Emotional mental imagery generation during spontaneous future thinking -
relationship with optimism and negative mood

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Abstract

Optimism is known to buffer against negative mood, thus understanding the factors that contribute to individual variation in optimism may inform interventions for mood disorders. Preliminary evidence suggests that the generation of mental imagery-based representations of positive relative to negative future scenarios is related to optimism. This study investigated the hypothesis that a lower tendency to generate positive relative to negative mental imagery during spontaneous future thinking would be associated with elevated negative mood via its relationship to lower optimism. Participants ($N = 44$) with varied levels of naturally occurring negative mood reported current levels of optimism and the real-time occurrence and characteristics of spontaneous thoughts during a sustained attention computer task designed. Consistent with hypothesis, lower optimism statistically mediated the relationship between lower proportional frequency of positive relative to negative mental imagery during spontaneous future thinking and elevated negative mood. Further, the relationship between emotional mental imagery and optimism was found for future, but not past, thinking, nor for verbal future or past thinking. Thus, a greater tendency to generate positive rather than negative imagery-based mental representations when spontaneously thinking about the future may influence how optimistic one feels, which in turn may influence one's level of negative mood.

[Word count: 200]

Keywords: mental imagery, spontaneous future thinking, optimism, negative mood

Negative mood states such as feeling sad, anxious and unhappy are common in daily life, and at any one time, with some individuals experiencing higher levels of negative mood than others at any one time. Researchers have sought to understand the cognitive factors driving heightened negative mood, as it may inform intervention development for prevalent mood dysregulation conditions such as depression and anxiety.

One factor known to drive the degree of negative mood is optimism, the generalised feeling that one's own future will turn out well (Carver, Scheier, & Segerstrom, 2010). It is well established that those who are optimistic tend to experience less negative emotional and physiological impacts under stress (Brydon, Walker, Wawrzyniak, Chart, & Steptoe, 2009; Carver & Gaines, 1987; Scheier & Carver, 1985; Segerstrom, Taylor, Kemeny, & Fahey, 1998). On the other hand, theory and evidence suggests that negative views of one's future is one factor driving heightened levels of depression and anxiety (Abramson, Metalsky, & Alloy, 1989; Beck, Rush, Shaw, & Emery, 1979; Miloyan, Bulley, & Suddendorf, 2016; Miranda & Mennin, 2007; Muris & Van Der Heiden, 2006; Pyszczynski, Holt, & Greenberg, 1987; Roepke & Seligman, 2016; Strunk, Lopez, & DeRubeis, 2006). Given that optimism buffers against negative mood, understanding factors that drive variation in how optimistic we feel may illuminate new pathways to reducing mood disturbance.

Emotional future mental imagery and optimism

As the future does not exist, it is likely that our mental representations of the future influences how optimistic we feel. Researchers have postulated that the human capacity to generate mental imagery-based representations of future scenarios that could occur is an important form of future thinking as it allows individuals to simulate and predict possible future outcomes (Bulley, Redshaw, & Suddendorf, 2019; Schacter, Benoit, & Szpunar, 2017). Mental imagery refers to internally generated sensori-perceptual experiences that can function as a weak form of veridical perception (Pearson, Naselaris, Holmes, & Kosslyn, 2015), thus mental imagery-based representations of future scenarios can allow individuals to pre-experience what might happen in an as-if-real manner (Ji, Heyes, MacLeod, & Holmes, 2016; Lang, 1979; Moulton & Kosslyn, 2009).

Experimental evidence suggests that generating mental imagery-based representations of hypothetical emotional scenarios can influence one's attitudes towards such scenarios (Benoit, Paulus, & Schacter, 2019). Further, hypothetical emotional scenarios that are imagined more frequently are judged as more realistic and likely to occur, but only when such scenarios are future-oriented, not past-oriented (De Brigard, Szpunar, & Schacter, 2013; Schacter, Benoit, De Brigard, & Szpunar, 2015; Szpunar & Schacter, 2013). Thus, when spontaneously thinking about the future, individuals who tend to generate mental imagery-based representations of positive rather than negative scenarios may also feel more optimistic about what the future holds, compared to those who are less likely to do so.

To our knowledge, no study has directly examined the relationship between biases in one's tendency to generate positive relative to negative mental imagery during spontaneous (uninstructed) future thinking and optimism. However, some researchers have examined the relationship between the ability to generate positive relative to negative future mental imagery and optimism. Such studies have found that, when instructed to deliberately generate mental imagery-based representations of future scenarios in response to emotional verbal cues, lower subjective imagery vividness for positive, but not negative, scenarios is associated with lower optimism (Blackwell et al., 2013; Ji, Holmes, & Blackwell, 2017; Sharot, Riccardi, Raio, & Phelps, 2007). In addition, clinical researchers have found that instructing participants to generate mental imagery representations of one's best possible self can increase optimism, and to a greater extent than generating mental imagery representations of daily activities (Meevissen, Peters, & Alberts, 2011; Peters, Flink, Boersma, & Linton, 2010). Thus, positive mental imagery about the future appears to be related to one's level of optimism. However, biases in instructed future mental imagery generation does not directly bear upon biases in one's tendency to do so spontaneously (i.e. without instructions or task requirements to do so).

Preliminary evidence from a recent experience sampling study suggests that anomalies in mental imagery during spontaneous future thinking may be related to optimism

(Beatty, Seli, & Schacter, 2018). Beatty et al. (2018) sampled the temporal direction and emotional valence of daily cognition across a seven day period, and found that higher optimism was associated with greater emotional positivity of future-oriented thought content, on average (Beatty et al., 2018). Interestingly, optimism was not related to the overall frequency of future thinking, or to the emotional valence of past-oriented thought content. Thus, optimism may be specifically related to positivity of mental imagery-based thoughts during future thinking. However, it is worth noting that the representational format of cognition was not explicitly assessed in Beatty et al. (2018), as the presence mental imagery-based future thinking was indirectly inferred from vividness ratings participants provided for all thoughts. In addition, the valence of thought content was averaged across all future-oriented thoughts, thus whether optimism was associated with higher frequencies of positive *relative to* negative future thinking remains unclear.

The present study

While previous research provides encouraging support for the existence of a link between emotional future mental imagery generation and optimism, the relationship between the tendency to generate positive relative to negative mental imagery during spontaneous future thinking and optimism remains to be directly tested. Most importantly, no study has assessed whether optimism mediates the relationship between individual differences in the tendency to generate positive relative to negative mental imagery during future thinking and negative mood.

The present study tested the hypothesis that a lower tendency to generate positive relative to negative mental imagery during spontaneous future thinking contributes to lower optimism, which in turn contributes to elevated negative mood. If this is true, then at any given time, individuals experiencing higher negative mood will be less optimistic about the future (prediction 1), and those feeling less optimistic about the future will exhibit lower tendency to generate positive relative to negative mental imagery during spontaneous future thinking (prediction 2). Further, lower optimism will statistically mediate the relationship

between lower tendency to generate positive relative to negative mental imagery during spontaneous future thinking and elevated negative mood (prediction 3).

To test the above relationships, the study required a task that could a) evoke and record the real-time occurrence of future-oriented thoughts without instructions to generate such thoughts; and b) distinguish between mental imagery-based future thoughts from those that do not involve imagery (verbal future thoughts); and c) distinguish between emotionally positive future thoughts from emotionally negative future thoughts. To achieve this, the study adapted a sustained attention to response task developed by Ji et al. (2018) to evoke spontaneous thinking by encouraging mindwandering. Without instructions to generate thoughts of any kind, participants self-reported the temporal direction (future, past, present, atemporal), representational format (imagery-based vs. verbal), and emotional valence (positive, negative, neutral) of spontaneous thoughts during the task. The task was further modified to include concurrent assessments of optimism and negative mood. This methodology also allowed for the exploration of the extent to which any observed relationships between the tendency to generate positive relative to negative mental imagery during future thinking and optimism is unique in temporal direction (future, but not past), and representational format (imagery-based, but not verbal, future thoughts).

Method

Participants

Forty-four individuals (28 females; age $M = 24.61$, $SD = 5.36$) from the local community and universities in Cambridge, United Kingdom participated in the study. Sample size was guided by bootstrapped (bias corrected) mediation analysis sample size recommendations for .80 power and medium and large paths for α and β respectively (Fritz & Mackinnon, 2010). To increase the likelihood of recruiting participants with varied levels of naturally negative mood, the study was advertised as seeking participants who are “feeling blue” or “not experiencing mood disturbance”. Eligibility criteria included: 1) age between 18 and 65; 2) not receiving current psychopharmacological or psychological treatment for a mental health condition; 3) no history of neurological disorder(s); and 4) self-identified native-

level English language proficiency. Participants were reimbursed for their time and travel.

The study was approved by the Cambridge Psychology Research Ethics Committee (ethics code: PRE.2014.13).

Materials

Spontaneous Thought Generation Task

The laboratory task used to evoke and record uninstructed spontaneous thoughts consisted of four components: a) a trial-by-trial sustained attention component to induce boredom and encourage spontaneous thought generation; b) a spontaneous thought reporting component initiated by the participant at any time during the task; and c) an optimism rating component, and d) a mood rating component

A) Sustained attention component. Each trial required participants to respond to a visually-displayed digit (1000 ms duration) on the computer screen, which ranged from “1” to “9” with equal probability. Participants were required to press a pre-specified key on the keyboard for all numbers except the number “3”, for which they were to withhold the keypress. To promote the occurrence of spontaneous thoughts using verbal cues (Vannucci, Pelagatti, & Marchetti, 2017), singular word cues were also presented aurally via headphones on each trial (max 1000 ms duration, spoken by a female native British English speaker). Word cues varied in emotional valence (negative, positive, or neutral), based on normative ratings from the Affective Norms for English Words corpus (ANEW; Bradley & Lang, 1999). There were no ANEW Arousal rating differences between the negative, positive, and neutral word cues, $F(2, 357) = 0.52$, $p = 0.603$, or differences in imageability ratings (ease with which a word evokes an associated mental image) provided by independent raters, $F(2, 357) = 2.33$, $p = 0.10$. There were 360 trials in total, with 120 word cues from each valence category. Each trial was preceded by a fixation cross (500 ms) and followed by a blank screen (1000 ms), thus stimulus onset asynchrony (SOA) duration was 2500 ms.

B) Spontaneous thought reporting component. Parallel to the sustained attention component of the task, participants were instructed to press a key every time they became

aware that their mind had wandered away from the computer task to think about other things. The key press paused the sustained attention component of the task so that the following features of thought content could be self-rated: (a) Representational Format (mental imagery; verbal; both); (b) Emotional Valence (on a 5-point scale, ranging from 1 (*Very negative*) to 5 (*Very positive*); and (c) Temporal Direction (on an 8-point scale, ranging from Past (1 – Years; 2 – Months; 3 – Days/Weeks); Present (4) (Present); Future (5 – Days/Weeks; 6 – Months; 7 – Years); and Atemporal (8)).

C) Optimism rating component. To assess the current level of optimism, participants received prompts to rate how optimistic they currently feel at four points throughout the task in response to the question “At the moment I am feeling “optimistic”. Ratings were provided on a 10-point VAS scale ranging from “not at all” to “extremely”. To explore whether the relationship between Biases in Future Imagery Tendency and Optimism is specific to optimism, we also asked participant to rate how hopeless they felt using the same rating scale in response to the question “At the moment I am feeling “hopeless”.

D) Negative Mood rating component. To assess the current level of negative mood, participants received prompts to rate how “sad”, “anxious”, and “happy” (reverse scored) they currently feel in the same manner as the optimism rating.

Procedure

Participants were tested individually. Upon arriving at the laboratory, participants gave written informed consent, completed a demographics questionnaire and received instructions for each of the three components of the task, including an explanation of the difference between mental imagery-based versus verbal thoughts. Participants then practiced all three components of the task before commencing the main task, following which participants were debriefed and reimbursed.

Data extraction

To assess the relationship between optimism and the tendency to generate positive relative to negative imagery during future thinking, the frequency of imagery-based spontaneous future thoughts rated by participants as being positive or negative in emotional

valence were computed as proportional to the total frequency of future-oriented thoughts. A Future Imagery Positive Bias Index was computed by subtracting negative future imagery proportional frequency from positive future imagery proportional frequency, where a positive score reflects a greater tendency to generate positive relative to negative imagery during future thinking. Bias Indices for verbal future thoughts, and imagery and verbal past thoughts were computed using the same approach. Further, a Negative Mood index score was computed by summing “Sad”, “Anxious”, and reverse-scored “Happy” ratings, where higher scores indicate higher levels of negative mood.

Results

Participant characteristics

Participants (63.60% females) were aged 18 to 42, $M = 24.60$, $SD = 5.36$, with 16.80 years of education on average ($SD = 2.78$ years). Negative Mood Index scores at test time ranged from 1.88 to 24.5, $M = 10.60$; $SD = 5.46$.

General Spontaneous Thought (ST) characteristics

A total of 906 Spontaneous Thoughts (STs) were reported, 143 (15.80%) of which were future-oriented. For Future STs, 110 (76.90%) involved mental imagery, with the most common type of Future ST being mental imagery-based and positive in valence (42.7%). The number of Future, as well as Past, Present and Atemporal STs by representational format and valence are shown in Table 1.

Table 1.
The frequency (raw and %) of Future, Past, Present and Atemporal Spontaneous Thoughts (STs) by Representational Format and Valence of STs

Temporal Orientation	Representation Format	Frequency	Valence			Total
			Negative	Neutral	Positive	
Future	Imagery	Raw	19	30	61	110
		%	13.3 %	21.0 %	42.7 %	
	Verbal	Raw	8	15	10	33
		%	5.6 %	10.5 %	7.0 %	
	Total	Raw	27	45	71	143
		%	18.9 %	31.5 %	49.7 %	
Past	Imagery	Raw	71	65	137	273
		%	22.0 %	20.2 %	42.5 %	
	Verbal	Raw	15	18	16	49
		%	4.7 %	5.6 %	5.0 %	
	Total	Raw	86	83	153	322

		%	26.7 %	25.8 %	47.5 %	
Present	Imagery	Raw	20	36	46	102
		%	7.2 %	13.0 %	16.6 %	
	Verbal	Raw	55	99	21	175
		%	19.9 %	35.7 %	7.6 %	
	Total	Raw	75	135	67	277
		%	27.1 %	48.7 %	24.2 %	
Atemporal	Imagery	Raw	29	34	35	98
		%	17.7 %	20.7 %	21.3 %	
	Verbal	Raw	15	37	14	66
		%	9.1 %	22.6 %	8.5 %	
	Total	Raw	44	71	49	164
		%	26.8 %	43.3 %	29.9 %	
Total	Imagery	Raw	139	165	279	583
		%	15.3 %	18.2 %	30.8 %	
	Verbal	Raw	93	169	61	323
		%	10.3 %	18.7 %	6.7 %	
	Total	Raw	232	334	340	906
		%	25.6 %	36.9 %	37.5 %	

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234 **The relationship between positive relative to negative future imagery frequency,**
235 **optimism, and negative mood**

236 Zero-order correlations between Negative Mood Index Scores, Optimism rating, and
237 Future Imagery Bias scores (Table 2) showed a significant negative relationship between
238 Negative Mood Index Scores and Optimism rating, $r = -0.73$, $p < 0.001$, consistent with
239 Prediction 1. Consistent with Prediction 2, a significant positive relationship was found
240 between Optimism and Future Imagery Bias score, $r = 0.40$, $p = 0.013$. Further
241 decomposition of this relationship revealed a significant positive relationship between the
242 percentage of positive imagery and optimism, $r = 0.36$, $p = 0.03$, and a smaller negative
243 imagery and optimism that fell below statistical significance threshold, $r = -0.25$, $p = 0.14$.
244 Therefore, lower Optimism was associated with reduced positive bias in future imagery
245 tendency, driven primarily by reductions in positive imagery generation tendency during
246 future thinking.

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Table 2.

Zero order correlations between Sad Mood, Optimism, and Future Thinking Frequency

		Sad Mood Index Score	Optimism Score	Future Thinking Total Frequency	Future Imagery Bias Score	Future Verbal Thought Bias Score
Sad Mood Index Score	Pearson's r	—				
	p-value	—				
Optimism Score	Pearson's r	-0.785	—			
	p-value	< .001***	—			
Future Thinking Total frequency	Pearson's r	-0.037	-0.055	—		
	p-value	0.812	0.723	—		
Future Imagery Bias Score	Pearson's r	-0.178	0.398	0.012	—	
	p-value	0.285	0.013*	0.941	—	
Future Verbal Thought Bias Score	Pearson's r	-0.208	0.116	-0.084	-0.057	—
	p-value	0.211	0.486	0.617	0.734	—

Note. * $p < .05$, ** $p < .01$, *** $p < .001$

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251 To test prediction 3, a mediation model with Future Imagery Bias score as predictor,
 252 Optimism rating as mediator, and Negative Mood Index score as outcome variable was
 253 conducted. As depicted in Figure 1, the regression coefficient between Future Imagery Bias
 254 and Optimism, and between Optimism and Negative Mood, were statistically significant.
 255 Consistent with Prediction 3, the indirect effect was $(1.60) (-2.10) = -3.36$. We tested the
 256 statistical significance of this indirect effect using 10,000 bootstrapped samples. The 95%
 257 confidence interval for the indirect effect, computed by determining the indirect effects at the
 258 2.5th and 97.5th percentiles, ranged from $[-6.38 \text{ to } -0.82]$, thus the indirect effect was
 259 statistically significant, $p = 0.015$. Thus, optimism statistically mediated a negative
 260 relationship between positive bias in future imagery tendency and negative mood.

Figure 1. Unstandardised (b) and standardised (β) regression coefficients for the relationship between Positive Bias in Future Imagery Tendency (higher score indicates greater tendency to generate positive relative to negative imagery during future thinking) and Negative Mood (higher score indicates higher negative mood), mediated by Optimism (higher scores indicate greater optimism). The regression coefficients between Positive Bias in Future Imagery Tendency and Negative Mood, controlling for Optimism, are presented in parentheses.

Note: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

To explore the specificity of the relationship between tendency to generate positive relative to negative imagery during spontaneous future thinking and optimism, zero-order correlations were conducted between optimism and verbal future thinking, as well as imagery-based and verbal past thinking. No significant relationships were found between Optimism ratings and Positive Bias scores for Future Verbal Thoughts, Past Imagery-based Thoughts or Past Verbal Thoughts, all $r \leq -0.28$, all $p \geq 0.09$, suggesting the relationship between optimism and positive bias in future imagery tendency is unique in representational format and temporal direction.

In addition, no significant zero-order correlation was found between Positive Bias scores for Future Imagery and Hopelessness, $r = -0.17$, $p = 0.31$, suggesting the relationship between emotional future imagery tendency and optimism was specific.

To determine whether the relationship between Positive Bias in Future Imagery Tendency and Optimism should be interpreted within overall differences Future Thinking as a function of Optimism, the relationship between Optimism and total Future ST frequency, and Optimism and total Neutral Future Imagery and Neutral Future Verbal ST frequency, were examined. No significant correlations were found, all $r \leq |0.08|$, all $p \geq 0.63$, indicating

that optimism was not related to the overall tendency to think about the future, or think about neutral aspects of the future.

Discussion

The present study investigated the relationship between the tendency to generate positive relative to negative mental imagery during spontaneous future thinking, optimism, and negative mood. Consistent with hypothesis, optimism was found to statistically mediate the relationship between reduced tendency to generate positive relative to negative mental imagery during spontaneous future thinking and elevated negative mood. Specifically, a lower tendency to generate positive imagery during spontaneous future thinking statistically predicted lower optimism, and lower optimism in turn statistically predicted elevated negative mood. Importantly, the relationship between positive bias in future imagery generation tendency and optimism was unique in representational format and temporal direction.

The present findings add to previous evidence showing that enhanced mental imagery-based representations of positive aspects of the future is related to greater optimism (Blackwell et al., 2013; Ji et al., 2017). While previous research focused on the subjective vividness of positive and negative imagery generated under instructions to do so, this study provides the first evidence that lower frequency of positive relative to negative imagery during spontaneous future thinking is uniquely associated with lower optimism. It is interesting to note that, consistent with Beatty et al (2018), optimism was not related to the tendency to think about the future in general. Thus, although less optimistic individuals may not think about the future less often, they may be less likely to generate mental imagery-based representation of positive when thinking about the future.

Further, the present findings also add to growing evidence that deficits in positive cognition and information processing may be driving mood dysregulation in conditions such as depression (Dunn, 2012; LeMoult & Gotlib, 2019; Winer & Salem, 2016). While previous research has shown that depression is associated with reduced accessibility of positive mental imagery of the future when instructed to imagine the future (Gamble, Moreau, Tippet, & Addis, 2019; MacLeod, 2016), the present results extend this research in showing

that when thinking about the future, reduced tendency to generate positive imagery may be related to elevated negative mood, in part be due to its mutual relationship to lower optimism.

It is interesting to note that the relationship between the tendency to generate positive relative to negative imagery during future thinking and one's feelings about the future was specific to optimism, and did not extend to hopelessness. While there is some evidence suggesting that distortions in spontaneous future-oriented cognition is linked to mood dysregulation via its relationship to hopelessness (Marchetti, Koster, Klinger, & Alloy, 2016), we note that the majority of participants in the present study exhibited a net positive bias in future imagery tendency (bias score > 0), and hopelessness is associated with clinical depression and suicidality (Abramson et al., 1989; Beck, Riskind, Brown, & Steer, 1988). Given previous research showing that clinically depressed and suicidal individuals have difficulty anticipating positive, but not negative, personal future events (MacLeod & Byrne, 1996; MacLeod & Salaminou, 2001), it is possible that the relationship between future imagery and hopelessness will be stronger in clinical populations that exhibit overtly negative biases in future imagery tendency.

Finally, the present results demonstrates the importance of distinguishing the representational format of mental representations when investigating individual difference in future thinking. While early mindwandering research distinguished, and emphasised the importance of, future-oriented thoughts that involve mental imagery versus those that did not (i.e. verbal future thinking) (Giambra, 1977; Singer & Antrobus, 1972), this distinction had been largely lost in subsequent research. Results from the present study demonstrate that assessing spontaneous future thinking frequency as a function of both the emotional valence as well as representational format of thought content can enhance the understanding of individual differences in future thinking.

Limitations and future directions

Given the cross-sectional nature of the study, the indirect relationship between reduced tendency to generate positive relative to negative imagery during future thinking and

elevated negative mood, via lower optimism, is statistical in nature, and does not bear upon the causality and directionality of these relationships. Future research should seek to replicate and establish the causality of these relationship, such as by experimentally inducing increases or decrease in the frequency of positive relative to negative mental imagery generation during future thinking, and assessing whether it leads to corresponding increases or decreases in optimism and negative mood. Such research will help to assess the relevance of emotional future mental imagery as a potential novel intervention target for mood and anxiety disorders.

Second, the present study did not directly assess thought *content*. Previous research has shown that spontaneous future thoughts tend to be more abstract and less about concrete plans for individuals with high relative to low dysphoria (Plimpton, Patel, & Kvavilashvili, 2015). Thus, it is possible that anomalies in emotional mental imagery during future thinking extends beyond the frequency of imagery generation to the degree to which future imagery, once generated, reflects concrete planning-related thoughts relating to future goals. Future research should investigate anomalies in future imagery content in relation to optimism and negative mood.

Finally, the occurrence of spontaneous thoughts were self-caught, thus relying on participants' monitoring of their own conscious experience (Giambra, 1993). Previous research suggests self, relative to probe-caught (via the delivery of pseudo-random thought probes), spontaneous cognition does not alter phenomenological experience during undemanding cognitive tasks (Schooler, 2002; Smallwood, Baracaia, Lowe, & Obonsawin, 2003). Nonetheless, the results must be interpreted as pertaining to spontaneous future thinking occurring within one's meta-awareness (Smallwood & Schooler, 2015). Future studies investigating individual differences in spontaneous future thinking frequency should employ both self and probe-caught approaches.

Conclusion

Findings from this study suggest that reduced tendency to generate positive relative to negative mental imagery during spontaneous future thinking may indirectly drive elevated

negative mood via its unique relationship to reduced optimism. In light of the growing consensus that psychopathology-linked individual differences in spontaneous future thinking is a clear research priority (Andrews-Hanna et al., 2013; Berntsen, 2019), the present study shows that assessing individual variation in biases in *mental imagery-based* future thinking may be a particularly important avenue for future research on mood dysregulation.

Declarations

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Conflicts of interest/Competing interests

The authors declare no conflicts of interest.

Availability of data and material

Data for this manuscript can be viewed via the Open Science Framework at: https://osf.io/x3h7t/?view_only=590ee853c8c64821ac4bc3215adcf784

Code availability Not applicable

Authors' contributions

- **Julie L Ji:** Conceptualization; Data curation; Formal analysis; Investigation; Methodology; Visualization; Writing – original draft; Writing – review & editing.
- **Fionnuala Murphy:** Conceptualization; Methodology; Supervision; Writing – review & editing)
- **Ben Grafton:** Conceptualization; Methodology; Writing – review & editing
- **Colin MacLeod:** Conceptualization; Methodology; Supervision; Writing – review & editing
- **Emily A Holmes:** Conceptualization; Funding acquisition; Methodology; Supervision; Writing – review & editing

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Table 1.

The frequency (raw and %) of Future, Past, Present and Atemporal Spontaneous Thoughts (STs) by Representational Format and Valence of STs

Temporal Orientation	Representation Format	Frequency	Valence			Total
			<i>Negative</i>	<i>Neutral</i>	<i>Positive</i>	
Future	Imagery	Raw	19	30	61	110
		%	13.3 %	21.0 %	42.7 %	
	Verbal	Raw	8	15	10	33
		%	5.6 %	10.5 %	7.0 %	
	Total	Raw	27	45	71	143
		%	18.9 %	31.5 %	49.7 %	
Past	Imagery	Raw	71	65	137	273
		%	22.0 %	20.2 %	42.5 %	
	Verbal	Raw	15	18	16	49
		%	4.7 %	5.6 %	5.0 %	
	Total	Raw	86	83	153	322
		%	26.7 %	25.8 %	47.5 %	
Present	Imagery	Raw	20	36	46	102
		%	7.2 %	13.0 %	16.6 %	
	Verbal	Raw	55	99	21	175
		%	19.9 %	35.7 %	7.6 %	
	Total	Raw	75	135	67	277
		%	27.1 %	48.7 %	24.2 %	
Atemporal	Imagery	Raw	29	34	35	98
		%	17.7 %	20.7 %	21.3 %	
	Verbal	Raw	15	37	14	66
		%	9.1 %	22.6 %	8.5 %	
	Total	Raw	44	71	49	164
		%	26.8 %	43.3 %	29.9 %	
Total	Imagery	Raw	139	165	279	583
		%	15.3 %	18.2 %	30.8 %	
	Verbal	Raw	93	169	61	323
		%	10.3 %	18.7 %	6.7 %	
	Total	Raw	232	334	340	906
		%	25.6 %	36.9 %	37.5 %	

Figures

Figure 1. Unstandardised (b) and standardised (β) regression coefficients for the relationship between Positive Bias in Future Imagery Tendency (higher score indicates greater tendency to generate positive relative to negative imagery during future thinking) and Negative Mood (higher score indicates higher negative mood), mediated by Optimism (higher scores indicate greater optimism). The regression coefficients between Positive Bias in Future Imagery Tendency and Negative Mood, controlling for Optimism, are presented in parentheses.
 Note: $*p < 0.05$; $**p < 0.01$; $***p < 0.001$