series designs limit the generality of findings. These are discussed in more detail.

Conclusions: This study suggests that whilst both CBM-I and the MRTP may have a positive impact on paranoia and social anxiety, the effects on JTC/belief inflexibility are largely specific to the MRTP. Relationships between social anxiety, JTC, belief inflexibility and paranoia existed in 10/12 individuals, supporting the Threat Anticipation Model.

239 Words

Keywords

Persecutory delusions

Psychosis

Cognitive bias modification for interpretation

The Maudsley review training program

Jumping to conclusions

Social anxiety

1. Introduction

The Threat Anticipation Model (Freeman, 2007) implicates social anxiety, the jumping to conclusions data gathering bias (JTC) and belief inflexibility as distinct yet related mechanisms in the onset and maintenance of persecutory delusions. Freeman (2007) suggests that JTC and belief inflexibility may influence the appraisal of experiences, including the experience of social anxiety itself, thereby contributing to delusion formation and maintenance. Treatments for social anxiety and JTC/belief inflexibility may therefore be helpful in the treatment of paranoia and persecutory delusions.

1.1. The role of social anxiety and rationale for using CBM-I in psychosis

Freeman (2007) suggests that psychological processes underlying anxiety and paranoia may be similar, as both concern fears of being physically, socially or psychologically harmed. Interpretation bias has been defined as "...a consistent tendency to interpret emotionally ambiguous stimuli, situations, or events in a negative (or positive) manner..." (Lee et al., 2016). Negatively biased interpretation of social information has been implicated in the onset and maintenance of social anxiety (e.g., Clark & Beck, 2010; Mobini, Reynolds & Mackintosh, 2013). Based on these findings,

experimental manipulations of negative interpretation bias have been developed, i.e., Cognitive Bias Modification for Interpretation (CBM-I; Mathews & Macintosh, 2000). Studies have shown that CBM-I reduces negative interpretation bias (e.g., Beard & Amir, 2008). A recent meta-analysis found a non-significant effect for CBM-I applied to clinical samples of socially anxious individuals when controlled for heterogeneity ($g = 0.23$, 95% CI = [0.001, 0.46] Cristea et al., 2015). Preliminary research into effects of CBM-I on social anxiety in the context of first episode psychosis indicated improvement in idiographic mood (Turner, Hoppitt, Hodgekins, Wilkinson, Mackintosh & Fowler, 2011). A study investigating the effects of a single session of CBM-I on state anxiety among individuals diagnosed with schizophrenia found no significant changes (Steel, Wykes, Ruddle, Smith, Shah & Holmes, 2010). Therefore, the efficacy of CBM-I on anxiety within the context of psychosis remains poorly understood. Savulich, Freeman, Shergill and Yiend (2015) found negatively biased interpretation of emotional information in subclinical paranoia, with a subsequent study demonstrating significantly stronger interpretation biases within a sample of people with paranoid psychosis when compared with non-clinical controls (Savulich, Shergill & Yiend, 2017). This suggests that it may be feasible to examine the effects of CBM-I on paranoia. We were interested in determining whether CBM-I would improve social anxiety within co-occurring persecutory ideation, and to explore any links between change in social anxiety and change in persecutory beliefs. We are unaware of evidence examining whether CBM-I significantly changes paranoia, JTC and belief inflexibility within the context of persecutory delusions. This will be explored in the current study.

1.2. The role of JTC and belief inflexibility; rationale for application of the Maudsley Review Training Programme to people with persecutory delusions

There is evidence that the JTC data gathering bias (reaching a decision without sufficient evidence) and belief inflexibility (difficulty with the iterative process of generating, questioning and evaluating explanatory beliefs for experiences) occur in higher rates among individuals with delusions (e.g., Garety, Freeman, Jolley, Dunn, Bebbington & Fowler, 2005; So et al., 2012). The JTC data gathering

bias has also been implicated in cognitive models of persecutory delusions, with empirical support (Startup, 2004; Startup, Freeman & Garety, 2008). Recent research has focused on inducing experimental manipulation of JTC and belief inflexibility in people with delusions. Waller, Freeman, Jolley, Dunn and Garety (2011) have extended the work of Ross, Freeman, Dunn and Garety (2011) by developing the MRTP, aimed at improving data gathering prior to reaching a decision and increasing belief flexibility in order to more fully evaluate beliefs in the light of new evidence. Waller et al. (2011) found a significant improvement in delusional conviction. A recent study has indicated that the MRTP significantly reduced state paranoia in a sample of individuals with delusions, although JTC and belief inflexibility did not mediate this change when controlling for confounding baseline variables (Garety et al., 2014). These preliminary findings guided use of the MRTP, in conjunction with CBM-I in this study, to explore if the MRTP also affects social anxiety as well as JTC/belief inflexibility.

1.3. Aims of the study

As mentioned above, studies have looked at the use of CBM-I and the MRTP in isolation. Paranoia is multifaceted and the evidence suggests a number of differing underlying mechanisms, including emotional pathways (anxiety) and the role of reasoning. The current study aimed to investigate whether combining these interventions is feasible. The aims of the current study were: 1. to ascertain the effects of CBM-I on social anxiety and the MRTP on JTC and belief inflexibility, 2. to investigate if CBM-I also changes JTC/belief inflexibility and if the MRTP also impacts on social anxiety, 3. to explore the effect of each programme on paranoia, and 4. to investigate if change in social anxiety, JTC and/or belief inflexibility corresponds with change in paranoia, irrespective of which task induced change. To address these areas, we posed the following research questions:

- a. Does CBM-I have an effect on JTC and/or belief inflexibility?
- b. Does CBM-I reduce paranoia?
- c. Does the MRTP improve social anxiety?

We also hypothesised the following:

1. In comparison to baseline, five sessions of CBM-I will reduce levels of social anxiety.
2. In comparison to baseline, five sessions of the MRTP will improve JTC and/or belief inflexibility.
3. In comparison to baseline, five sessions of the MRTP will reduce paranoia.

We were also interested in ascertaining relationships between improved social anxiety, JTC and/or belief inflexibility corresponding with improved paranoia on a case-by-case basis, irrespective of which task induced change, in order determine whether or not the assertions of the Threat Anticipation Model (2007) would be upheld.

2. Method

2.1. Participants

Potential participants in two community mental health teams were contacted by their care coordinator and invited to participate in the research. Twelve participants completed the study. Inclusion criteria were adults with a primary diagnosis of schizophrenia spectrum disorder and presence of persecutory delusions, according to Freeman and Garety's (2000) definition, held at 50% conviction or higher. Exclusion criteria included being involved in any psychological intervention at the time of the study, primary diagnosis of substance dependency, learning disability or difficulty with English such that understanding the tasks and related documentation would be too difficult. Table 1 gives the demographic and clinical characteristics of participants.

Characteristic	Value	Range
Mean age (SD)	39.4 (14.5)	19-61
Gender		
Male	8	
Female	4	
Mean estimated NART IQ (SD)	109.7 (5.9)*	100-116
Ethnicity		
White British	12	
Diagnosis		

Paranoid schizophrenia	5	
Non-organic psychosis	3	
Schizoaffective disorder	3	
Delusional disorder	1	
Mean length of difficulties in years (SD)	10.29 (7.59)	1-23
Patient status		
Outpatient	12	
Recruited from Early Intervention	3	
Recruited from Recovery Services	9	
Participants taking antipsychotics	11	
Mean daily chlorpromazine equivalents (SD)	420.8 (285.6)	0 – 1000mg daily
Mean initial delusional conviction (SD)	85% (15%)	50-100%
Mean delusional conviction at follow up (SD)	53% (37%)	0-100%
Baseline PSYRATS B total scores (SD)	19.67 (1.83)	16-22
Follow-up PSYRATS B total scores (SD)	11.5 (5.81)	0-19

Table 1 Clinical and demographic characteristics of participants

Note: *Participant 3 declined to do the NART. All other data are complete. Chlorpromazine equivalents were calculated according to Woods (2003 & 2011) and Atkins, Burgess, Bottomley and Riccio (1997); PSYRATS B – Psychotic Symptoms Rating Scale B: Delusions Subscale (Haddock, McCarron, Tarrier & Faragher, 1999).

2.2. Measures

2.2.1. The National Adult Reading Test (NART; Nelson, 1982)

The NART is a commonly used indicator of premorbid IQ (McGurn et al., 2004) and was used in this study to estimate IQ of participants, as part of general demographic data.

2.2.2. The PSYRATS-B (Haddock et al., 1999)

This semi-structured interview assesses severity of delusions in several different domains; preoccupation with delusions, conviction, distress and disruption to life caused by beliefs. Good psychometric properties, including sensitivity to change, have been reported (Drake, Haddock, Tarrier, Bentall & Lewis, 2007).

2.2.3. The Social Interaction Anxiety Scale (SIAS; Mattick & Clarke, 1998)

The SIAS assesses severity of social anxiety; out of a total of 80, scores of 34 or above indicate clinically significant social anxiety. Mattick and Clarke (1998) report high internal consistency ($\alpha =$

.94), while others have demonstrated good test-retest reliability (range from .86 to .92; Heimberg, Mueller, Holt, Hope & Liebowitz, 1992).

2.2.4. The Green et al., Paranoid Thoughts Scale (GPTS; Green et al., 2007)

The GPTS is a 32-item scale with two constructs measuring (1) ideas of reference and (2) overt persecution, which combined make a robust measure for paranoia. Reliability was found to be very high ($\alpha = .90$) and factor analysis demonstrated good measurement of ideas of reference and persecution.

2.2.5. Measures of JTC; the 85:15 and 60:40 Beads Tasks (Garety et al., 2005)

These tasks represent the 'easy' and 'difficult' versions of a Bayesian probabilistic reasoning task that has been extensively used among individuals with delusions. Data were grouped by category of whether participants JTC or not.

2.2.6. Measures of belief inflexibility; Possibility of being Mistaken (PBM), Reaction to Hypothetical Contradiction (RTHC) and Explanations of Experiences (EoE; Freeman, Garety, Fowler, Kuipers, Bebbington & Dunn, 2004)

The PBM and RTHC are from the Maudsley Assessment of Delusions Schedule (MADS; Wessely et al., 1993). These measures have been extensively used in delusions research (e.g., Garety et al., 2014) and yield categorical and ordinal data, respectively. Wessely et al. (1993) reported good inter-rater reliability for PBM ($k = .91$) and RTHC ($k = .90$) components.

2.2.7. Idiographic ratings of social anxiety, conviction and paranoia

Social anxiety, delusional conviction and paranoia were measured using daily idiographic ratings, ranging from 0-100%. Anchor points were provided, e.g., 0% = not at all, 25% = somewhat, 50% = moderately, 75% = very, 100% = extremely. Similar anchor points were used for delusional conviction and paranoia. The wording for each measure was as follows; 'today I am feeling __%

socially anxious,' 'today, I am feeling under threat by others___%,' and 'thinking about your main worry, how much do you believe it is true?___%.'

2.3. *Experimental manipulations*

2.3.1. *Text-based CBM-I for social anxiety in psychosis, Turner et al. (2011)*

CBM-I encourages benign or positive, rather than negative interpretation of ambiguous social information. Bias modification (Mathews & Mackintosh, 2000) is hypothesised to induce symptom reduction (Amir & Taylor, 2012). The materials used in the current study were identical to those developed by Turner et al. (2011). Participants were presented with written instructions and 100 social scenarios, given in blocks of 10. Each scenario was emotionally ambiguous until the final word, which was fragmented and resolved the scenario positively. Each scenario concluded when the correct letter was inserted into the fragmented word. A comprehension question was then presented to ensure interpretation of the scenario in the intended way. Feedback on whether the participant's response was 'correct' or 'incorrect' was given.

An example of one scenario is: "You decide to take the bus into town. The bus is very crowded with teenagers shouting at each other. A young man lurches up to you and raises his hand in a [word presented with missing letters: gre-ting]. [Correct word: greeting]. [Missing letter: e]. Do you think the young man is being unfriendly? [Correct response: No]."

2.3.2. *The Maudsley Review Training Programme; the MRTTP – Waller et al. (2011)*

This package aims to reduce frequency of JTC, improve ability to generate alternative explanations of experiences and reduce delusional conviction. The training package was delivered in task format by computer. Each of the five tasks is described in detail by Waller et al. (2011), and include real-life videos, visual puzzles, and ambiguous situations in which multiple choice-style answers are encouraged in order to facilitate slowing down decision making, generating alternative explanations for situations and realising when we JTC and how it can be unhelpful.

3. Design

A concurrent multiple baseline ABC crossover design was used (Kazdin, 2010), which involves allocation of baseline of two differing lengths, along with counterbalancing of order of task allocation, followed by a follow up assessment after one month. Obtaining baseline data establishes that symptoms may not be on a natural path to recovery with some confidence (Kazdin, 2010), thereby allowing attribution of any change to the task introduced. The ABC aspect depicts the three phases; baseline, intervention one and intervention two. Twelve participants were block randomised to one of four conditions. The four conditions comprised two differing baseline lengths of either two or three weeks and counterbalanced order of task blocks, comprising 5 sessions of each task over a period not exceeding that of the baseline. The use of alternating cognitive interventions is well documented; Barlow and Hayes (1979) and Kratochwill and Levin (2010) review many applications of cross-over (or counterbalancing) designs of two psychosocial interventions and report that they are appropriate for small N case studies, once treatments are randomly counterbalanced.

Figure 1 illustrates the design and order of task allocation. *Please include Fig 1 in online colour only, thank you.

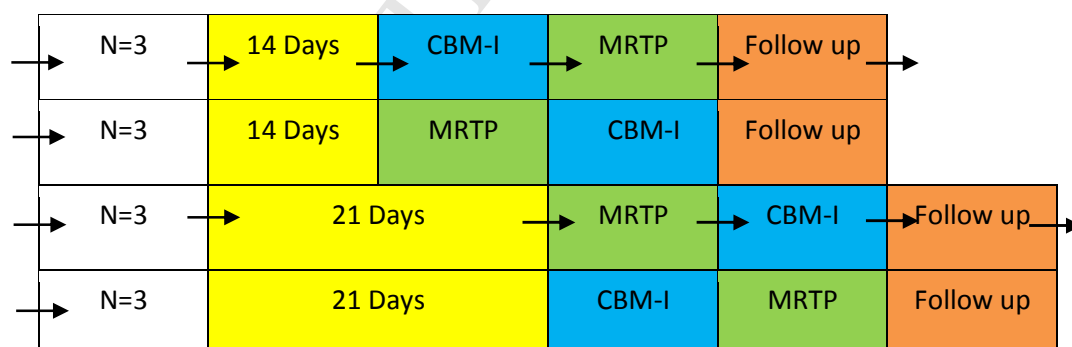


Fig. 1 Outline of four conditions to which participants were randomised, arrows indicate assessment points.

The study protocol was approved by the East of England NHS Research Ethics Committee and the Norfolk and Suffolk NHS Foundation Trust Research and Development Committee. Potential participants underwent a screening meeting to determine eligibility for inclusion. Figure 2 details recruitment.

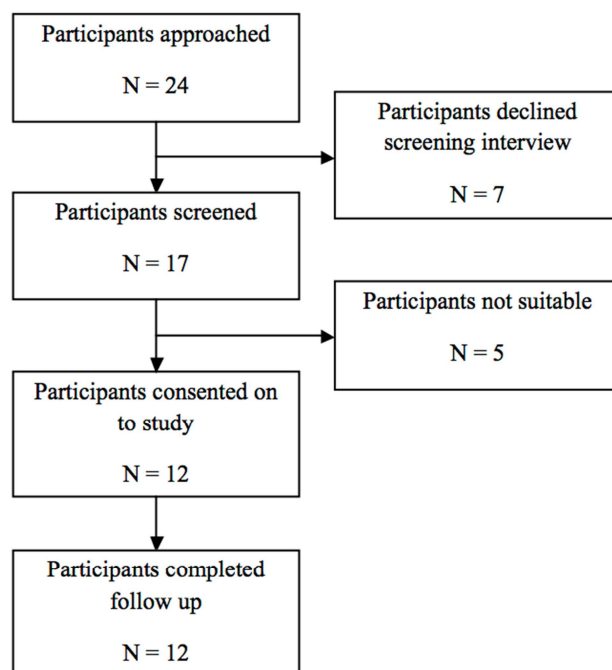


Fig. 2 CONSORT diagram of recruitment

Following the screening interview, five individuals were deemed not suitable for the study because they experienced beliefs of reference, or beliefs of being followed without any intention to harm, not persecutory delusions as operationalised by Freeman and Garety (2000). Upon completion of the first meeting, participants began their two or three week baseline period, during which they self-rated their own levels of social anxiety, conviction in their main delusion, and severity of paranoia once daily. Apart from completing the idiographic data once daily during the two or three week baseline phase, all other assessment and intervention sessions were delivered with the researcher (JH) present. After completion of the baseline period, the researcher conducted the assessment again. The first session of the first computerised task was immediately given, with the researcher present. Participants completed three idiographic measures of conviction, paranoia and social

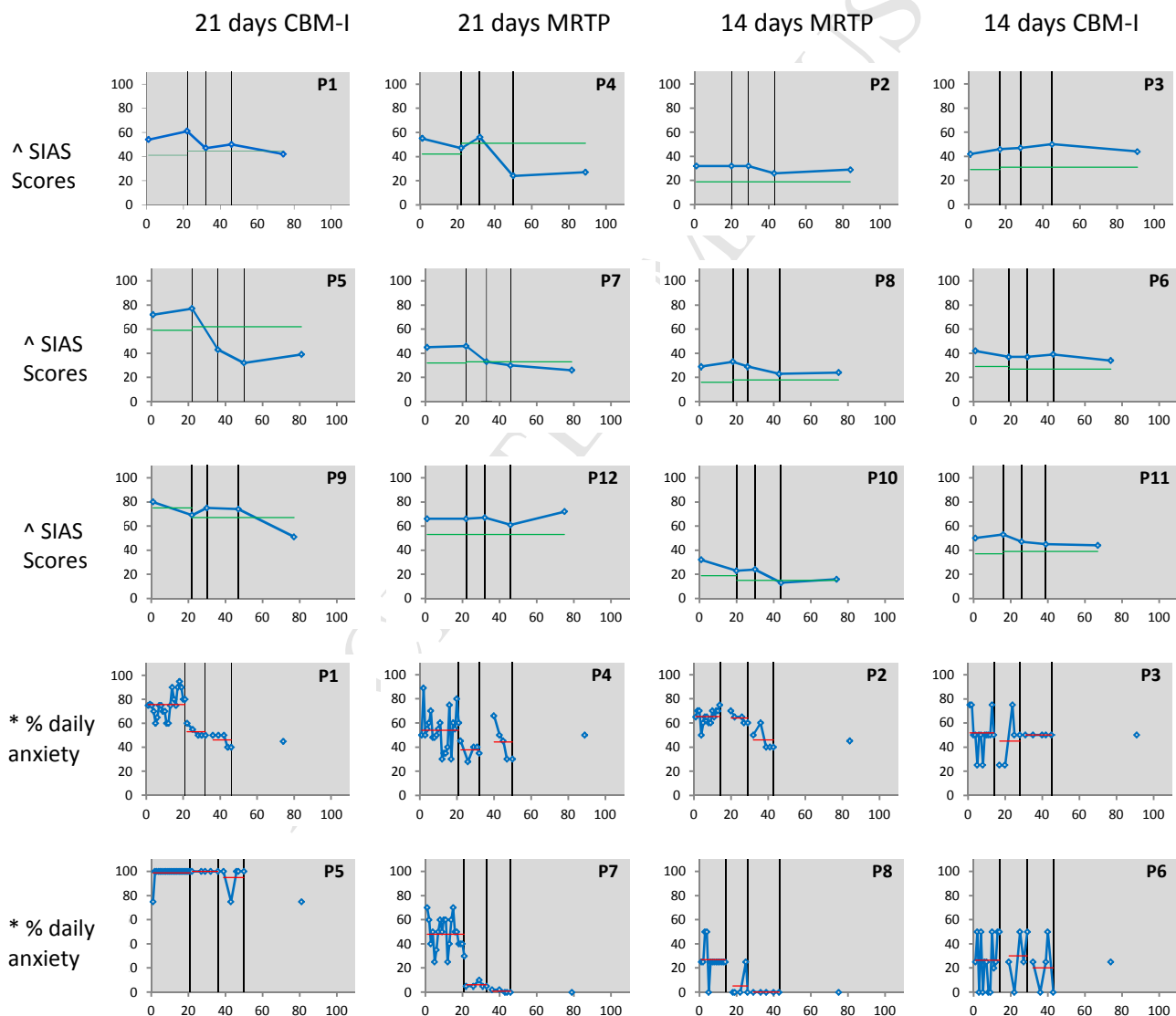
anxiety at the end of each session. Both blocks of computerised tasks were five sessions long, delivered over two weeks at a rate of approximately one session every two or three days. Following completion of the first five session block, the participants completed the research assessment again. The second block then began two or three days after completion of the first. As before, the three idiographic measures were completed at the end of each session. Upon completion of the second block, participants completed the research assessment and then entered the follow-up phase. After one month, the follow-up meeting was conducted, where the research assessment was re-administered. Participants then discussed with the researcher how they found using the programmes, any new ideas or learning they had encountered, whether or not they found the tasks helpful, etc.

3.1. Data analyses

The primary analysis comprised visual inspection of time series data according to Kazdin's (2010) four criteria examining change in mean values, slope, level and latency of change of values across conditions. Reliable change indexes (RCI) were calculated for GPTS and SIAS data, according to Jacobson and Truax (1991). Using the standard deviation and reliability coefficient reported by Mattick and Clarke (1998), the RCI for the SIAS was 12.86. Data from Green et al. (2007) yielded a RCI for the GPTS of 18.69. Therefore, reductions greater than or equal to 13 points on the SIAS and 19 points on the GPTS were considered significant. Clinical cut-off scores, using psychometric data from Green et al. (2007), were calculated as 86.2. GPTS scores above 86 during baseline that reduced to below 86 during intervention phases were considered clinically significant. For the SIAS and GPTS data, reliable change was established if the line plotted between two scores bisected the horizontal line. Baseline reliable change was derived by subtracting the RCI from the first baseline score. Reliable change across intervention and follow-up conditions was calculated by subtracting the RCI from the average of both baseline scores, to account for fluctuation of score during baseline. Effect was attributed to the first task that induced reliable reduction in SIAS or GPTS scores, due to

potential confounding of carry-over effects. For the JTC and belief inflexibility data (measured by JTC 85:15 and 60:40 tasks, PBM, EoE and RTHC measures), visual inspection was performed by tabulating all measures per participant across all conditions. If JTC or belief inflexibility improved during either intervention phase, effect was attributed to the respective task. As with the SIAS and GPTS data, once an effect had been established in one condition, further improvement was difficult to attribute to a subsequent condition. This is because it would be unclear if further improvement resulted from carry-over effects of the first task, new effects from the second or interaction of both.

*Please include Figs 3, 4, & 5 in online colour only, thank you.



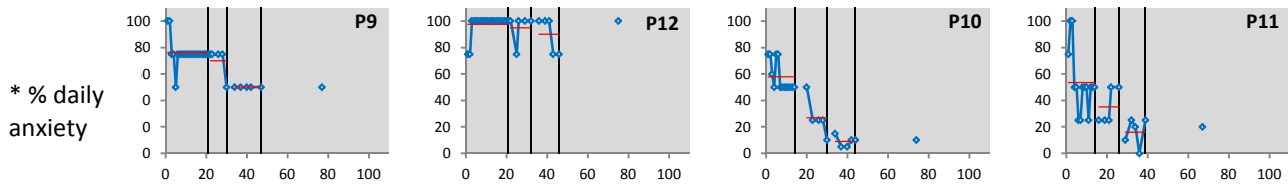
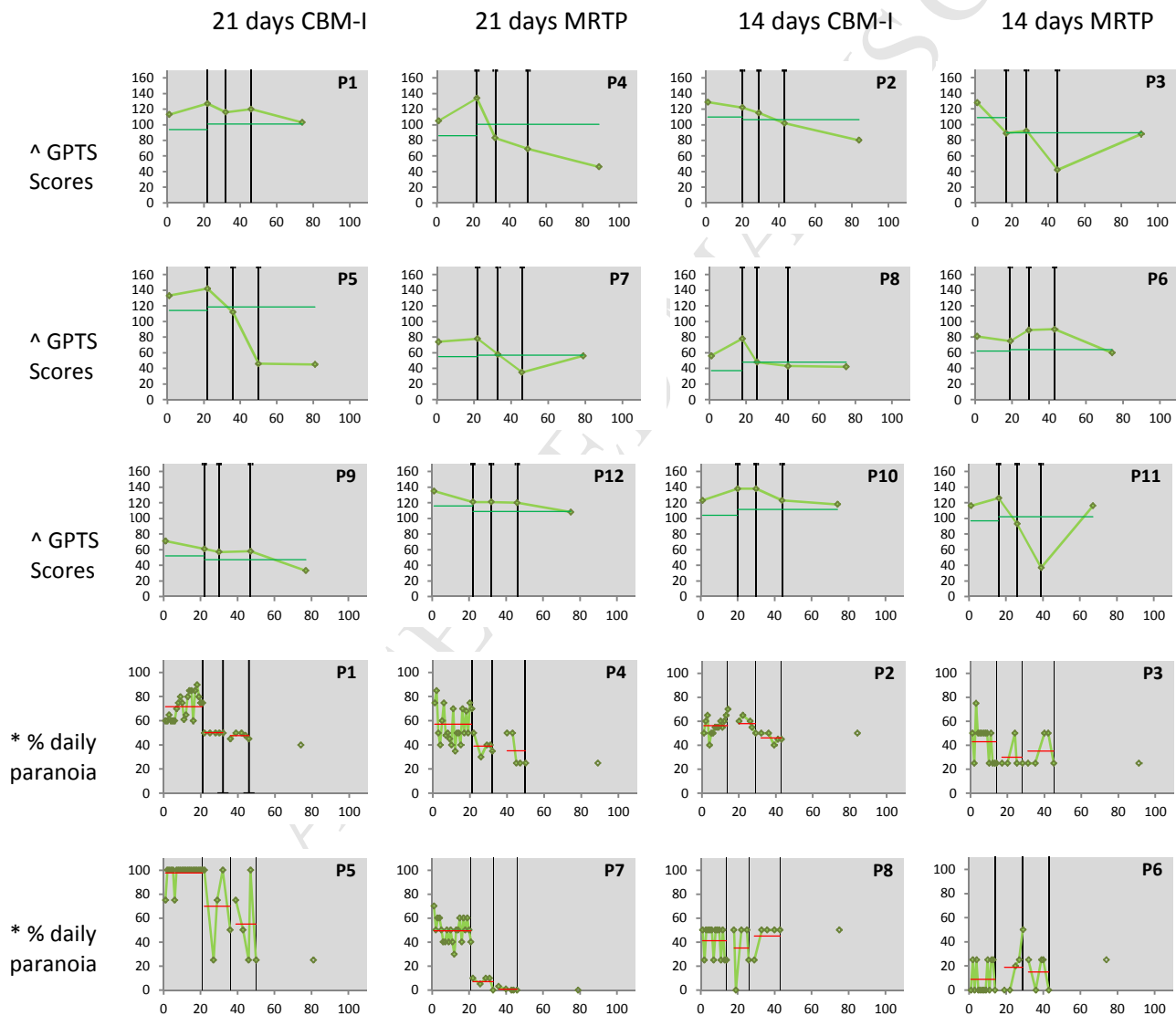


Fig. 3 Case series of idiographic and standardised social anxiety

Note: \wedge SIAS (range 0 – 80) — = reliable reduction in SIAS score. * Idiographic social anxiety (range 0-100%) — = mean idiographic ratings. Y-axes = SIAS scores, or percentage daily anxiety scores. X-axes = number of days. 21 days CBM-I = 21 day baseline, followed by 5 sessions of CBM-I, then 5 sessions of MRTP, then one month follow up. 14 days MRTP = 14 day baseline, followed by 5 sessions of MRTP, then 5 sessions of CBM-I, then follow up. Each phase is separated by a vertical black line.



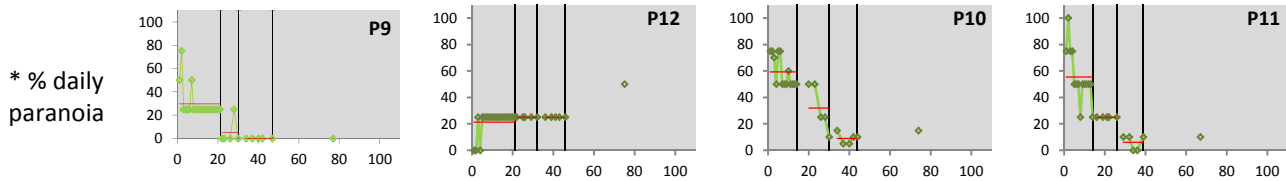


Fig. 4 Case series of idiographic and standardised paranoia

Note: ^ GPTS (range 0 – 160) — = reliable reduction in GPTS score. * Idiographic paranoia (range 0-100%) — = mean idiographic ratings. Y-axes = GPTS scores, or percentage daily paranoia scores. X-axes = number of days. 21 days CBM-I = 21 day baseline, followed by 5 sessions of CBM-I, then 5 sessions of MRTPT, then one month follow up. 14 days MRTPT = 14 day baseline, followed by 5 sessions of MRTPT, then 5 sessions of CBM-I, then follow up. Each phase is separated by a vertical black line.

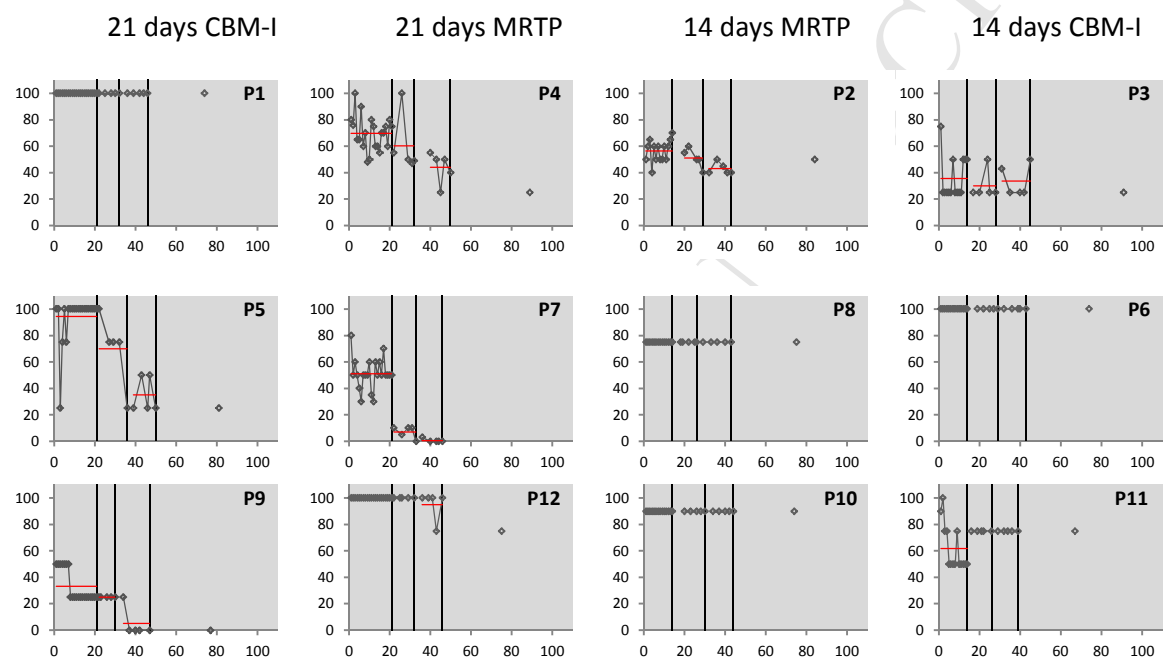


Fig. 5 Case series of idiographic conviction

Note: — = mean idiographic conviction ratings. Y-axes = percentage daily conviction scores. X-axes = number of days. 21 days CBM-I = 21 day baseline, followed by 5 sessions of CBM-I, then 5 sessions of MRTPT, then one month follow up. 14 days MRTPT = 14 day baseline, followed by 5 sessions of MRTPT, then 5 sessions of CBM-I, then follow up. Each phase is separated by a vertical black line.

Measure of JTC / belief inflexibility	Baseline 1 frequency	Baseline 2 frequency	N improved following CBM-I	N improved following MRTPT	Follow up frequency
JTC 85:15	5/12	4/12	0/4	3/4	1/12
JTC 60:40	5/12	4/12	0/4	3/4	1/12
PBM	7/12	6/12	0/6	4/6	4/12
EoE	11/12	10/12	0/10	8/10	3/12
RTHC	8/12	6/12	0/6	3/6	4/12

Table 2 Frequency table for reasoning (JTC, PBM, EoE and RTHC)

Note: JTC 85:15 – N who jumped to conclusions on the 85:15 task, JTC 60:40 – N who jumped to conclusions on the 60:40 task, PBM – N who reported no possibility of being mistaken about their delusion, EoE – N who could not report at least one possible explanation qualitatively different to the current delusion, RTHC – N who demonstrated belief inflexibility by either rejecting the contradiction or accommodating the contradiction into their delusion.

4. Results

Results for hypothesis one (that CBM-I will improve social anxiety) indicated that social anxiety significantly improved in three of twelve cases (Participants 4, 5 & 10). Although further reduction in social anxiety was observed in some graphs in figure 3, it was unclear whether this was due to lasting change induced by CBM-I or by other causes such as interaction effects of both tasks (e.g., Participants 1 & 9). Therefore, effect on social anxiety was attributed to CBM-I only in those cases where it was clear. In two out of three cases (Participants 4 & 5), reduction in social anxiety was maintained at follow up.

Results for hypothesis two (that the MRTP would improve JTC and/or belief inflexibility), in figure 3 and table 2 indicated improvement in JTC and/or belief inflexibility in nine of twelve cases (Participants 2 – 5 & 8 – 12). Improvements in JTC/belief inflexibility remained for all nine participants at follow up. Figures 4 & 5 indicated that the MRTP also improved paranoia (GPTS scores and/or delusional conviction) in six out of twelve cases, supporting hypothesis three (Participants 3, 4, 5, 7, 8 & 9 - effects of the MRTP & CBM-I overlapped in cases 4 & 5). All six cases maintained improved paranoia at follow up.

Research question A (does CBM-I improve JTC/belief inflexibility?) found no improvement in any cases following CBM-I. In relation to research question B (does CBM-I improve paranoia?), figures 4 and 5 and table 3 indicate improved paranoia and/or delusional conviction in six of twelve cases (Participants 2, 4, 5, 7, 11 & 12). Five out of six of those cases maintained reduced paranoia at follow up. Results indicated that the MRTP improved social anxiety in one case (Participant 7; research question C).

Participant	CBM-I Improved Social Anxiety	CBM-I Reduced GPTS	CBM-I Reduced Conviction	M RTP Improved JTC/belief inflexibility	M RTP Reduced GPTS	M RTP Reduced Conviction	Relationship Supported
1	N	N	N	N	N	N	Y
2	N	Y	Y	Y	N	N	Y
3	N	N	N	Y	Y	N	Y
4	Y	N	Y	Y	Y	N	Y
5	Y	Y	N	Y	N	Y	Y
6	N	N	N	N	N	N	Y
7	N	Y	Y	Y	N	Y	Y
8	N	N	N	Y	Y	N	Y
9	N	N	N	Y	N	Y	Y
10	Y	N	N	Y	N	N	N
11	N	Y	N	N	N	N	N
12	N	N	Y	Y	N	N	Y

Table 3 Relationship between improved social anxiety, JTC/belief inflexibility and paranoia according to task

Note: Y – Yes, N – No, ‘relationship supported’ column shows whether change (or lack thereof) in social anxiety, JTC/belief inflexibility, or paranoia corresponded with change in persecutory ideation, irrespective of task.

Table 3 indicates whether improved social anxiety, JTC and belief inflexibility corresponded with improved paranoia (as measured by either improved GPTS scores and/or reduced delusional conviction). Irrespective of task – paranoia, social anxiety, JTC and/or belief inflexibility correspondingly reduced in eight cases (participants 2, 3, 4, 5, 7, 8, 9 & 12). In two cases, no improvement was observed in social anxiety, JTC/belief inflexibility or paranoia (participants 1 & 6). The remaining two cases contradicted a relationship between improved social anxiety, JTC/belief inflexibility and paranoia (participants 10 & 11).

5. Discussion

The aims of this study were: (1) to ascertain if CBM-I reduced social anxiety and if the MRTP improved JTC/belief inflexibility in a case series of individuals with persecutory delusions, and (2) to determine the effect of the MRTP on paranoia. Research questions asked if CBM-I improves JTC/belief inflexibility and paranoia, and if the MRTP improves social anxiety. Any relationship between improved social anxiety, JTC/belief inflexibility and improvement in paranoia was noted.

In support of hypothesis one (that CBM-I will improve social anxiety), analysis indicated that social anxiety improved in 3/12 cases with maintenance of improvement in 2/12 cases at one-month follow up. However, in one case, the MRTP also improved social anxiety, maintained at follow up. Considering hypothesis two (that the MRTP will improve JTC/belief inflexibility), visual inspection suggested that in 9/12 cases, the MRTP improved this. All participants' improvements in JTC/belief inflexibility were maintained at follow up. Results for hypothesis three (MRTP will improve paranoia) found improved GPTS scores, conviction level, or both in 6/12 cases. These improvements remained at follow up.

The results of research question A found no effect of CBM-I on JTC and/or belief inflexibility. Research question B (does CBM-I improve paranoia?) showed improved paranoia in 6/12 cases. These improvements were maintained in 5/6 cases at follow up. Results for research question C (does the MRTP reduce social anxiety?) indicated reduced social anxiety in one case following the MRTP.

5.1. Theoretical implications

Improved social anxiety in 3/12 cases following CBM-I is limited evidence to support modification of negatively biased interpretation of social information resulting in improved social anxiety (e.g., Mogg & Bradley, 1998; Matthews & MacLeod, 1994). However, social anxiety remained high in the majority of cases. This is consistent with other studies examining CBM-I in individuals with social anxiety alone (Cristea et al., 2015) and with anxiety in the context of psychosis (e.g., Steel et al., 2010) and suggests that further research into the efficacy of this approach with this population is needed. One reason for the limited effect could be that individuals with psychosis represent a qualitatively different sample to individuals with sub-clinical or clinical social anxiety, which has been more extensively studied. CBM-I reduced paranoia in six cases, interestingly four of whom experienced no corresponding change in social anxiety (Participants 2, 7, 11 & 12). It is possible that the CBM-I task induced a more general change in negatively biased interpretation of emotional

information, such as that found by Savulich et al. (2015). The findings from this initial study provide little empirical evidence for the emergent finding of improved paranoia following CBM-I without corresponding social anxiety, but do indicate that applying CBM-I to severe levels of paranoia may be worthwhile. Establishing the presence, nature and proportion of interpretation bias among individuals with co-occurring persecutory ideation and social anxiety is important in clarifying cognitive mechanisms of social anxiety and paranoia, and work on establishing the presence and distribution of interpretation bias in clinical paranoia has begun (e.g., Savulich, Shergill, & Yiend, 2017).

This study has added to the evidence that JTC and belief inflexibility occur among individuals with persecutory delusions. It has also established that the version of the MRTP programme used was effective in improving JTC and/or belief inflexibility and paranoia in a small sample of people with persecutory delusions, mirroring findings in other studies (e.g., Garety et al., 2014).

These results indicate that JTC/belief inflexibility and social anxiety may have separate aetiologies. This fits with findings linking psychosis and neuropsychological difficulties, such as working memory and IQ (Broome et al., 2007; Garety et al., 2013). Difficulties with working memory have been shown to be specific to psychosis, rather than social anxiety, and have previously been proposed as a potential endophenotype of psychosis (e.g., Wood et al., 2003).

Results from research question C indicated that the MRTP did improve social anxiety in one case. Outside of psychosis, the effects of the MRTP are less known, but it is possible that the MRTP could be applied to other biases relating to other disorders.

This study also investigated any relationship between improved social anxiety, JTC, belief inflexibility and/or paranoia, irrespective of task. Considered together, the findings from the current study may provide some preliminary evidence for three questions that the Threat Anticipation Model (Freeman, 2007) poses. (1) Can it be shown that psychological factors are causal in paranoid

thinking (Freeman, 2007)? One advantage of this study was use of specific computerised tasks, aimed at discrete mechanisms of persecutory delusions, using an experimental prospective design. This study established with reasonable confidence that symptoms were not on a natural path to recovery. Therefore, experimental manipulation of these mechanisms corresponding with reduction in delusional conviction and persecutory ideation may lead to the conclusion that social anxiety, JTC, belief inflexibility and persecutory thinking are causally related. (2) Do psychological factors interact in the development of paranoia (Freeman, 2007)? Improved social anxiety, JTC and/or belief inflexibility corresponding with reduced paranoia and/or conviction in six cases (P3, P4, P5, P7, P8, and P9) suggests that these mechanisms may interact synergistically in the development and maintenance of paranoia. (3) Are threat beliefs most likely to become of delusional intensity when accompanied by data gathering biases such as JTC, or belief inflexibility? This study found that improved bias in JTC and/or belief inflexibility corresponded with reduction in persecutory ideation in six out of twelve cases. Improved JTC and/or belief inflexibility corresponding with improved ideas of reference, ideas of persecution and/or reduced delusional conviction do suggest that presence of data gathering biases may exacerbate delusional severity.

5.2. Clinical implications

The final research question asked by Freeman (2007; pp. 452) is 'can the developments in the understanding of paranoia be used to improve treatments?' This study indicates that the underlying mechanisms of social anxiety, JTC and/or belief inflexibility might be targeted with corresponding benefits in paranoia. Tasks that improve these underlying mechanisms without specifically challenging the delusional content may be more tolerable and agreeable for many people. However, findings from this small study will need replication.

The results of the current study indicate that CBM-I and the MRTP may not exert clinical effects large enough to be used as the only means of input for individuals. However, they might prove to be a useful adjunct to other evidence based interventions, such as CBT for social anxiety (Clark & Beck,

2010) or CBT for paranoid thoughts (Freeman & Garety, 2006). Use of the CBM-I and MRTTP scenarios may facilitate development of behavioural experiments, decreasing isolation and facilitating processing of disconfirmatory information.

A combination of some initial computerised sessions may be helpful for individuals who are suspicious and/or anxious and may therefore be unwilling to engage with services in the initial stages of therapy. As people make increased use of technology and computers in many areas of their lives, the idea of digital intervention delivered at home gains merit and feasibility. It also may be seen as an option for NHS trusts that seek cost effectiveness.

5.3. Advantages of the study

This study has several strengths. Rather than studying computerised packages in isolation, this study examines the effect of two interventions. Randomly allocated baseline lengths of either two or three weeks – without any treatment phase being longer in duration than the baseline – is methodologically sound for interpretation of temporal change (Kazdin, 2010). Although there is the potential for carry-over effects (which counterbalancing of treatment did address to some extent), the methodology enables differential effects to be tested. A further advantage was no participant drop out and no loss of data. Recent studies have shown that clinician involvement helps with engagement and outcome in self-help packages, (e.g., Cuijpers, Donker, van Straten, Li, & Andersson, 2010). Therefore, although there are potential reasons as to why researcher involvement may impact on study findings, there are also clear advantages for this approach.

5.4. Study limitations

The nature of single case series designs means that the findings of this study need to be interpreted with caution. Due to the repeated measures nature of single case series designs, study of more than one programme becomes difficult, due to the potential for cross-over and interaction effects. This is particularly true for studies that use tasks designed to induce lasting change in cognitive processes,

such as CBM-I and the MRTTP. It would also help to be mindful of any co-occurring complexity in clinical and research samples of individuals with psychosis, compared with samples of socially anxious people with a view to maximising effectiveness of interpretation and reasoning bias manipulation.

As outlined above, social anxiety is hypothesised to develop and be maintained by negative interpretation biases of social information, as defined above in section 1.1. (Stopa & Clarke, 2000; Staugaard, 2010). Not measuring interpretation bias and its relationship to social anxiety is a limitation, because it may have clarified the reasons why paranoia responded more to CBM-I than social anxiety. Further work into establishing prevalence rates of interpretation bias in this population has begun and does indicate that CBM-I may be a helpful approach for targeting interpretation bias in the context of clinical paranoia (Savulich et al., 2017).

The methodology would have benefitted from introducing another researcher who was blinded to condition allocation, although it was not feasible for this small-scale study. It is a possibility that demand characteristics influenced the results in unquantifiable ways.

5.5. Future research

Although the findings with respect to efficacy and application of CBM-I in persecutory delusions are equivocal, further research into the effects of both programmes in individuals with psychosis may be warranted. As mentioned above, continuing to establish prevalence rates of interpretation bias of social information among people with co-occurring social anxiety and persecutory thoughts is important, and initial rates have been obtained (Savulich et al., 2017). Findings by Savulich et al (2017) suggest fundamentally different cognitive mechanisms reflected by measures of interpretation bias and JTC in clinical paranoia.

Larger group designs may allow clarification of any relationship between social anxiety, JTC, belief inflexibility and paranoia, and whether mechanisms of change exert greater effects on reduced

paranoia. Identification of potential moderator variables may also further our understanding and refinement of interventions, e.g., do negative symptoms mitigate the efficacy of the MRTP on JTC and belief inflexibility, and therefore on paranoia?

Although social anxiety was reduced in a minority of cases, this study has somewhat replicated other literature on the experimental efficacy of CBM-I in reducing anxiety symptoms (e.g., Hallion & Ruscio, 2011). If further research into the application of CBM-I to persecutory delusions is warranted, then the next step may be to increase its efficacy. This may be accomplished by focusing on different perceptual processes, such as audio (e.g., Steel et al., 2010), or visual, rather than text-based delivery. Augmentation of CBM-I using computerised self-immersion or behavioural experiments may prove to be more effective for persecutory delusions. Recent studies have indicated that CBM-I tasks enhanced with prospective cognition to help consolidation of newly acquired interpretations may significantly boost its effectiveness (e.g., Lee, Matthews, Shergill, Yiu Chan, Majeed, & Yiend, 2015), although this will require replication in social anxiety and persecutory ideation.

6. Conclusion

In summary, this study yielded limited support for an effect of CBM-I on social anxiety in 3/12 cases and for an effect of CBM-I on paranoia in 6/12 cases. The MRTP improved social anxiety in 1/12 cases and improved paranoia in 6/12 cases. CBM-I did not have any effect on JTC or belief inflexibility but the MRTP improved JTC and/or belief inflexibility in 9/12 participants. The results therefore suggest that whilst both CBM-I and the MRTP may have a positive impact on paranoia, the effects on JTC and belief inflexibility are largely specific to the MRTP. The relationship between improved social anxiety, improved JTC and/or belief inflexibility corresponding with reduced persecutory ideation suggests further support for the Threat Anticipation Model (Freeman, 2007). However, these findings require replication in larger samples. Future research focusing on various

enhancements and clinical applications of these computerised tasks may help to improve their efficacy, potentially increasing the effectiveness of CBT for persecutory delusions.

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- We used two computerised tasks in 12 cases of persecutory ideation
- CBM-I reduced social anxiety in 3/12 cases; the MRTP reduced social anxiety in one
- The MRTP improved jumping to conclusions and/or belief inflexibility in 9/12 cases
- CBM-I had no effect on JTC/belief inflexibility in any cases
- Both programmes reduced paranoia in six of twelve cases each

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