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Me, my thoughts and I – Personality as a moderator of the effect of thoughts on subjective well-being

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ABSTRACT

We study how personality impacts people's experiences of their thoughts in terms of experienced happiness and worthwhileness. Over two weeks, 483 participants completed over 20,000 experience sampling questionnaires including reports of hedonic and eudemonic well-being, and type and content of thoughts. Using multi-level modelling we show that personality traits recorded prior to the start of the study for all participants interact with thought variables to significantly predict experiences of worthwhileness. Openness was the personality trait with the greatest impact on how content and type of thoughts affected worthwhileness. Predictions of happiness were not significantly improved by the addition of interactions between personality and thoughts. Implications for the broader literature on the relationship between personality and well-being are discussed.

1. Introduction

The idea that our thoughts are intricately tied to how we feel is not a new one. In fact, it is an intuition that can be traced back several millennia. Yet, despite the keen interest of philosophers, thinkers and, more recently, scientists in the relationship between well-being and thoughts, surprisingly little is known about the role that individual differences play in this relationship. In other words, do different people benefit more from (or suffer more under) different kinds of thoughts?

While there is some research focusing on clinical populations (Sin & Lyubomirsky, 2009), less is known about how non-clinical traits in the general population affect people's experiences of thoughts. Previous research has already shown that personality acts as a moderator in the relationship between external factors and well-being (Anusic et al., 2014; Boyce et al., 2016). In this paper, we explore the question of whether personality moderates the relationship between thoughts and two elements of well-being, namely, hedonic well-being (happiness) and eudemonic well-being (worthwhileness).

Most of the research to date has chosen to study the relationship between thoughts and well-being by focusing predominantly on the hedonic dimension of well-being, even though eudemonic well-being is associated with different contextual and cognitive predictors. Past research has shown these constructs to be highly correlated, but clearly distinct from one another, as there is plenty of evidence that people have experiences of low happiness and high worthwhileness, and vice versa (Choi et al., 2017; White & Dolan, 2009). However, no previous research has explored differences between the hedonic and eudemonic experiences of thoughts.

1.1. Thoughts

We are particularly interested in the phenomenon of mind-wandering, whereby people's attention drifts away from the activity, task or experience that they are engaged in (Smallwood & Schooler, 2015). We know from previous literature that mind-wandering is prominent across the population, with researchers finding that it makes up almost half of our waking thoughts (Killingsworth & Gilbert, 2010). Here, we focus on thoughts that people report to be unrelated to the current activity that they are engaged in. While the literature does not have an existing label for such thoughts, we estimate that they are closest to what the experimental literature defines as task-unrelated thoughts (TUT; Seli et al., 2018; Smallwood & Schooler, 2015).

The theoretical consensus in the mind wandering literature is that individual characteristics affect how people experience their thoughts. This was most prominently argued in Smallwood and Andrews-Hanna's (2013) *context regulation hypothesis*, which stipulates that people with different characteristics will experience different costs and benefits from task-unrelated thoughts. Previous research has already explored how

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certain individual-specific characteristics, like cognitive capacity (Rummel & Boywitt, 2014) affect people's experience of thoughts, but no studies to date have explored how personality affects the well-being costs or benefits that people may derive from their thoughts. Therefore, this paper aims to provide an empirical basis for future research unpacking the context regulation hypothesis.

1.2. Pair-wise links

While we may expect the interaction between individual characteristics, thoughts and well-being to be relatively complex, previous research has brought ample evidence on the pair-wise links. Individual-specific characteristics, and personality in particular, explain large amounts of variation in well-being reports – between 30 and 50 % (Lyubomirsky et al., 2005). Specifically, neuroticism and extroversion are strong predictors of several well-being measures, while conscientiousness also shows consistent relationships with well-being (Anglim et al., 2020; Hayes & Joseph, 2003).

Furthermore, personality is related to the thoughts people report (Kane et al., 2017; Robison et al., 2020). Higher neuroticism and lower conscientiousness predict higher frequencies of mind-wandering reports (Carciofo et al., 2016), while openness to experience relates to default network activity in the brain, which is also associated with mind-wandering (Beaty et al., 2016). Personality has also been linked to valence of thoughts (Neff et al., 2007), while the relationships between content of thoughts and personality have yet to be explored in more depth.

The research on the relationship between thoughts and well-being has confirmed that how we feel is related to various dimensions of our thoughts. Specifically, it has been demonstrated that what we think about (content; Andrews-Hanna et al., 2013; Nyklíček et al., 2021; Smallwood & Schooler, 2015), whether or not it is related to the current activity (type; Brose et al., 2011; Killingsworth & Gilbert, 2010) and whether it is positive or negative (valence; Smallwood & Andrews-Hanna, 2013; Welz et al., 2018) have consistent effects on well-being in the general population. Early research showed that TUT tend to be negatively associated with well-being, although more recent developments have suggested that it may not actually be the type of thought, but rather the content and the valence that are most predictive of well-being.

However, it is still unclear whether there are individual differences in the long-established relationship between thoughts and well-being. In this study, we apply multi-level modelling to a longitudinal panel dataset of university students to explore how the interaction between individual-specific characteristics (specifically, Big 5 personality traits) and type, valence and content of thoughts affects people's reports of experienced happiness and worthwhileness.

We explore whether accounting for individual-specific differences in relation to thoughts better explains variation in experienced well-being than thoughts alone. We use multi-level models to determine whether the relationship between thoughts and well-being is better explained by accounting for individual differences in general, and (2) whether self-reported personality traits are able to account for this individual-specific variation.

2. Methodology

2.1. Data collection

The study was approved by the LSE Ethics Committee. Data were collected using a custom-made mobile app that requires participants to fill in a set of individual-specific characteristic (ISC) questionnaires, after which they are asked to answer Ecological Momentary Assessment (EMA) questionnaires five times a day for two weeks. Informed consent was obtained from all participants when they first opened the app, before they started the ISC questionnaires. The EMA questionnaires ask people about their activities, their company, their thoughts and their well-being (Shiffman et al., 2008). Participants are prompted by a notification at random times during separate two-and-a-half-hour windows throughout the day. After receiving the prompt, they have thirty minutes to answer before it expires. The EMA questionnaires are available in the supplementary materials.

2.2. Participants

Participants were students and staff from the LSE that were recruited through the school's Behavioural Research Lab and on-campus advertising between January and February 2019. During this time, 816 participants completed the onboarding questionnaires, including all ISC questionnaires, demographic and general well-being questions.

We use the data from all participants that provided complete answers to the personality questionnaire and whose EMA entries included at least one report of thoughts alongside a happiness or worthwhileness report. Of the 816 starting participants, 284 failed to fill in a single valid EMA questionnaire. This attrition level is in line with other EMA studies (Csikszentmihalyi & Hunter, 2003) and was likely due to the length of the onboarding questionnaire, which might have demotivated some participants. Of the remaining 532 participants, 49 did not provide complete answers to the personality questionnaire, meaning that the final sample that is considered in this study is composed of 483 participants and 20,393 EMA entries. This sample is composed of 66.7 % of female respondents and 81.5 % of students.

The mean rate of completion of the EMA questionnaires was 60.3 % (42.2 out of 70 possible). The median completion rate was 74.3 % (52 out of 70). As it was possible for participants to report multiple thoughts per entry, a total of 27,802 thoughts were reported across all entries, 11,804 of which were TUT (39.9 %).

Of the 20,393 entries, 5363 included reports of happiness but not worthwhileness, and 5309 included reports of worthwhileness but not happiness, meaning that our final samples for momentary happiness and worthwhileness differ slightly in size. Specifically, the sample used to analyse momentary happiness is composed of 479 individuals and 15,029 observations, and the sample used to analyse momentary worthwhileness of 477 individuals and 15,084 observations. In these respective samples, the mean happiness is 6.37 (SD = 1.93) and the mean worthwhileness is 6.39 (SD = 2.18).

2.3. Measures and coding

Well-being. We focus on momentary reports of hedonic and eudemonic well-being (Dolan & Metcalfe, 2012). Momentary happiness and worthwhileness were measured using the following questions: *'How happy did you feel?'* and *'How worthwhile did this feel?'*. Both questions were answered on a scale of 0–10, and resulting variables were treated as continuous. Reports of well-being were standardized (mean = 0, SD = 1) at the participant level, using individual means and SD, to facilitate interpretability of coefficients resulting from interaction models.

Personality. Personality traits were captured using the big 5 classification using the IPIP, as this instrument showed a good balance between low number of questions and high level of internal consistency in previous studies (Gow et al., 2005). No changes were applied to the scores for agreeableness (Cronbach's $\alpha = 0.83$), extroversion ($\alpha = 0.89$), conscientiousness ($\alpha = 0.77$) and openness to experience ($\alpha = 0.81$). Neuroticism (emotional stability, $\alpha = 0.89$) was reverse scored in the data in order to reflect the idea that a higher score is associated with the more desirable trait. All aggregated personality trait scores were standardized (mean = 0, SD = 1). As such, coefficients associated to personality traits and interactions with thought variables will be interpreted as the effect of a 1 SD increase in the relevant personality trait.

Thoughts. For type of thought, two variables were created: to capture (a) whether the participant reported that they were thinking about

their *current activity* (TCA), and (b) whether their mind was wandering. We label this mind-wandering as "having a *task-unrelated thought*" (TUT). Content of thoughts was split according to social and temporal dimensions. In the social dimension, two variables were created to indicate when a thought was related (a) to the self and (b) to others. In the temporal dimension, two variables were created for thoughts related (a) to the past and (b) the future. For both dimensions of content, we accounted for the possibility that the social or temporal content was not specified. We also created two variables for the valence of thought, for (a) positive and (b) negative thoughts. All above-mentioned thought variables were coded in binary format (1 if the relevant component of thought was present, 0 if not).

Table 1 shows descriptive statistics for measures of personality, thoughts and well-being.

2.4. Statistical methodology

To test whether personality moderates the relationship between thoughts and well-being, we use mixed-effects multilevel regressions (MLM), to capture both between- and within-person effects, as well as interactions between the two. We construct our model step-by-step, using the effect of the type of thoughts on momentary well-being as a starting point. We estimate each model using random intercepts first, followed by the inclusion of random slopes for each thought variable. If the random slopes model is a significant improvement on the model without slopes (as determined by the likelihood ratio), random slopes are preserved in every subsequent model. Personality variables are included in the models using random slopes. Interactions between personality variables and thought variables, as well as the relative fit of each model, are discussed. In the event that including a random slope causes the model to fail to converge, we identify which variables cause this failure to converge and remove them from the list of random slopes. These variables are preserved in the model as control variables, for consistency with earlier models.

In the following sections, we discuss coefficients and associated significance levels after applying a False Discovery Rate Controlling Procedure (FDR, Glickman et al., 2014) to correct for multiple hypothesis testing. Analysis was performed using STATA (SE17.0).

Table 1
Descriptive statistics.

Variable	Min	Max	N	Mean	SD
Well-being					
Happiness	0	10	15,029	6.37	1.90
Worthwhileness	0	10	15,084	6.37	2.21
Thoughts					
TUT	0	1	20,393	0.38	0.49
TCA	0	1	20,393	0.82	0.38
Negative	0	1	20,393	0.14	0.34
Positive	0	1	20,393	0.56	0.50
TUT content					
Social: self	0	1	7783	0.35	0.48
Social: others	0	1	7783	0.29	0.45
Temporal: past	0	1	7783	0.22	0.42
Temporal: future	0	1	7783	0.46	0.50
Personality					
Agreeableness	0	40	483	29.62	6.15
Conscientiousness	0	40	483	25.63	6.14
Extroversion	0	40	483	20.21	8.02
Openness	0	40	483	26.10	6.60
Emotional stability	0	40	483	17.94	8.54

3. Results

Including random slopes in models where thoughts predict well-being suggests that accounting for individual-specific differences in the way people experience type and content of thoughts better explains momentary well-being than when we treat the relationship between thought variables and well-being as identical across individuals. In these random slope models, we find no significant relationships between well-being and type or content of thoughts after applying the FDR correction.

Direct relationship with personality. In accordance with the literature, the personality traits that significantly predict well-being are conscientiousness ($p = 0.007$ for happiness, $p < 0.001$ for worthwhileness), extroversion ($p = 0.050$, $p = 0.001$) and emotional stability ($p < 0.001$, $p < 0.001$). Agreeableness ($p = 0.105$, $p = 0.185$) and openness to experience ($p = 0.425$, $p = 0.980$) do not significantly predict well-being.

Interactions between thoughts and personality (happiness). We find that the model including interactions does not explain momentary happiness better than the model without interactions ($\chi^2(25) = 28.796$, $p = 0.273$). This is confirmed by the AIC (31,121.11 for model without interactions vs 31,142.31 with interactions) and BIC (31,387.73 vs 31,599.38). From this, we conclude that the relationship between thoughts and happiness does not vary according to people's Big 5 personality traits, suggesting that other individual-specific characteristics may play a more important role in determining how people experience their thoughts in terms of momentary happiness.

Interactions between thoughts and personality (worthwhileness). Unlike happiness, we find that worthwhileness is significantly better predicted by the model that includes interactions between personality and thoughts ($\chi^2(25) = 42.892$, $p = 0.014$). Notably, the AIC (33,549.65 vs 33,556.76) and the BIC (33,816.40 vs 34,014.04) still favour the model without interactions. Nonetheless, we report the findings from the interaction model below. In this model, applying the FDR correction reveals that only coefficients with an original $p < 0.011$ meet the 5 % significance threshold. These coefficients are reported with their original *p*-values. Regression results including significant interactions are presented in Table 2.

We find that openness moderates the relationship between TUT and worthwhileness. People who report higher levels of openness before the start of the study report lower levels of worthwhileness alongside TUT ($\beta = -0.078$, $p = 0.009$). Openness also moderates the relationship between thoughts related to others and worthwhileness, where people with higher openness seem to experience higher worthwhileness alongside thoughts related to others ($\beta = 0.140$, $p < 0.001$). Finally, it seems that more agreeable people experience significantly lower worthwhileness alongside thoughts related to others ($\beta = -0.078$, $p = 0.008$). We find no evidence that extroversion, conscientiousness or emotional stability moderated the relationship between thoughts and worthwhileness.

4. Discussion

This paper presents evidence that the relationship between thoughts and experiences of well-being is specific to each individual, but that little of these differences can be explained by personality. Models attempting to explain this individual-specific variation using personality traits did not show meaningfully significant results, as we find that interactions between thought variables and personality do not predict reports of happiness better than the model without interactions. The model predicting worthwhileness using interactions between personality and the remaining thought variables was a significant improvement over the model without these interactions, however, most personality traits (extroversion, conscientiousness and emotional stability) did not significantly moderate the relationship between thoughts and well-being.

We find that the main personality trait that moderates this

Table 2
MLM regressions on worthwhileness (DV) including (1) thought and personality variables with random slopes for thought variables, and (2) significant interactions between thought and personality variables. DV and personality variables are standardized (mean = 0, SD = 1). ***: $p < 0.001$, **: $p < 0.01$.

Worthwhileness	(1)	(2)
TUT	−0.061(0.028)	−0.062(0.027)
Social		
Self	0.053(0.032)	0.050(0.032)
Others	0.006(0.030)	0.011(0.028)
Temporal		
Past	−0.002(0.033)	0.004(0.033)
Future	−0.017(0.029)	−0.011(0.029)
Valence		
Negative	−0.365***(0.020)	−0.366***(0.020)
Positive	0.404***(0.014)	0.403***(0.014)
Agreeableness	0.035(0.027)	0.046(0.028)
Conscientiousness	0.092***(0.026)	0.104***(0.027)
Extroversion	0.090**(0.028)	0.091**(0.029)
Openness	−0.001(0.027)	0.004(0.028)
Stability	0.115***(0.026)	0.109***(0.027)
Interactions		
Open*TUT		−0.078**(0.030)
Open*Others		0.140***(0.031)
Agr*Others		−0.078**(0.029)
Intercept	−0.148***(0.028)	−0.149***(0.028)
Random effects		
User		
TUT	0.103(0.020)	0.098(0.019)
Self	0.091(0.025)	0.087(0.024)
Others	0.067(0.022)	0.047(0.018)
Past	0.098(0.027)	0.091(0.026)
Future	0.053(0.018)	0.051(0.018)
Intercept	0.284(0.021)	0.285(0.021)
Residual	0.476(0.006)	0.476(0.006)
Number of obs	15,084	15,084
Number of groups	477	477
Log likelihood	−16,739.825	−16,718.379

relationship is openness to experience. Openness moderates both the relationships between TUT and worthwhileness, and between thoughts related to others and worthwhileness. Specifically, the model shows that more open people tend to experience lower worthwhileness when they report TUT, but higher worthwhileness when they report thoughts related to others. While these findings alone are not sufficient to draw robust conclusions regarding the mechanism underpinning how openness affects how people perceive their thoughts, they complement existing evidence that finds positive correlations between openness and both the efficient functioning of the brain's default network, which is the brain network that is active when people are experiencing TUT (Beaty et al., 2016) and mindfulness (Giluk, 2009; Hanley, 2016). As such, openness seems to be a personality trait that is important to the regulation and experience of where people focus their attention.

Openness to experience is known to capture attentiveness to internal and external stimuli, and has been linked to a range of cognitive processes (Connelly et al., 2014). As such, while the direct correlations between openness and well-being tend to be insignificant, it is plausible that it would play an important role in how people experience their thoughts. If people high in openness are more attuned to their internal experiences than people low in openness, this may lead them to be more strongly aware of, and therefore impacted by, the type and content of their thoughts. This idea is supported by recent research showing that people high in openness tend to be more aware of their mind wandering (Ibaceta & Madrid, 2021). For worthwhileness, this may suggest that highly open people are better at estimating how being distracted compares to focusing on the current activity, leading them to report lower worthwhileness scores when they experience TUT during activities that they would rather (or feel like they should) focus on. The same mechanism might explain why thoughts related to others are associated with higher levels of worthwhileness for people high in openness. It could be that such people find it inherently more rewarding to have thoughts related to others.

We also find that more agreeable people tend to report lower worthwhileness when they report thinking about other people. This is an interesting finding, since agreeableness tends to capture how people interact with others, where more agreeableness is associated with avoiding interpersonal conflict. One explanation for this could be that more agreeable people tend to compromise more, meaning that their thoughts, when relating to others, might focus more on what they lost in the compromise than less agreeable people.

In general, including random slopes for all thought variables reveals that the relationship between TUT, their content and well-being indeed varies due to unobserved individual-specific characteristics. In other words: no type or content of thoughts is definitively good or bad irrespective of who someone is. While this is altogether unsurprising, it has important implications for mindfulness or other thought-related interventions, particularly in light of recent evidence suggesting that such interventions may not be as ubiquitously beneficial as previous literature suggested (Kaufmann et al., 2021). Different types of interventions may be better suited to people with different individual-specific characteristics.

That being said, the present study raises more questions than it answers about the role of individual-specific characteristics in how people experience their thoughts. While we can confidently say that individual differences in internal experiences exist, the current state of the literature does not allow intervention designers to rely on psychometric scales to personalise their well-being interventions. One important step in this direction would be to understand what *kinds* of individual-specific characteristics drive this relationship. In this paper, we focused on self-reported personality scales, and while such scales are intended to capture a broad range of behavioural and psychological characteristics, they tend to overlook cognitive traits, like working memory capacity and attention control. Exploring these traits and their impact on the relationship between thoughts and well-being could shed more light on what drives the individual differences in how people react to their thoughts.

The individual-specificity of the relationship between thoughts and well-being also raises the question of how to quantify thoughts and their content in a way that accurately captures their incredible diversity. While we limited ourselves here to social and temporal dimension of thoughts to explore their content, individual differences in how people react to their thoughts could also be driven by the fact that thinking "about others", or "about the past", for example, likely means different things depending on who is reporting the thought. While part of this difference will be captured by the same individual-specific characteristics as we mentioned above, the remainder might depend on a broader socio-demographic context. In other words, how you think about others depends not just on who you are, but also on who these others are, and how you think about the past depends on what has happened in and around your life.

4.1. Limitations

Our study is limited by several factors. Firstly, data were collected using a convenience sample of university students and staff. Our sample is therefore not representative of the general population, and findings may not be generalisable. With LSE welcoming a large proportion of international students, it is likely that our sample was more culturally diverse than the average population in the UK. While a culturally diverse sample would normally be desirable, our lack of cultural variables means that the effect of cultural background could not be disentangled

from other individual-specific effects. Therefore, research focusing on more homogenous samples might find stronger or more straightforward interactions between personality and thought variables.

In addition, we are limited by the potential non-randomness of our missing data. Participants may have self-selected into dropping out of the study at any point along the way or may have non-randomly missed certain notifications depending on what activity they were engaged in or who they were with. While we find no differences between participants that dropped out and participants who stayed in the study when looking at the individual-specific characteristics that they reported, we cannot completely rule out the possibility that unmeasured characteristics caused attrition or missing data.

Finally, we are limited by the fact that we did not ask participants to complete the individual-specific characteristics questionnaires again at the end of the study. While the individual-specific characteristics that we discussed tend to be relatively stable overtime, there is evidence to suggest that personality measures can be affected by contextual factors, and that the resulting changes are associated with changes in well-being (e.g., Boyce et al., 2016).

5. Conclusion

These limitations notwithstanding, our findings have broader implications for our understanding of the relationship between personality and well-being. Our findings imply that all personality traits may affect how we feel, either through direct or indirect pathways. Whereas previous studies had shown effects of emotional stability, extroversion, conscientiousness and agreeableness on well-being, the consensus in the literature is that openness to experience is the personality trait that is least predictive of well-being measures (Anglim et al., 2020). In showing that openness may contribute to experiences of eudemonic well-being through the way people experience their thoughts, we suggest that openness may influence how we feel as well. Although the importance of this association and other personality–thoughts–well-being pathways need to be explored in more depth, the present study highlights a new mechanism through which both personality and thoughts may play an important role in determining well-being.

Nevertheless, our measures of personality were unable to explain the differences in people's experiences of thoughts in terms of happiness. This may suggest that the experience of thoughts is driven by more complex individual-specific characteristics. Certain combinations of personality traits or other characteristics may be better able to predict how people's thoughts relate to their well-being. Namely, cognitive traits like working memory capacity and attention control may prove to be more important moderators of the relationship between thoughts and well-being than self-reported personality traits. In addition, our findings encourage further work on exploring whether other individual differences, like cultural or socio-economic background can better explain these variations.

Overall, our findings confirm that, when it comes to how thoughts relate to how we feel, a "one-size-fits-all" approach simply does not tell the whole story. While psychometric tools like the Big 5 personality inventory may not be best suited to explain how different people experience different types and contents of thoughts, we hope that this paper can inspire future research to explore this question in more depth.

CRediT authorship contribution statement

Luc Schneider: Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis, Conceptualization. **Aleksandar Matic:** Writing – review & editing, Software, Methodology, Data curation, Conceptualization. **Teodora Sandra Buda:** Writing – review & editing, Software, Methodology, Conceptualization. **Paul Dolan:** Writing – review & editing, Supervision, Methodology, Funding acquisition, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The authors do not have permission to share data.

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Appendix A. Supplementary data

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