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Voluntary and involuntary emotional memory following an analogue traumatic stressor: The differential effects of communality in men and women

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ABSTRACT

Background: Men and women show differences in performance on emotional processing tasks. Sex also interacts with personality traits to affect information processing. Here we examine effects of sex, and two personality traits that are differentially expressed in men and women - instrumentality and communality - on voluntary and involuntary memory for distressing video-footage.

Methods: On session one, participants (n=39 men; 40 women) completed the Bem Sex-Role Inventory, which assesses communal and instrumental traits. After viewing film-footage of death/serious injury, participants recorded daily involuntary memories (intrusions) relating to the footage on an online diary for seven days, returning on day eight for a second session to perform a voluntary memory task relating to the film.

Results: Communality interacted with sex such that men with higher levels of communality reported more frequent involuntary memories. Alternatively, a communality x sex interaction reflected a tendency for women with high levels of communality to perform more poorly on the voluntary recognition memory task.

Limitations: The study involved healthy volunteers with no history of significant psychological disorder. Future research with clinical populations will help to determine the generalizability of the current findings.

Conclusion: Communality has separate effects on voluntary and involuntary emotional memory. We suggest that high levels of communality in men and women may confer vulnerability to the negative effects of stressful events either through the over-encoding of sensory/perceptual-information in men or the reduced encoding of contextualised, verbally-based, voluntarily accessible representations in women.

1. Introduction

Distressing involuntary (intrusive) memories are a common experience in psychological disorders (Brewin, Gregory, Lipton, & Burgess, 2010) especially after stressful life-events, as in Post-Traumatic Stress Disorder (PTSD). However, susceptibility to these symptoms varies as a function of pre-existing vulnerability factors (DiGangi et al., 2013). A more complete understanding of these vulnerabilities depends on prospective studies which are time-consuming and expensive. In the meantime, the contribution of specific risk factors to symptom-development can be fruitfully explored using experimental approaches which model psychological distress in healthy individuals. One commonly-used laboratory approach for investigating intrusive memories is the stressful-film paradigm

(Holmes & Bourne, 2008). This approach has been used, for example, to examine the role of psychological traits such as positive schizotypy (Steel, Fowler, & Holmes, 2005) and trait mood variables (Laposa & Alden, 2008) in the development of intrusive memories.

Sex has rarely been investigated in well-powered analogue studies of intrusive memories. This is perhaps surprising given that (female) sex is an established risk factor for the development of psychological disorders. On the other hand, sex *per se* may not be sufficient to determine risk. For example, in the case of elevated risk of Posttraumatic Stress Disorder (PTSD) in women, pre-existing and habitual information-processing styles may also play an important role in aetiology (Olf, Langeland, Draijer, & Gersons, 2007). However the nature of sex-specific information-processing factors in the onset and maintenance of

psychological distress remains unclear, although clues from related research suggest that ‘gender-role’¹ rather than sex may be an important determinant of how emotional information is processed. These studies suggest that an individual’s self-concept, particularly their social identity, defined in terms of stereotyped masculine (agentic, instrumental) and feminine (communal, expressive) traits, affect the way in which emotional information is perceived and encoded.

These traits are influenced by both biological and socialisation processes in childhood (Eagly & Wood, 2013) such that women are more likely to (be encouraged to) develop affiliative, empathic and interpersonally-oriented behaviours whereas men develop task-focused, assertive and systemizing behaviours.

A relatively small number of studies have investigated the relationship between emotional information processing, and instrumentality and communality. For example, Bourne and Maxwell showed that an interaction between participant sex and instrumentality (referred to as ‘masculinity’) predicted lateralization of facial emotion recognition (Bourne & Maxwell, 2010). Similarly, Cahill and colleagues showed that voluntary recognition memory for peripheral, visual aspects of a negatively-valenced story was higher in individuals with high levels of communality (referred to as ‘femininity;’ Cahill, Gorski, Belcher, & Huynh, 2004). ‘Central’ information, conveying the gist of the story on the other hand, was better recognised in those with higher levels of instrumentality.

Behavioural responses to negatively valenced stimuli may also be influenced by communality and instrumentality. For example while women showed higher levels of anxiety and avoidance in a behavioural avoidance task, low levels of instrumentality, regardless of sex, were associated with higher levels of avoidance (McLean & Hope, 2010). These studies suggest that processing of threat-relevant stimuli is at least partially determined by gendered personality traits rather than sex alone.

It remains unclear how these traits affect memory for highly negatively-valenced and arousing material such as that designed to simulate (within ethical limits) aspects of the highly stressful or traumatic experiences associated with the onset of psychological disorders (e.g. PTSD and depression). According to some clinical theories of PTSD, highly emotional events result in memory representations formed at a sensory level (involving, for example, perceptual priming) as well as verbally-based, conceptual and contextual-level representations (Brewin, Dalgleish & Joseph, 1996; Brewin et al. 2010; Ehlers & Clark, 2000). Distressing intrusive memories reflect the preferential encoding of

sensory/perceptual detail during highly stressful events, whereas the contextual/conceptual memory system is simultaneously inhibited by stress, resulting in impoverished verbally-based, voluntarily retrievable memory for the event. As such, clinical theories of disorders characterised by intrusive memories predict *impairment* in voluntary memory for highly stressful events (Brewin, 2014), at least in some vulnerable individuals.

Here we investigate both voluntary and involuntary memory for distressing film scenes involving death and injury (i.e. an analogue traumatic stressor), focusing on sex, and the gender-related personality constructs, instrumentality and communality as predictors, in a study that also investigated the effects of a post-encoding working memory task. To date only a single study has reported a role for instrumentality and communality in emotional memory performance, although that study focused exclusively on voluntary memory (Cahill et al, 2004). No study that we are aware of has yet examined the role of these traits on the occurrence of involuntary emotional memories.

Given the higher prevalence of psychological disorder characterised by intrusive memories in women, our main hypothesis was that sex, and/or communality would predict frequency of involuntary memories for the stressful film. Further, given that one theory of intrusive memories (Brewin et al, 1996) proposes that separable systems subserve voluntary and involuntary emotional memory, and the suggestion that voluntary memory *suppression* may accompany the over-encoding of sensory/perceptual aspects of events (Brewin, 2014), we also explored the possibility of a negative association between communality and/or (female) sex and voluntary memory performance. Instrumentality has, by and large, been associated with psychological well-being (Helgeson, 1994) rather than psychopathology so was not predicted to be associated with the occurrence of involuntary memories.

2. Method

2.1 Design and Participants

The study received approval from University College London/University College London Hospital ethics committee. Participants from a research-participant database completed an online screening survey to assess inclusion/ exclusion criteria. Inclusion criteria were: age 18-40 years and fluency in English. Exclusion criteria included previous experiences of significant distress at the sight of blood or injuries or previous experience of any mental health problem requiring psychiatric or psychological treatment. Seventy nine participants provided consent and completed the study (39men, 40women).

2.2 Procedure

Although a primary aim of the study was to examine sex and gender-related differences between groups, another aspect of the study examined whether

¹ Some researchers have used the terms ‘femininity’ and ‘masculinity’ to refer to individual differences purportedly measured by ‘gender role’ inventories (e.g. the Bem Sex Roles Inventory). However, there is now wide agreement that such measures actually tap narrower constructs of communality (expressiveness) and instrumentality (agency) respectively (Spence, 1993) which are nonetheless, more strongly expressed in women and men respectively.

performing a visuospatial versus a verbal *post-film* task influenced subsequent intrusion frequency (Holmes, James, Coode-Bate, & Deeproose, 2009). As such participants were sequentially allocated to one of two working memory tasks (visuospatial or verbal 2-back) or a control task performed 30 minutes *after* the stressful film (during which time they completed filler tasks: book-search and listening to music). The former two groups were designed to use equivalent stimuli (as described in Gray, 2001) to test whether matched visuospatial and verbal task stimuli in the respective types of a 2-back working memory task modulated intrusive memories. All groups showed equivalent levels of intrusions in the follow-up period [$F(2,79)=0.41$, $p=0.665$] so groups were collapsed to concentrate this report solely on effects of sex and gender-related traits (communality and instrumentality) on emotional memory.

Participants attended two experimental sessions. In session one they completed trait and pre-film state questionnaires, viewed the stressful film, repeated the state questionnaires. At the end of the session participants were then given detailed instructions on completing the online intrusions diary for seven days. They returned on day eight to complete a compliance measure and episodic memory tasks related to the stressful film.

2.3 Stressful film

All participants viewed the 14 min stressful film on a 15.6 inch laptop computer in the same laboratory. The consisted of five scenes depicting accidental death or serious injury, with each scene preceded by a brief audio commentary containing autobiographical information including details about how the event occurred, and the fatalities and injuries sustained (Soni, Curran & Kamboj, 2013).

2.4 Measures and additional tasks

Intellectual functioning. The Wechsler Test for Adult Reading (WTAR; Wechsler, 2001) requires participants read 50 words with atypical grapheme-phoneme translations. One point is given for each correct response.

Communality and instrumentality. The BEM Sex-Role Inventory (Bem, 1981) was used to index communality ('femininity') and instrumentality ('masculinity'). Participants rate how well they are described by 60 adjectives (20 each of instrumental and communal traits and 20 fillers) on a 1-7 scale from 'never or almost never true' to 'always or almost always true' (Bem, 1981). The communality items largely relate to interpersonal concern and competence and have generally been associated with female gender role ('affectionate,' 'sympathetic,' 'sensitive to the needs of others,' 'understanding,' 'compassionate,' 'eager to soothe hurt feelings,' 'yielding,' 'loyal,' 'tender,' 'warm' etc.). Instrumentality items tend to refer to general self-efficacy and have been associated with male gender role ('self-reliant,' 'independent,' 'athletic,' 'assertive,'

'defends own beliefs,' 'strong personality,' 'forceful,' 'analytical,' 'has leadership abilities'). A separate average for communality and instrumentality was calculated for each participant. *Anxiety.* State and trait anxiety were assessed using the Spielberger Anxiety Inventory (Spielberger, 1983). Participants indicate how well 20 statements describe how they feel on a 4-point scale from 'almost never' to 'almost always' either *right now* (state) or *generally* (trait).

Dissociation. An adapted version of the Clinician-Administered Dissociative States Scale (CADSS) was used (Bremner et al., 1998). Participants indicated how closely 19 descriptions of dissociative symptoms matched their experience, '*at this moment in time, in this room*', on a 5-point scale from 'not at all' to 'extremely'.

Online intrusion diary. Participants were provided with a login and were sent email reminders to complete the online diary. Once logged in, participants recorded the frequency of intrusive memories that related to the film occurring on that day. They also rated these for distress, vividness and re-experiencing at the end of each day on a dedicated online diary on a 0-100 scale (0 = not at all, 100 = extremely).

Dairy compliance. On session two, participants indicated level of compliance using a 100 mm visual-analogue scale (VAS) representing the full range of compliance from 'did not follow instructions at all' (0%), to 'followed instructions exactly' (100%). Average compliance ratings were high and the same in men ($81.3\pm 18\%$) and women ($81.3\pm 18\%$).

Episodic memory. A 25 item 'true'/'false' test comprising five statements per film scene was used as a test of episodic memory for the film contents on session two. The questions predominantly related to gist, namely questions related to events unfolding over time, those related to reasons, motivations, causes, emotions or outcomes (17/25 questions) rather than perceptual, usually visual detail (8/25 question). The total possible score was 25. A period of free recall, during which participants wrote about what they could recall about the scenes, served as a check for appropriate content (showing that participants had attended to an encoded the scenes) but was not scored.

2.5 Statistical analysis

All data was normally distributed. Between groups comparisons were conducted with independent sample t tests. Multiple linear regression was conducted following full diagnostic statistical checks (for multiple colinearity; centred leverages; Cook's and Mahalanobis distances). Assumptions for the regression model were met and that there were no individual influential cases after removal of outliers (see below). Predictor variables (sex, communality and communality x sex interaction) were entered simultaneously with intrusion frequency as the dependent variable. For the interaction term, sex was assigned dummy binary values.

Missing data and outliers: Data entry difficulties experienced by some participants meant that while intrusions were recorded, intrusion characteristic variables were not entered on the online intrusions diary

in some cases. Outliers were identified as those with Z scores >2.5 (Field, 2009). Three participants' intrusions frequencies were identified as outliers: one man and two women. Differences in reported degrees of freedom reflect list-wise exclusion of cases due to recording difficulties or outlier status.

3. Results

3.1 Demographics, state and personality variables

Men and women were well matched in terms of age and WTAR scores (Table 1). There was no difference between men and women in trait anxiety or changes in state anxiety or dissociation. As expected, instrumentality was higher in men while communality was higher in women (Table 1).

While intrusion frequency was higher in women, it was not statistically significantly different from men (Table 1). There were also no sex differences in voluntary recognition memory relating to the stressful film. In addition re-experiencing and vividness of intrusions did not differ between men and women although intrusion-related distress was significantly higher in women than men.

Table 1

Demographic, gender-related (trait) and mood (state) measures are displayed as means (\pm SD) separately for men and women.

	Men (n=39)		Women (n=40)		t(df=77)
	Mean	SD	Mean	SD	
<i>Demographic</i>					
Age	22.08	4.50	21.36	3.47	0.79, p=0.43
WTAR	43.56	5.57	43.55	4.45	0.01, p=0.99
<i>State / trait measures</i>					
Trait Anxiety	39.10	7.04	41.93	10.08	0.15, p=0.154
State Anxiety change	17.46	10.34	20.85	11.00	1.41, p=0.163
State dissociation change	6.95	11.12	4.75	8.31	1.00, p=0.322
Instrumentality	4.91	0.81	4.46	0.62	2.77, p=0.007
Communality	4.51	0.59	4.96	0.50	3.58, p=0.001
<i>Memory</i>					
Recognition	16.97	1.56	16.15	2.84	1.58, p=0.118
Intrusions ^{††}	2.68	2.28	3.61	2.83	1.54, p=0.123
<i>Intrusion characteristics^{†††}</i>					
Distress	32.33	20.13	43.02	21.56	2.12, p=0.038
Re-experiencing	28.32	21.55	33.28	22.13	0.94, p=0.351
Vividness	47.10	28.77	46.76	24.57	0.05, p=0.957

^{††}df=74; ^{†††}df=67

3.2 Association between voluntary and involuntary memory, sex and gender-related traits

The association between sex, communality, instrumentality and intrusions was explored using linear regression. Since the subsequent multiple regression (below) involved examining the interaction between sex and communality, the correlations are displayed separately for men and women to illustrate the source of potential interactions (Table 2). Instrumentality was not associated with communality ($r(77)=-0.069$, $p>0.5$).

Table 2

Pearson correlations (r) between communality and instrumentality, and involuntary and voluntary memories by sex.

	Men		Women		All participants	
	Instrumentality	Communality	Instrumentality	Communality	Instrumentality	Communality
Intrusive memories	.155	.563***	-.127	-.018	-.044	.300**
Recognition Memory	.205	.000	.159	-.406*	0.131	.189

* $p=0.014$

** $p=0.01$

*** $p<0.0009$

All other p values >0.1

Instrumentality and communality were uncorrelated ($r=-0.069$, $p>0.5$)

Communality was associated with involuntary memories only in men, accounting for $\sim 32\%$ of the variance. In women, there was a negative association between communality and voluntary memory for the stressful film ($R^2=0.165$). No associations between instrumentality and memory were found (Table 2). There was also no significant correlation between voluntary and involuntary memory in men ($r(38)=0.241$, $p>0.1$) or women ($r(35)=0.108$, $p>0.5$).

The association between involuntary memory frequency and communality, sex, and their interaction was analysed by entering the latter three terms simultaneously into a regression model (Table 3a). The overall model was significant ($R^2=0.151$, $F(3,73)=4.165$, $p=0.009$). Moreover, the interaction between sex and communality was explained by the moderate strength association between involuntary memory frequency and communality in men and the absence of such an association in women (Table 3).

Table 3

Multiple regression analysis predicting (a) involuntary and (b) voluntary memories as a function of sex, communality and their interaction.

(a) Involuntary memory			
	β	t	P
Sex	2.163	2.223	0.029
Communality	0.494	3.146	0.002
Communality x sex	-2.191	2.160	0.034
(b) Voluntary memory			
	β	t	p
Sex	2.895	2.963	0.004
Communality	0.193	1.220	0.227
Communality x sex	-3.128	3.067	0.003

A similar regression model was used to examine the relationship between voluntary memory and the above predictors (Table 3b). Again, the overall model was significant (adjusted $R^2=0.144$, $F(3,73)=3.922$, $p=0.012$) and there was a significant interaction between sex and communality. As shown in table 2, a correlation between communality and voluntary memory was only found in women.

4. Discussion

This study examines the association between the gender-related traits of communality and instrumentality, and voluntary and involuntary memory for negatively valenced material designed to mimic a 'traumatic stressor' in analogue studies. Overall, voluntary and involuntary memory in men and women was statistically equivalent. However, our main findings relate to the differential effects of communality on voluntary and involuntary memory in men and women. In particular, communality was positively correlated with involuntary memory (intrusion) frequency only in men, while its negative association with voluntary memory performance was only seen in women. The association between communality and intrusion frequency in men was not predicted, but is unlikely to be a type I error, suggesting that communality is a specific novel vulnerability to psychological symptoms in men. Our other main finding was the negative correlation between voluntary memory and communality, an association restricted to women.

The association between communality and emotional memory performance has only been reported in one previous study (Cahill et al. 2004). This showed that when the sex of participants was ignored and men and women were classified on the basis of their 'gender-role' (determined by median split on the Bem Inventory), those with high levels of communality had relatively impoverished memory for central or 'gist' aspects of an emotional narrative, while showing enhanced memory for its peripheral details. While gist and detail refer to the output of voluntary (recognition) memory processes, there are aspects of the information recollected as peripheral detail that have parallels to distressing involuntary memory. In particular, both types of recollection involve an absence of context and abundance of sensory/perceptual representations. Considered in this way, the enhancement in voluntary emotional memory for peripheral detail in people with high levels of communality found by Cahill et al. (2004) is consistent with our observation of a positive association between communality and involuntary memory. However Cahill et al's study (2004) did not examine the sex by communality interaction so it is unclear if their findings were specifically applicable to men.

There currently appears to be an absence of literature examining the effects of communality on psychological symptoms in men. Gender-role conflict theory outlines the negative effects of rigid gender-role socialization as a potential vulnerability to distress in men (O'Neil, 2008), but emphasises what might be considered hyper-masculine qualities such as restrictive emotionality, obsession with achievement and success, socialised control, power and competition. This theory does not address the effects of being male while possessing a self-identity defined in terms of attributes that are often culturally reinforced in females. Clearly we are very far from being able to extend our discussion into this area, except to raise the possibility that communality may be associated with negative

psychological effects following stressful life events in men in particular.

Whether the associations between communality and intrusions found in men is a true information processing effect (e.g. men scoring highly on communality encode emotional information differently to men with low communality or to women) rather than reflecting response bias (e.g. men with high levels of communality are more likely to over-report intrusive memories) remains unclear. Furthermore, other variables that may explain the relationship between communality and intrusions in men but were not assessed in this project. For example, communality predicts unique variance in coping with stress. One possibility then, is that the correlation between communality and intrusions in men is mediated by avoidant coping (Lengua & Stormshak, 2000). The other main finding of this study was the negative relationship between voluntary emotional memory and communality, observed only in women. These findings also have some parallels with the Cahill et al. (2004) study referred to above. In particular, given that the questions used in our recognition test related predominantly to 'central gist' (rather than detail) of the stressful video scenes, our findings of impoverished voluntary recognition memory in those with higher levels of communality is consistent with Cahill et al. (2004). Again however, it is unclear to what extent the relationship found by Cahill et al. (2004) was specific to women.

The implications of these two findings can be considered within a 'dual representation' framework of psychopathology (Brewin et al., 1996). This model proposes that stressful events are encoded in two types of memory trace which differ in terms of retrieval 'strategies' (Brewin et al, 1996). Over-encoding of perceptual/sensory detail and under-encoding of contextual information are both potential vulnerabilities for distressing psychological symptoms. For example impaired episodic (autobiographical) voluntary memory, as seen here in women with higher levels of communality is associated with trauma symptom severity in patients with PTSD (Moradi et al. 2008). It has been suggested that more highly elaborated and accessible contextually-based voluntary memories for traumatic events tend to exert top-down inhibitory control over the cue-driven retrieval that results in intrusive memories (Brewin et al. 1996). Conversely, a less accessible (less well encoded or retrieved) contextual memory trace for the event is unable to provide this inhibitory influence. As such, high levels of communality may be a specific and indirect vulnerability - through effects on voluntary memory - for developing distressing symptoms following a stressful event in women.

There are several limitations of the current study. Firstly, the sample consisted of those without any history of psychological disorder, which may limited the generalizability of the findings, as well as their applicability to clinical samples. We did not record the menstrual phase or use of hormonal contraceptive of women in the study. This omission is significant because

hormonal changes across the menstrual cycle can affect the occurrence of intrusive memories (Ferree, Kamat & Cahill, 2011; Nielsen, Ahmed & Cahill, 2013; Soni et al., 2013). It is possible that the effects of communality on voluntary emotional memory observed here may be more or less pronounced depending on menstrual phase. Moreover, it is likely that significant sex differences would have been observed if the sample of women consisted of those who were 'naturally cycling' (not using hormonal contraceptives) and were tested during a sensitive period of the menstrual cycle, when susceptibility to involuntary distressing memories is particularly high (i.e. the luteal phase; see Ferree & Cahill, 2009). An additional issue is that the analysis of sex and gender-role occurred in the context of groups who completed different visuospatial, verbal and control tasks 30 min after the trauma video. Future studies should aim to examine these relationships in the absence of such tasks. Finally, whereas we could indirectly and subjectively assess 'engagement' with the intrusions task (compliance with completing the intrusions diary) and show this to be equivalent in men and women, there was no sense in which such engagement could be assessed (and shown to be equivalent) in the recognition memory task used here. It may be possible that the men and women in our sample differed in this respect, although we know of no precedent for such an explanation for differences in performance between sexes in any measure of cognition.

In summary, using a stressful film paradigm we find a potentially important role for communality in emotional memory. Both over- or under- encoding (or retrieval) of aspects of a stressful event may be determined by communality, potentially leading to a vulnerability to experiencing distressing psychological symptoms. Further research aimed at parsing the role of communality in relation to other mediating variables (e.g. coping style) in men and women would be a potential next step for future research.

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