RUNNING HEAD: TRAUMA-RELATED VS. POSITIVE INVOLUNTARY THOUGHTS

Trauma-related versus positive involuntary thoughts with and without meta-awareness

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Abstract

In earlier work, we asked subjects to report involuntary thoughts relating to a trauma film and also probed subjects periodically. Subjects often reported involuntary thoughts in response to probes, suggesting they lacked meta-awareness of those thoughts. But it is possible that some or all probe-detected thoughts were continuations of thoughts subjects had spontaneously reported, leading us to overestimate involuntary thoughts lacking meta-awareness. It is also unclear whether failures in meta-awareness occur for other emotional events. We exposed subjects to a negative or positive film. Subsequently, they reported involuntary film-related thoughts and responded to probes that distinguished new from continuing thoughts. Many (54%) but not all probe-caught thoughts were thought continuations. This result supports our earlier finding that people can lack meta-awareness for trauma-related thoughts, but suggests caution in how meta-awareness is assessed. We also found that self-caught negative and positive involuntary thoughts occurred at a similar frequency, with different characteristics.

Keywords: emotion, intrusions, mind-wandering, meta-awareness

1 Introduction

Involuntary memories are recollections that enter consciousness without any specific effort to retrieve them (Berntsen, 1996; Rasmussen & Berntsen, 2009). These memories share some characteristics with other types of spontaneous thought processes, such as mind wandering (Smallwood & Schooler, 2015), remindings (Hintzman, 2011), “earworms” (Hyman et al., 2015), and traumatic flashbacks (Brewin, 2014). Recent research has focused on whether these phenomena are related, and how they might be differentiated (Kvavilashvili, 2014; Meyer, Otgaar & Smeets, 2015; Takarangi, Lindsay, & Strange, 2015).

Mind-wandering is the shift of attention from external information, such as an ongoing task, towards self-generated, internal information, such as thoughts and memories (Smallwood & Schooler, 2006). These shifts in attention are frequent, perhaps occurring as often as half our waking lives (Killingsworth & Gilbert, 2010). They can arise without deliberate intention (i.e., involuntarily), and lack meta-awareness; in other words, when people are not explicitly aware that the current contents of their consciousness are “off-task” thoughts (Smallwood & Schooler, 2015). This phenomenon appears to extend to thoughts about negative autobiographical events (Baird, Smallwood, Fishman, Mrazek, & Schooler, 2013).

People also sometimes lack meta-awareness of thoughts about analogue trauma. Takarangi et al. (2014) used the typical trauma film paradigm, whereby subjects watched a stressful film intended to cause involuntary thoughts (Holmes & Bourne, 2008). They then had subjects engage in a reading task during which they measured film-related mind-wandering (see Baird et al., 2013). Subjects indicated when they were aware of having a thought about the film (by pressing a computer key). To capture thoughts of which subjects were not aware, probes appeared

intermittently throughout the reading task (e.g., as in Schooler, Reichle, & Halpern, 2004). Each probe asked subjects whether or not they had been thinking about the film at the moment the probe was presented. Along with spontaneously reporting involuntary thoughts from the film, subjects also sometimes responded "yes" to probes. According to Takarangi et al., these responses could indicate that subjects had been thinking about the film but had not yet become aware that they were doing so. If the frequency of involuntary thoughts extends beyond that which a subject can accurately self-report, there may be important implications for research on and treatment of maladaptive intrusions. One example is how involuntary thoughts—such as those that arise from Post-traumatic Stress Disorder (PTSD)—are captured and addressed.

A limitation of Takarangi et al.'s (2014) study is that some or all of what they classified as "probe-caught" involuntary thoughts might really have been non-reported (but meta-aware) continuations of a previously self-caught thought. In other words, it is possible that subjects may have self-reported thinking about the film and then continued to ruminate about that thought until the next probe appeared. In these cases subjects' "yes" responses to probes would not represent failures in meta-awareness. If this explanation is accurate, then the rate of probe-caught involuntary thoughts Takarangi et al. reported may exaggerate the rate of subjects' genuine failures in meta-awareness of thoughts about the trauma film. Of course, it is important that probe-caught methods accurately identify failures in meta-awareness. Thus, in the present study we altered the probe instructions so that we could identify whether subjects had a previously reported thought in mind when they responded to probes. Hence, our first question in the current study is: Do involuntary thoughts

classified as lacking meta-awareness sometimes reflect the non-reported (but meta-aware) continuation of a previously self-caught thought?

If subjects do lack meta-awareness for involuntary thoughts about a negative event—in a similar way to instances of mind wandering without awareness—then it is also important to examine whether lapses in meta-awareness also characterize thoughts about other emotionally significant material. Some clinicians and theorists have argued that the process of remembering emotionally significant events—that are typically negative or traumatic—is different to that of ordinary, everyday experiences; in particular, some have argued that memory for emotional experiences involves a "special" mechanism (e.g., "flashbulb memories"; Brown & Kulik, 1977; see also Shobe & Kihlstrom, 1997, for a review) or an absence of certain elements of normal memory processing. For example, according to Brewin (2014) the emotional intensity and difficulty in conceptualizing traumatic events can lead to an incomplete narrative of those experiences. The result is a disjointed narrative in which voluntary retrieval of the memory is less prevalent than involuntary, unwanted memories.

According to these models of trauma memory, an increase in involuntary memories is accompanied by an inability to recall memories voluntarily. Yet studies of voluntary and involuntary memory show that frequency of both types of memories correlate positively with PTSD symptoms (Berntsen & Rubin, 2008). Berntsen and Rubin (2008) argued that these involuntary thoughts reflect *basic* memory processes. Indeed, we know that recurrent, intrusive, and involuntary cognition also occurs for neutral and positive information. For example, surveys, diary studies, and laboratory analogues (akin to the trauma film paradigm but with a positive film used as the target event) have shown that people also experience positive involuntary thoughts and memories (see Berntsen & Rubin, 2008; Clark, Mackay, & Holmes, 2013; Davies,

Malik, Pictet, Blackwell, & Holmes, 2012). Do involuntary thoughts share underlying characteristics, such as meta-awareness, regardless of valence? That is the second question we address here.

What do we know about the differences between positive and negative memories? Research indicates that there are differences in the frequency with which negative and positive involuntary memories are experienced. For example, using a diary method, Berntsen and Rubin (2008) found that positive involuntary memories were more common than negative involuntary memories in daily life. Similarly, when probed with questions about their past, people recalled both positive and negative autobiographical memories, with a clear reminiscence bump—remembering more personal events from adolescence and early adulthood than other periods of life—for positive memories. When questioned about the content of their last involuntary memory, subjects were more likely to report positive memories (Berntsen & Rubin, 2002). However, this bias toward positive involuntary cognition can be reversed. There is evidence that negative cues (e.g., “childhood nightmares”) more often trigger an involuntary autobiographical memory than positive cues (“going on holiday”), or neutral cues (“buttering bread”; Schlagman & Kvavilashvili, 2008). Thus, when positive and negatives cues are equally available—as in a controlled laboratory study, where there is an equivalent number of each—the negative cues may be more likely to trigger involuntary memories.

It may be that prior findings of differences in the frequencies of positive versus negative involuntary memories reflect a difference in meta-awareness of thoughts. On the one hand, negative involuntary thoughts might be characterized by stronger meta-awareness than other involuntary cognitions, due to their nature as intrusive and distressing, or because negative memories are subject to special

processing (e.g., Brewin, 2014). Our previous data suggest that people experience at least some negative involuntary thoughts without meta-awareness, but it might be that positive involuntary thoughts are even more likely to occur without meta-awareness. On the other hand, perhaps people are actually more meta-aware of their positive involuntary thoughts. If so, then that could explain their apparent accessibility in everyday life.

To summarize, we address two main questions in this study: Did involuntary thoughts defined as "probe-caught" in Takarangi et al.'s (2014) procedure sometimes reflect non-reported (but meta-aware) continuations of a previously self-caught thought? And (2) Does the distinction between meta-aware and unaware thoughts occur similarly for both negative and positive emotional material? To address (1), we re-worded the probes used by Takarangi et al. so that we could differentiate between (a) thoughts that the subject was not aware of having until probed versus (b) continuation of thoughts for which the subject had already reported awareness. To address (2), we followed previous research that has successfully elicited positive involuntary thoughts via the use of a positive film paradigm (e.g., Clark et al., 2013). We also followed Takarangi et al.'s general procedure: Subjects first watched a film of either positive or negative emotional valence, then reported their thoughts while completing an unrelated task, during which intermittent probes prompted subjects to report the current contents of their thoughts.

2 Method

2.1 *Subjects*

We recruited 90 subjects from the research subject pool at Flinders University. We excluded three subjects; two because they had seen the film before and one for not following instructions. Thus, our analyses focused on data from 87 subjects, aged

18-38 years (*M* = 21.41 *SD* = 5.41). The majority (78.2%) were female and identified their ethnicity as Caucasian (including White; 75.9%). Others identified as Asian (12.6%), European (4.6%), Middle Eastern (2.3%), Hispanic (1.1%), and mixed ethnic origin (3.4%). Subjects received either course credit or cash payment (AUD $30) for their time.

2.2 *Design*

Approximately half of our subjects watched a traumatic film (*n* = 42), the remaining subjects watched a positive film (*n* = 45) described below. Our key dependent variables were the number of self-caught involuntary thoughts and probe-caught involuntary thoughts, which we divided into two types: thought continuations that subjects had already self-reported (meta-aware), and new thoughts (not meta-aware).

2.3 *Materials and procedure*

The Social and Behavioural Research Ethics Committee at Flinders University approved this research. Subjects took part in one laboratory-based session. Before commencing the study, we told subjects we were interested in how aspects of executive cognition affect the processing of negative events. Subjects were tested individually. We warned all subjects in the negative film condition that participation could involve viewing a brief film depicting sexual and physical violence.

2.3.1. *Phase 1* After subjects gave consent to continue with the study, we collected demographic information and assessed subjects' mood using the 20-item version of the Positive Affect Negative Affect Schedule *(PANAS;* Watson, Clark, & Tellegen, 1988). Subjects rated their current feelings along 10 positive (e.g., "enthusiastic") and 10 negative (e.g., "nervous") dimensions on a 5-point scale (1 = very slightly or not at all, 5 = extremely). The PANAS has good internal reliability

with a Cronbach's alpha ranging from .86 to .90 for positive affect and from .84 to .87 for negative affect (Watson et al., 1988). We also measured subjects' subjective ratings of their overall proneness to intrusive cognition and tendency to suppress such cognition, using single-item measures (Davies & Clark, 1998). The Proneness to Intrusive Cognitions Scale (PICS) item asked: "After you have seen something unpleasant on the television or at the cinema, do you find that it comes back into your mind without you wanting it to?" (0=not at all, 10=always). The Thought Suppression Scale (TSS) item asked: "When something unpleasant has happened in your life, to what extent is the following statement true of you?...I make an effort not to think about it" (0=not at all true of me, 10=true of me). Finally, we used the 8-item Frequency of Involuntary Thoughts Scale (Hyman et al., 2015) to assess people's general propensity to experience involuntary thoughts. This scale asks people how often various types of thoughts (e.g., visual images, memories, thoughts about money, etc.) come to mind involuntarily, defined in the questionnaire as without choosing to think about them. Ratings for each thought type are made on a Likert-type scale: (1 = never, 2 = almost never, 3 = a few times per month, 4 = a few times per week, 5 = a few times each day, 6 = constantly). Cronbach's α for our sample = .77.

2.3.2 *Phase 2* We next presented subjects with either the positive or negative film, which they viewed on iMac computer screens, using headphones. For the traumatic film, we used a scene from ''The Accused'' (1988). The film depicts a woman in a bar being sexually assaulted by a group of men, and has been successfully used as a trauma analogue in previous research (Lepore, Fernandez-Berrocal, Ragan, & Ramos, 2004; Takarangi et al., 2014). For the positive film, we used footage of an American figure skater, Sarah Hughes, winning an Olympic gold medal. The footage depicts the skater's flawless routine and the surprise and joy on her face when she

finds out that she won the gold medal. Other researchers have used this footage to elicit "happiness" and other positive emotions in subjects (Gruber, Johnson, Oveis, & Keltner, 2008; Gruber, Oveis, Keltner, & Johnson, 2011; Werner et al., 2007). Both films ran for 8 min 3 s.

2.3.3 *Phase 3* After the film, we asked subjects whether they had seen the film before, and to rate on an 11-point Likert-type scales (0 = not at all, 10 = extremely) (a) how unpleasant they found the film, (b) how distressed they felt after it, and (c) how closely they paid attention to it. We also re-administered the 20-item PANAS.

2.3.4 *Phase 4* We asked subjects to read a seven-paragraph science article, presented one paragraph at a time (with 112-231 words per paragraph), followed by a multiple-choice comprehension test. Subjects read the article at their own pace, pressing the space bar to advance through the paragraphs. The article was followed by a 10-item multiple-choice comprehension test (e.g., How much blood does your heart need to pump in an hour?). During the reading task, we measured subjects' involuntary thoughts in two ways. We asked subjects to press a key whenever they found themselves thinking about the film, and then try to bring their focus back to the reading task. In addition, probes appeared periodically on screen (8-150s between probes with an average of one probe every 30s, and asked subjects what they were thinking the moment before the probe appeared (see Baird et al., 2013). Subjects received 11.54 (SD = 2.71, range 8-25) probes on average. More specifically, we gave the following instructions verbally to subjects just before they began the reading task:

> From time to time you will see a blue screen asking what you were just thinking about in the moment just before the blue screen popped up. You will be asked to use the number keys 1-3 to respond. If you are aware that you are STILL thinking about the film since when you last pressed the "x" key, then

> please choose that response that you were STILL thinking about the film. If you are thinking about the film AGAIN (or for the very first time), but had not realized it until the blue screen appeared, then please choose the response that you were AGAIN thinking about the film. In the case of thinking AGAIN about the film, the thought you are experiencing may be the same or a different thought than what you had experienced previously. If you are not thinking about the film, please select the response that you were NOT thinking about the film.

Subjects spent on average 7.25 mins (*SD* = 2.31) on the reading task. There was no difference in reading duration by film condition, $t < 1$.

2.3.5 *Phase 5* After the reading task, we again measured subjects' mood using the 20-item version of the PANAS. We also assessed their experience of involuntary thoughts using the *Experience of Intrusions Scale (EIS;* Salters-Pedneault, Vine, Mills, Park, & Litz, 2009). Subjects rated the frequency (one item) of their involuntary thoughts during the reading task (0 = almost never, 1 = infrequently, 2 = occasionally, 3 = frequently, 4 = very frequently), as well as the phenomenology of those thoughts (four items): the extent to which they created interference and distress, and were unpredictable and unwanted (0 = not at all, 1 = a little, 2 = moderately, 3 = quite a bit, 4 = extremely). Previous psychometric examination indicates that the EIS has good internal consistency values and convergent validity with PCL scores (Salters-Pedneault et al., 2009). We also found high internal consistency in our EIS data: $\alpha = 0.87$.

We then asked subjects a series of questions, again using 11-point Likert-type scales (0 = not at all, 10 = extremely): (a) How distressed they were by any thoughts, pictures/images of the film that may have entered their mind since watching the film,

(b) how hard they tried NOT to think about the film since watching it, (c) How well they adhered to the instructions to record intrusive thoughts; (d) How accurate they were in responding to probes, (e) how difficult they found the reading task, and (f) how interesting they found the reading task. We also asked subjects open-ended questions (not analyzed here) to establish: that they understood the probe instructions ("When answering the questions about what you were thinking before the blue screen appeared: (a) I said I was "still" thinking about the film when… (b) I said I was "again" thinking about the film when…"); the nature of the most frequent intrusive thought they experienced after viewing the film.

At the conclusion of the study, subjects were thanked and debriefed.

3 Results and discussion

Recall that our study had two primary aims: We were interested first in whether our method accurately captured involuntary thoughts for which subjects lacked meta-awareness; and second, whether subjects experience similar patterns of involuntary thoughts after exposure to a positive vs. negative event. Before addressing these aims, we established that there were no significant group differences in the degree to which subjects reported following instructions for self- and probe-caught thought monitoring, or in baseline levels of propensity to intrusions (as measured by PICS), and thought suppression (as measured by TSS) (see Table 1). We next assessed the emotional impact of our films.

Table 1

Descriptive and inferential statistics for subjects' reactions to the films, by film condition.

	Negative film *(M, SD)*	Positive film	*t* (85)	*p* value	Cohen's d [95% CIs]

	(M, SD)				
Adherence to instructions (self-caught)	6.98 (3.07)	7.04 (2.71)	0.11	0.913	.02 [-0.40, 0.44]
Adherence to instructions (probe-caught)	8.60 (1.42)	7.93 (2.34)	1.58	0.117	.34 [-0.09, 0.76]
Proneness to Intrusions Scale (PICS)	5.33 (2.49)	5.56 (2.78)	0.39	0.696	.08 [-0.34, 0.51]
Thought Suppression Scale (TSS)	5.29 (2.33)	5.24 (2.58)	0.08	0.938	0.02 [-0.40, 0.44]
Film unpleasantness	8.83 (1.65)	0.36 (0.96)	29.54	< .001	6.28 [5.29, 7.37]
Distress from film	6.90 (2.64)	0.27 (0.72)	16.24	< .001	3.45 [2.81, 4.15]
Distress at involuntary thoughts	1.79 (1.14)	0.44 (0.84)	6.15	< .001	1.31 [0.85, 1.78]
Suppression attempt	5.83 (3.03)	4.60 (3.24)	1.83	0.070	0.39 [-0.03, 0.82]
Attention to film	8.24 (1.34)	8.04 (1.52)	0.63	0.532	0.13 [-0.29, 0.56]

3.1. *Emotional impact of the films*

We first examined whether the films differentially affected subjects' mood. We compared subjects in the positive versus negative film conditions over time, on both positive and negative affect. More specifically, we ran two 2 (film condition: positive, negative) × 3 (Time: before-film, after-film, after-reading) mixed ANOVA analyses. Focusing first on positive affect, as shown in Fig. 1a, there was a significant interaction between time and film, $F(2, 170) = 41.73$, $p < 0.001$, partial $\eta^2 = .33$. Planned comparisons revealed that for subjects who watched the positive film, positive affect increased significantly from baseline to immediately after the film, $t(44) = -3.83$, $p < 0.001$, Cohen's $d = 0.45$, 95% CI [0.20, 0.71], and then fell below

baseline following the reading task, $t(44)=3.86$, $p < 0.001$, $d = 0.38$, 95% CI [0.17, 0.59]. Conversely, subjects who viewed the negative film reported a decrease in positive affect after watching the film, $t(41) = 8.49$ $p < 0.001$, $d = 1.16$, 95% CI [0.80, 1.55], which did not change significantly during the reading task, $t(41) = -1.46$, $p = 0.152$, $d = 0.16$, 95% CI [-0.06, 0.38]

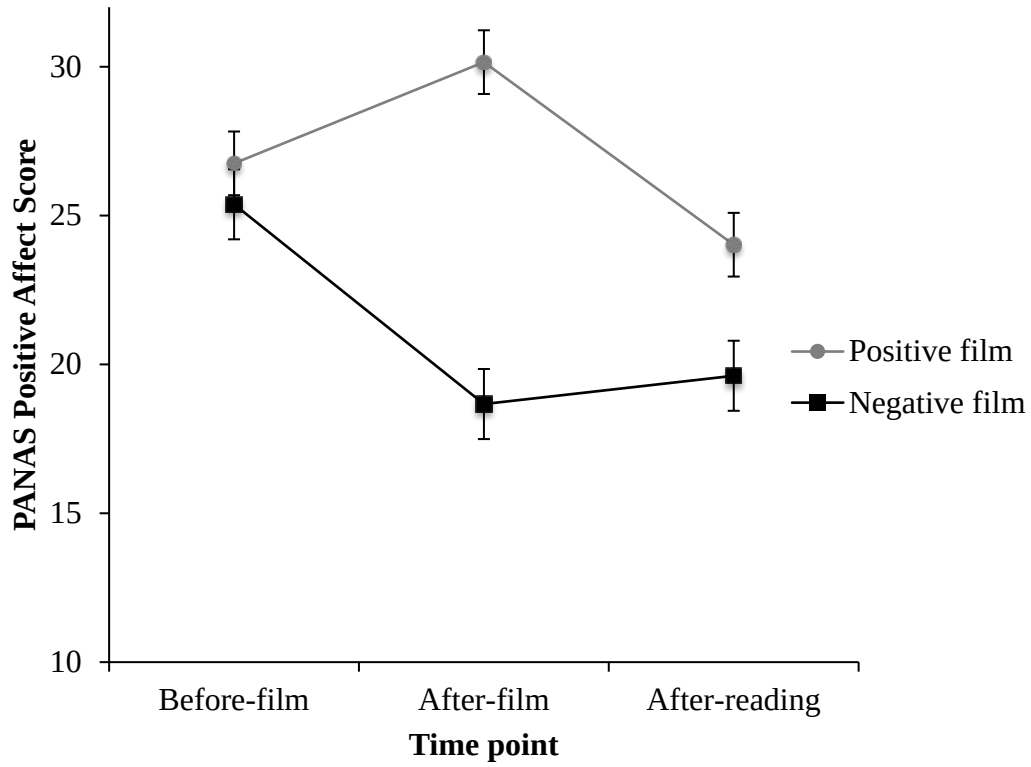

Figure 1a. Positive affect changes at initial measure, following film, and after reading task by film valence condition. Error bars represent 95% within subjects confidence intervals.

We next examined negative affect. As shown in Figure 1b, there was a significant interaction between time and film, $F(2, 170) = 45.49$, $p < 0.001$, partial $\eta^2 = 0.35$. For people who watched the negative film, negative affect increased from baseline to after the film $t(41) = 7.96$, $p < 0.001$, $d = 1.40$, 95% CI [0.95, 1.89], and then decreased following the reading task, but not to baseline levels $t(41) = 7.50$, $p <$

0.001, *d*= 0.55, 95% CI [0.20, 0.92]. Negative affect was unchanged in the positive film condition over time, $F(1, 44) = 2.15$, $p = 0.150$, partial $\eta^2 = 0.05$.

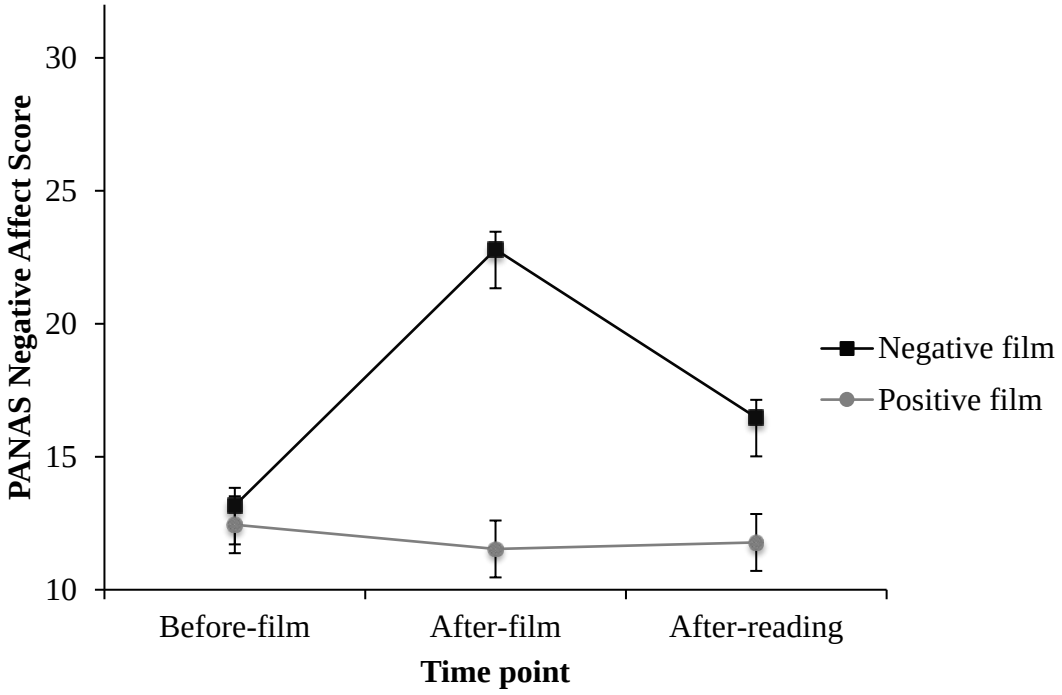

Figure 1b. Negative affect changes at initial measure, following film, and after reading task by film valence condition. Error bars represent 95% within subjects confidence intervals.

3.2 *Reactions to the films*

We next examined subjects' ratings of the film, which they reported immediately after watching it. As we expected, subjects reported that the negative film was more unpleasant and distressing than the positive film, and that involuntary thoughts about the negative film were more distressing. There was a non-significant tendency for subjects to report trying harder not to think about the negative compared to the positive film, but the two conditions reported paying a similar level of attention to the films.

3.3 *Meta-awareness of Intrusions*

We next examined our first primary research question: does our method accurately capture involuntary thoughts for which people lack meta-awareness? More specifically, we wanted to identify probe-caught thoughts that were versus were not simply continuations of previously self-caught thoughts. We focused first on subjects who watched the negative film. Recall that the film and reading task were identical to Takarangi et al. (2014; Experiment 2). Overall, subjects were "caught" thinking about the film on 35.79% (95% CI [27.43, 44.14]) of probes. This rate is comparable to the rate found in Takarangi et al. (39.48%). We then divided probe-caught thoughts into two categories: involuntary thoughts subjects claimed they had already reported (hereafter "continuing probe-caught thoughts") were reported on an average of 18.99% [13.09, 24.90] of the probes; new thoughts, of which subjects were presumably not meta-aware, were reported on an average of 16.79% [12.21, 21.37] of the probes (see Fig. 2). Thus, Takarangi et al. almost certainly overestimated the rate of analogue trauma-related involuntary thoughts lacking meta-awareness, due to "double-counting" self-caught thoughts as probe-caught. But nearly half of probe-caught thoughts were described as new thoughts that subjects had not previously reported.

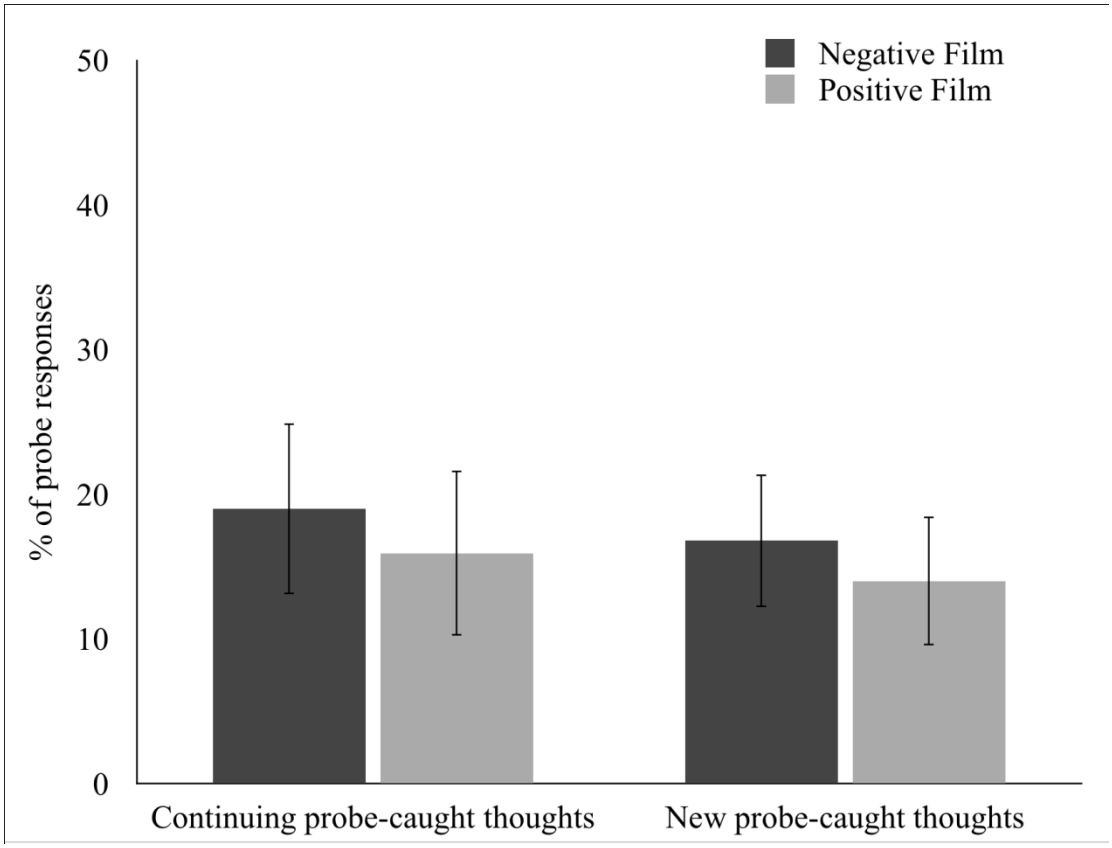

Figure 2. Frequency of probe-caught involuntary thoughts by film valence condition and probe response type. Error bars represent 95% confidence intervals.

3.4 *Negative vs. positive film involuntary thoughts*

We next turned to the question of whether subjects experience a similar pattern of involuntary thoughts after exposure to a positive versus negative event. First, we examined involuntary thoughts that subjects self-caught. We used a log-transformation to correct for positive skew in the distribution of self-caught responses. Subjects who viewed the positive film self-caught a similar number of involuntary thoughts (M = 0.54, 95% CI [0.42, 0.65]) compared to subjects who viewed the negative film (M = 0.58 [0.47, 0.70]), $t(85) = 0.58$, $p = 0.563$, d = .12 [-0.30, 0.55]. (Untransformed data: Positive film: M = 4.00, 95% CI [2.68, 5.31] negative film M = 4.29 [2.96, 5.61], d = 0.07 [-0.36, 0.49]). We ran an independent-sample Bayesian t-test with default Cauchy prior (Rouder, Speckman, Sun, Morey, & Iverson, 2009) on

the number of self-caught involuntary thoughts in each condition to quantify the certainty of this similarity. We found a $BF_{01} = 4.28$. Adhering to the statistical interpretation that Wetzels, et al. (2011) suggest, this Bayes factor indicates moderate evidence that the difference between the self-caught involuntary thoughts by condition is negligible. Put differently, these data are 4.28 times more likely to occur if the null hypothesis is true than if self-caught thoughts differ by condition (Wetzels et al., 2011). Thus, people experienced a similar *number* of involuntary thoughts about the positive and negative videos.

We also wanted to know if thoughts about the negative versus positive film were distinguishable on other characteristics. The Experience of Intrusions Scale (EIS) assesses thought frequency combined with the extent to which those thoughts led to interference and distress, and were unpredictable and unwanted. A t-test revealed that subjects in the negative film condition had higher EIS scores (M = 11.09, 95% CI [9.73, 12.46]) compared to subjects in the positive film condition (M = 8.00, *[6.53, 9.47]*), $t(85) = 3.10$, $p = 0.003$, $d = 0.66$ [0.23, 1.10]. Thus, despite an equivalent number of self-caught involuntary thoughts, subjects in the negative film condition rated their involuntary thoughts as qualitatively different from subjects in the positive film condition.

Next, we compared subjects in the positive and negative film conditions on probe-caught involuntary thoughts. Overall, subjects who watched the positive film were caught thinking about the film on 29.92% (95% CI [21.85, 37.99]) of probes. This rate was not significantly different from the 35.79% for subjects in the negative condition $t(85) = 1.00.$, $p = .318$, $d = 0.20$ [-0.22, 0.63]. As with the negative film, probe-caught responses appeared to capture both continuing and new thoughts about the positive film. Specifically, subjects were caught having continuing involuntary

thoughts about the positive film on 15.93% [10.22, 21.63] of the probes; they reported having new involuntary thoughts on 13.99% [9.57, 18.42] of the probes (see Fig. 2). The rate of new (without meta-awareness) involuntary thoughts for the positive and negative films was similar, $t(85) = 0.87$, $p = 0.385$, $d = 0.12$ [-0.31, 0.54]. We ran an independent-sample Bayesian t-test with default Cauchy prior (Rouder et al., 2009), and found a $BF_{01} = 3.19$, which once again indicates moderate evidence that the difference between the new probe-caught thoughts in each condition is negligible (Wetzels et al. 2011). That is, these data are 3.19 times more likely to occur than if the null hypothesis is true than if new probe-caught thoughts differ by condition (Wetzels et al., 2011). These data indicate that the presence of thoughts lacking meta-awareness is not associated exclusively with negative material, but extends to other emotional events.

Finally, we examined whether the frequency of self-caught and new probe-caught thoughts were related to the EIS, which captures the phenomenological experience of involuntary cognition, particularly its intrusiveness. Self-caught thoughts correlated with the EIS for both the negative ($r = 0.38$, 95% CI [0.09, 0.61]), $p = 0.012$ and positive film ($r = 0.60$ [0.37, 0.76], $p < 0.001$) conditions. Similarly, the frequency of new probe-caught thoughts were also correlated with the EIS for both the negative ($r = 0.45$, 95% CI [0.17, 0.66], $p = 0.003$) and positive film ($r = 0.49$ [0.23, 0.69], $p < 0.001$) conditions. Additionally the frequency of *continuing* probe-caught thoughts correlated with EIS for both negative ($r = 0.60$ [0.36, 0.77], $p<.001$) and positive film ($r = 0.64$ [0.42, 0.78], $p < 0.001$). These data suggest that the frequency with which involuntary thoughts are experienced, regardless of their valence, contributes to the extent those thoughts feel intrusive (see Hyman et al., 2015). Of course, the EIS does incorporate a retrospective assessment of frequency

and—since it is completed after the reading task—captures both thoughts about which subjects had meta-awareness at the time of reporting, and those thoughts that were brought to their meta-awareness by probes.

3.5 *Reading comprehension performance*

Subjects' performance on the reading comprehension test was similar in the negative film (M = 0.57, 95% CI [0.50, 0.64]) and positive film (M = 0.55, [0.50, 0.60]) conditions, $t < 1$. We calculated a partial correlation between self-caught involuntary thoughts and reading comprehension performance, controlling for overall time spent reading. There was no significant relationship, in either the negative film (r = -0.02, 95% CI [-0.32, .29], p = 0.917) or positive film (r = -0.08 [-0.37, 0.22], p = 0.606) conditions. We next calculated the correlation between the frequency of *new* probe-caught intrusions and performance. Again, there was no significant relationship in either condition (negative film: r = -0.23 [-0.50, 0.08], p = 0.141); positive film: r = -0.04 [-0.33, 0.26], p = 0.814). Interestingly then, mind-wandering about the films without meta-awareness did not appear to impair attention to the reading task.

3.6 *Individual differences*

We next examined whether frequency of involuntary thoughts, with or without meta-awareness, was related to our baseline measurements of proneness to intrusive cognition (PICS), involuntary cognition (FITS), and thought suppression (TSS), using correlations. As shown in Table 2, there was a consistent directional positive association between proneness to intrusive cognition and all measures of involuntary thoughts for the film(s). However, only the relationship between PICS and self-caught negative film thoughts was statistically significant.

Table 2

Correlations between measures of involuntary thought and baseline individual differences, by film condition.

Response type	Film condition	PICS	TSS	FITS
Self-caught†	Negative	0.38 [0.08, 0.61]*	0.28 [-0.03, 0.54]	0.11 [-0.20, 0.40]
	Positive	0.25 [-0.05, 0.51]	-0.05 [-0.34, 0.25]	-0.11 [-0.39, 0.19]
Probe-caught (continuation)	Negative	0.27 [-0.53, 0.04]	0.07 [-0.24, 0.36]	0.15 [-0.16, 0.43]
	Positive	0.19 [-0.11, 0.46]	0.12 [-0.18, 0.40]	-0.20 [-0.47, 0.10]
Probe-caught (new)	Negative	0.26 [-0.04, 0.53]	-0.06 [-0.36, 0.25]	-0.004 [-0.31, 0.30]
	Positive	0.25 [-0.05, 0.50]	0.08 [-0.22, 0.37]	0.17 [-0.14, 0.44]

Note: $*p < 0.05$,. †The correlations with self-caught intrusions controlled for overall time spent on the reading task.

3.7 *Summary and implications*

To summarize, our data reveal three important findings, with several implications for future research. First, self-caught measures do not capture all involuntary thoughts. This result is consistent with Takarangi et al.'s (2014) finding that subjects are not always meta-aware of their own thoughts about an analogue trauma. Second, using probes to alert subjects to thoughts for which they lack meta-awareness may overestimate the number of involuntary thoughts those subjects are experiencing. However, importantly, our results indicate that not all probe-caught thoughts overlap with self-caught thoughts. In other words, probes still *do* appear to capture thoughts of which subjects are yet to be meta-aware. Third, we found that involuntary thoughts about an emotional film stimulus occur at a similar frequency, and with similar meta-awareness, for both negative and positive emotional events.

However, subjects rated their experience of thoughts about the negative event differently; more akin to symptoms of PTSD. More specifically, PTSD is characterized by persistent, involuntary and unwanted thoughts about a trauma, including intense distress after exposure to traumatic reminders. Our subjects rated involuntary thoughts arising from the negative film as having these kinds of features, relative to involuntary thoughts arising from the positive film.

Our findings have methodological implications. Self-report procedures are often used to capture re-experiencing symptoms of trauma, task-unrelated thoughts, and other involuntary thoughts and memories. However, we know from extensive research in the mind-wandering literature that people often lack meta-awareness of their own thoughts (McVay & Kane, 2009, 2012; Smallwood & Schooler, 2006). Our data adds to a growing body of evidence that self-report measures do not always accurately reflect involuntary thought experiences, and that probes can help bring these non meta-aware thoughts to consciousness. Indeed, we found that subjects were thinking about the film when asked about it, in the absence of self-report. Importantly however, our data also suggest that the probes may sometimes 'double-count' involuntary thought experiences that are already captured by self-report. Subjects in our study identified approximately half of probe-caught thoughts as continuations of previous self-reported thoughts. Hence, although using probes to investigate the presence of non meta-aware thoughts is essential for detecting such thoughts, our results highlight the importance of identifying unique thought experiences for which subjects genuinely lack meta-awareness. Future research should therefore be cautious in how probe questions and potential responses are presented to and interpreted by subjects.

Our findings also have practical and theoretical implications. First, when the cues to a negative vs. positive stimulus were equally available and time since the event occurred held constant, as in previous lab research, we found no difference in self-caught involuntary thought frequency. In field research, people tend to report more positive than negative involuntary memories, which may reflect these methodological differences. For example, the emotions associated with negative memories tend to fade faster than the emotions associated with positive memories (*fading affect bias*; Walker, Vogal, & Thompson, 1997), and most people tend to encounter more positive than negative stimuli on a day-to-day basis, and we know that involuntary memories are most often triggered by environmental cues (Berntsen, 1996; Schlagman & Kvavilashvili, 2008). However, negative involuntary thoughts differed qualitatively, and this finding fits with other research showing that problematic negative thoughts are higher in emotional intensity than positive involuntary thoughts (Rubin, Boals, & Berntsen, 2008). Moreover, in involuntary musical imagery research, although people typically report more liked than disliked songs as the most recent song stuck in their heads, when their most recent stuck song is from further in the past, they more likely to report the song as disliked (Hyman et al., 2013). Hyman et al. suggest that people may more easily remember negative intrusive experiences for a longer period of time.

Our data also lend support to the idea that it is important to distinguish between the characteristics of involuntary thoughts —such as the distress they cause, feelings of intrusiveness, and interpretations of their meaning—and their frequency, when explaining problematic outcomes such as PTSD (Ehlers & Steil, 1995; Steil & Ehlers, 2000). However, we also found that subjects were equally meta-aware of both negative and positive involuntary thoughts. This finding lends support to the basic

mechanisms view of memory: traumatic involuntary thoughts are meta-cognitively similar to involuntary thoughts for positive events. However, we cannot rule out whether these patterns of meta-awareness are unique to emotional, as opposed to more neutral, material.

Of course, our study has limitations: we used an analogue trauma, which may not be as generalizable to real life situations as using a real-life autobiographical event would be. Although analogue traumas have been shown to reliably induce involuntary thoughts in the short-term, the memories dissipate quickly, and are therefore not exactly synonymous with real-life traumatic experiences (Holmes & Bourne, 2008). Furthermore, an analogue positive event, although much easier to replicate, is also not synonymous with positive autobiographical experiences, which are likely to be more personally relevant and salient to people than an analogue positive experience. Thus, the observed difference between the events is likely to remain. We also focused on negative characteristics of cognition. Future studies could also use measures to specifically tap into positive feelings arising from a positive event. We used a non-clinical population. It is possible that studying a population with a susceptibility to PTSD, or a subclinical population, may reveal more about the pattern of negative involuntary thoughts, and mechanisms that lead to these thoughts becoming problematic. It would be interesting to look at whether the same pattern of positive and negative involuntary thoughts held up within a subclinical, or clinical population.

4 Conclusions

We replicated Takarangi et al.'s (2014) study and found that subjects failed to recognize some of their involuntary thoughts about an emotional event. We also found that involuntary thoughts are equally frequent for both negative and positive events, but these memories differed in recall characteristics. Importantly, we found

that previous studies using probes to catch non meta-aware thoughts may have overestimated the number of non meta-aware thoughts. Future studies should include the opportunity for subjects to report the difference between a new and continuing thoughts when responding to probes.

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