Need Satisfaction in Daily Well-Being: Both Social and Solitude Contexts Contribute to Well-Being

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Abstract

Daily need satisfaction for relatedness (social connection), autonomy (volitional self-congruent action), and competence (self-efficacy) fosters well-being, but those findings primarily reflect experiences during social interactions. A three-week daily diary study (N =178) explored psychological need satisfaction in two key everyday contexts: solitude and social. Holding constant the benefits of need-satisfying social contexts, autonomy satisfaction during solitude was key to peaceful affect, whereas competence satisfaction during solitude contributed to lower loneliness; both psychological needs in solitude contributed to evaluating the day as more satisfying. Relatedness-deficiency in solitude did not contribute to loneliness; instead, those who were relatedness-deficient in social interactions felt lonely. Further, solitude need satisfaction compensated for deficient needs in social contexts, reducing loneliness (autonomy and relatedness) and increasing day satisfaction (all needs) when social contexts failed to satisfy needs. Findings suggest daily solitude can shape daily well-being and further attention is needed to understand and ultimately improve everyday solitude.

Keywords: Solitude; psychological need satisfaction; self-determination theory; well-being; loneliness

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According to self-determination theory, people feel well-being when their life

experiences satisfy their basic psychological needs. Empirical evidence supports this view,

showing that when people experience satisfaction of the specific needs for *autonomy* (the

sense they can be volitional and self-congruent), *relatedness* (the feeling of being close and

connected to others), and *competence* (the experience of being effective in pursuing

important goals) they benefit on various well-being indicators (Chen et al., 2015; Tang et al.,

2020). These benefits are commonly observed at a *general* level or within specific life

domains (e.g., Lataster et al., 2022; Milyavskaya et al., 2013). Digging deeper, those broad

benefits are comprised of a series of brief periods of time, each with distinct time-specific

effects on well-being (Reis et al., 2000).

Indeed, targeted observations analyzed *within* days consistently show that daily

psychological need satisfaction influences daily well-being, even accounting for individual

differences. Studies testing both trait and state levels show comparable effect sizes linking

need satisfaction and well-being ranging from $\beta = .13$ to $.18$ for trait, and $\beta = .15$ to $.31$ for

daily levels, respectively, even when accounting for well-being from the previous day

(Sheldon et al., 1996). Similarly, Reis et al. (2000) found that autonomy, relatedness, and

competence need satisfaction within a given day each contribute to the day's well-being in

terms of positive affect. These studies suggest that each of the three psychological need

satisfactions contributes to daily well-being on that day, with comparable effects as when

examining these links at the individual-difference level.

Such experiences of need satisfaction are contingent on the events of the day. For

example, on days in which individuals conceal more from others, they experience reduced

psychological need satisfaction, as well as lower ratings of life satisfaction and vitality (Uysal

et al., 2010). On days when athletes receive greater autonomy support from their parents, they experience greater need satisfaction, resulting in more positive emotions, self-esteem, and vitality (Gagne, 2003). Similarly, on days when individuals are autonomously prosocial, they experience greater psychological need satisfaction, along with reports of increased satisfaction and happiness (Mojza et al., 2011). Further, Reis et al. (2000), found that social experiences that involved non-argumentative interactions, as well as a sense of fun and feeling understood, were particularly important in fulfilling relatedness needs at the day level. Together, this research, in line with a broader focus linking social contexts to psychological need satisfaction (Sheldon & Bettencourt, 2002), offers extensive evidence that everyday need satisfaction and its corresponding well-being depends on enriching social contexts.

In the current paper, we argue that *solitude* contexts (i.e., time spent alone and not interacting with others face-to-face, or virtually; Lay et al., 2018) can also satisfy basic psychological needs and foster daily well-being. Qualitative work and theory consistently identify that solitude has the potential to evoke a peaceful mood (Buchholz, 1999; Koch, 1990; Thomas, 2021), characterized by low-arousal positive affect that can be differentiated from high-arousal feelings such as excitement or happiness (Kensinger & Schacter, 2006; Russell, 1980). This is reflected in findings from a large multinational survey that reported 'being in solitude' as a top source of relaxation (Hammond & Lewis, 2016), as well as empirical evidence indicating that solitude provides low arousal affect benefits (Long & Averill, 2003; Weinstein et al., 2021). Nevertheless, the evidence regarding the benefits of solitude is mixed, with some researchers identifying potential well-being costs associated with time spent in solitude, such as increased feelings of loneliness and elevated levels of hydrocortisol (Matias et al., 2011; Pauly et al., 2017). Additionally, in-depth analyses of diary data indicate that low-arousal positive (peaceful) affect is typical of solitude for some but not others (Lay et al., 2019). Just like the social interaction literature, which highlights that only

certain social conditions satisfy daily need satisfaction and well-being, solitude's contributions may come from those moments alone when people experience greater psychological need satisfaction for autonomy, relatedness, and competence.

Although this topic has received little direct exploration, it is plausible that solitude may contribute to need satisfaction in a similar manner to social contexts. Solitude provides a space free from external pressures, which might foster a sense of autonomy by aligning an individual's actions with their authentic selves. Solitude may also provide an opportunity for introspection, enabling individuals to cultivate a deeper sense of self-connection and further satisfy autonomy (see also, Weinstein et al., 2023). Similarly, it may promote a sense of competence when allowing individuals to engage in activities that they find optimally challenging and personally rewarding. Finally, although individuals are separated from others during solitude, taking time to reflect on social connections and interactions can help establish a sense of relatedness even in the absence of others, satisfying the relatedness need. Indirect evidence that psychological needs can be satisfied in solitude comes from research on activities undertaken in solitude, primarily in the realm of hobbies. For example, leisure crafters have been shown to shape their psychological need satisfaction and fulfillment through their hobby (Petrou & Bakker, 2016), while hobby musicians have been shown to experience more psychological need satisfaction and subsequent positive affect on days they produce music (Koehler & Neubauer, 2020). Building on this nascent literature, it is reasonable to believe that psychological needs can be experienced similarly in either context (hypothesis, H1 below) and that need satisfaction experienced in each context contributes to daily well-being (H2 below).

In addition to testing relations between solitude as well as social psychological need satisfaction and daily well-being, we were inspired by work that examines psychological need satisfaction across life's domains to test how those contexts interact. For example, a

foundational study in this area (Milyavskaya et al., 2009) identified the benefits for young people's positive affect of having need satisfaction balanced *across* different domains of daily life. In a subsequent study, researchers examined adults' *compensatory interactions* between need satisfaction at work and at home and found that competence need satisfaction at home was especially important for well-being when individuals did not feel a sense of competence at work (Hewett et al., 2017). In other words, this research suggested the protective benefits of one domain over the other. Contrary to their predictions, the researchers did not find such compensatory effects for autonomy and relatedness need satisfaction; in these cases, independent experiences in each domain were more important than their relation to one another.

Compensatory interactions may also occur in the context of solitude and social daily experiences. Specifically, it may be that experiencing psychological need satisfaction in one domain compensates for its absence in another (H3, below). For example, individuals who experience very little psychological need satisfaction when they are with others may depend more on the psychological need satisfaction they experience when alone; such a phenomenon may help to elucidate research demonstrating that individuals with conflictual social relationships benefit from being alone (Birditt et al., 2019; Choi et al., 2023) and the body of work showing that those who have less functional social relationships prefer solitude (Rubin et al., 2014). On the other hand, having a strong and supportive social network may act as a buffer for those who experience solitude more negatively, potentially counterbalancing the adverse impact of time spent alone. For example, the presence of close and supportive connections has been associated with a reduction in various negative aspects of solitude, including low-arousal negative affect (Koch, 1994; Pauly et al., 2018), loneliness (Masi et al., 2011), and symptoms of depression (Kuczynski et al., 2022). As such, the relationship

between psychological need satisfaction and well-being may be based on the dynamic

interplay between these needs across different contexts.

Current Research

In the current research, we explore three hypotheses (H) that reflect the relative

contributions of need satisfaction in both social and solitude contexts to daily well-being:

H1)   Given there is reason to believe psychological need satisfaction could be experienced

in solitude as well as social contexts, we anticipated that psychological need

satisfactions for autonomy, relatedness, and competence would be experienced

similarly in social and solitude contexts.

H2)   Psychological need satisfactions for autonomy, relatedness, and competence in each

of two daily contexts (either social or solitude) independently will contribute to

peaceful daily mood, lower loneliness, and greater day satisfaction.

H3)   Psychological need satisfactions in each of two daily contexts (either social or

solitude) will have a compensatory effect when predicting daily peaceful mood, lower

loneliness, and greater day satisfaction, such that the costs of deficits in one are

compensated for the presence in the other.

And one research question (RQ):

RQ1) Do psychological need satisfactions in each of two daily contexts (either social or

solitude) account *disproportionally,* relative to the other, for daily peaceful mood,

lower loneliness, and greater day satisfaction? That is, does one context (social or

solitude) matter more for shaping daily well-being than another?

Method

Participants and recruitment. We recruited 178 English speaking adults (79 men, 1

non-binary or genderqueer, 95 women, and three did not answer) from the UK and US. The

mean age of participants was 47 years (IQR: 39 - 53). Participants were recruited via Prolific

and compensated up to £60 ($72) each for taking part, in full or partially, as a function of the number of days completed. Demographic characteristics are found in Table 1. Our sample allowed us to achieve 2967 data points, which exceeds the minimum number of data points (1600 - 1700) recommended for mixed effect models with no clear prior effect size (Brysbaert & Stevens, 2018; Meteyard & Davies, 2019; Nezlek, 2020). These measures were collected as part of a larger project focused on hours spent in solitude daily, motivation for solitude, and corresponding well-being ([masked for review]; [OSF masked for review]); no two relations are tested twice across the two studies. A priori power analyses from the previous project using the 'simr' package (version 1.0.5) in R, suggested that a sample size of 150 participants with 21 observations per participant allowed more than 80% power to detect significant fixed effects at .05 alpha levels. To ensure this power analysis applied to the data in the current study we conducted an additional post-hoc sensitivity analysis following guidelines by Murayama et al. (2022), using $t = 3.07$[†] and 21 observations. Results suggested an ideal number sample size of 151 to achieve 80% power to detect fixed effects at .05 alpha levels.

Procedure. All participants completed an initiation session, a baseline questionnaire, and up to 21 daily diaries. The initial session was delivered via Zoom and was designed to increase adherence across three weeks and vet individuals' age and eligibility (namely, that participants were adult English speakers living in the US or UK). During this session, participants also completed a baseline survey consisting of a battery of demographic and trait-level questions and received verbal instructions on how to complete their upcoming daily diaries. Following this, a 21-day diary study using a fixed-interval design with surveys participants emailed reminders each evening (i.e., between 20:00 and 24:00) containing a link

[†] We used the value of autonomy in social contexts, a conservative t-value lower than the average of the six t-values from our models ($M = 3.69$), see Table 4 for details.

to the Qualtrics survey. This daily survey incorporated the Day Reconstruction Method (DRM; Kahneman et al., 2004), a technique that has been used successfully to improve recall of events of the previous day (Diener & Tay, 2014). Here, we adapted the wording of the DRM for the purpose of recalling earlier events and activities from the same day. Participants were asked to spend at least three minutes (enforced via the timing question in Qualtrics) thinking back over their day before reconstructing events of the day using the DRM recall prompts (e.g., to recall what they were doing, who they were with, and how they were feeling or what they were thinking at the time of each new event). After completing the DRM procedure with the events of the day salient to them, participants completed the study measures described below.

Measures

Treatment of all outcome measures. All outcome measures were paired with a scale ranging from 0 (*not at all*) to 6 (*extremely*) unless noted otherwise for consistency across the survey, and because 7-point Likert-type scales provide higher internal consistency and test-retest reliability than do measures with fewer scale points.

Independent Variables

Psychological need satisfaction in solitude and social contexts. Daily need satisfaction was assessed using the basic psychological needs scale (La Guardia et al., 2000). This scale consists of 9-items, split into three subscales (autonomy, competence, and relatedness). For our purposes, we reference shifted these scales to fit both contexts of solitude and social interaction by changing the wording of the question. Following guidance by Lay et al. (2018), for solitude contexts, the prompt was, "When you were alone (not interacting with anyone in-person or over technology), how true were these statements for you..." . while for social contexts, it was "When you were interacting (interacting with others

in-person or over technology), how true were these statements for you...". This ensured that we were able to record separate need satisfactions for each context.

Specifically, autonomy need satisfaction was measured using the three-item subscale of the basic psychological need scale (La Guardia et al., 2000), including "I felt free to be who I am", and "I felt controlled or pressured to be certain ways" (α = .92, α = .93, for solitude and social contexts, respectively). Competence need satisfaction was measured using the three-item subscale of the basic psychological need scale (La Guardia et al., 2000), including "I felt confident that I can do things well…" (αs = .96 for both solitude and social contexts). Relatedness need satisfaction was measured using the three-item subscale of the basic psychological need scale (La Guardia et al., 2000), including "I felt connected with people who care for me, and for whom I care." (αs = .96 for both solitude and social contexts).

Dependent Variables

Peaceful affect. We assessed daily peaceful affect using a composite measure that combined four items of daily affect. Participants were asked to "Please rate how you felt today" for each state (calm, relaxed, at-ease, peaceful) on a 100-point scale (0 = *Not at all*, to 100 = *Very much*) (e.g., Lay et al., 2018). Internal consistency of our composite peaceful affect measure yielded a Cronbach's alpha of .96.

Loneliness. We selected a single-item measure of loneliness since this was more suitable for administering daily over the course of the 21-day period. This direct measure, "I felt lonely today", provided a face-valid way of assessing feelings of loneliness that day (Shiovitz-Ezra & Ayalon, 2012), and was more appealing and less burdensome on participants (Victor et al., 2005) over repeated exposures than more involved alternatives such as the UCLA Loneliness Scale.

Day satisfaction. Day satisfaction is a cognitive evaluation of the day derived from life satisfaction, but one that is appropriate for capturing day-level variations (Przybylski et al., 2021; Sagioglou & Greitemeyer, 2014; Weinstein & Ryan, 2010). Participants were asked: "How was your day?", on a scale ranging from 0 = *Very Bad* to 6 = *Very Good*. This brief method for assessing satisfaction produces similar results to multi-item measures in past research (Cheung & Lucas, 2014).

Results

Preliminary Tests

Correlation analyses (Table 2) suggested strong relations between psychological need satisfactions within solitude (rs = .65 – .84) and social contexts (rs = .73 – .86) on any particular day, and interestingly, equally strong relations across both solitude and social contexts (rs =.75 to .84). Examining each separately, each psychological need in both social and solitude contexts related to our three indicators of everyday well-being (relations of psychological need satisfactions in solitude contexts, rs = .44 to .53, and social contexts rs = .48 to .56, with peaceful affect; in solitude contexts, rs = -.30 to -.35, and social contexts rs = -.33 to -.40, with loneliness; and in solitude contexts, rs = .43 to .56, and social contexts rs = .48 to .58, with day satisfaction.

Table 1

Descriptive Statistics for Participant Demographic Characteristics.

Variable	Proportion of participants who chose this response
Gender (N = 173)	
Male	.46
Female	.54
Non-binary	.01
Ethnicity (*N* = 173)	
Asian	.04
South Asian	.10
African / Black	.11
Middle Eastern	.01
Hispanic	.01
White/ Caucasian	.69
Other	.05
Education (*N* = 173)	
Some Secondary	.01
Completed Secondary School	.08
Vocational or Similar	.14
Some university but no degree	.08
University bachelor's degree	.42
Graduate or professional degree	.28
Employment (*N* = 171)	
Working full-time	.53
Working part-time	.26
Unemployed and looking for work	.04
Homemaker or stay-at-home parent	.04
Student	.02
Retired	.06
Other	.04

Table 2

Correlations Between Study Variables

	1	2	3	4	5	6	7	8
Solitude Context								
1. Autonomy	-							
2. Relatedness	.71***	-						
3. Competence	.84***	.65***	-					
Social Context								
4. Autonomy	.80***	.67***	.74***	-				
5. Relatedness	.61***	.75***	.60***	.75***	-			
6. Competence	.73***	.63***	.84***	.86***	.73***	-		
Day Level								
7. Peaceful Affect	.53***	.44***	.51***	.56***	.48***	.53***	-	
8. Loneliness	-.30***	-.31***	-.35***	-.33***	-.40***	-.37***	-.27***	-
9. Day Satisfaction	.56***	.43***	.56***	.58***	.48***	.56***	.64***	-.44***

Note: *** Correlations are significant at $p < .001$.

Analysis Plan for Primary Models

We used multilevel modeling (R lme4 package; Bates, Mächler, Bolker, & Walker, 2015, JASP; JASP Team, 2023) to account for the hierarchical data structure (daily diaries nested within people). To prevent confounding by between-person differences, we group-mean centered all measures to allow for a clearer interpretation of the effects at different levels (Bryk & Raudenbush, 1992). All models were initially fit with a maximal random effects structure. However, due to issues of singular fit we dropped these random effects in an effort to reduce the complexity of the models. As such, we retain only the random intercept model, following guidelines set out by Barr et al. (2013).

Does context elicit need satisfaction to similar degrees? In the absence of evidence to the contrary and with likely mechanisms for psychological need satisfaction in both

contexts, we hypothesized (H1) that psychological need satisfactions for autonomy, relatedness, and competence are experienced *similarly* in social and solitude contexts. To examine this, we tested state as a nested variable within context, with context as a Level 2 predictor. Both were nested within participants (at Level 3), but no variables were defined at this level. The results showed that context significantly predicted autonomy $F (1, 175.34) = 6.10, p = .014$; with individuals reporting greater autonomy in social($M = 5.13, SE = 0.08$, CIs [4.97, 5.29] compared to solitude contexts ($M = 5.04, SE = 0.08$, CIs [4.88, 5.20]. Likewise, context significantly predicted relatedness need satisfaction, $F (1, 181.88) = 50.57, p = < .001$; with greater relatedness reported in social contexts ($M = 5.53, SE = 0.08$, 95% CI [5.37, 5.69]) compared to solitude contexts ($M = 5.14, SE = 0.10$, 95% CI [4.95, 5.34]). However, Context did not predict competence $F (1, 181.10) = 0.000024, p = .98$, indicating no significant differences between the social ($M = 5.34, SE = 0.08$, CIs [5.17, 5.50] or solitude contexts ($M = 5.34, SE = 0.08$, CIs [5.17, 5.50]). Taken together, these results suggest that, against expectations, context *does* play a significant role for both *autonomy* and *relatedness* needs, with both being enhanced during time spent in social interaction when compared to time spent in solitude. However, both contexts appeared to elicit *competence* need satisfaction similarly.

Do psychological needs in both social and solitude contexts contribute to daily well-being? To examine Hypothesis 2, we investigated how psychological need satisfactions (autonomy, competence, and relatedness) in different contexts (social and solitude) contribute to daily wellbeing outcomes (peaceful affect, loneliness, and day satisfaction) using three random-intercept models. Psychological needs in two contexts were modelled as simultaneous predictors at level 1. The results are summarized in Table 3.

During daily social contexts, all three need satisfactions demonstrated significant associations with increased peaceful affect: autonomy ($\beta = 1.94$, 95% CI [0.70, 3.17], $p =$

.002), competence ($\beta = 3.11$, 95% CI [1.80, 4.42], $p < .001$), and relatedness ($\beta = 2.37$, 95% CI [1.30, 3.44], $p < .001$). Likewise, all three psychological needs were shown to have significant positive associations with day satisfaction: autonomy ($\beta = 0.17$, 95% CI [0.10, 0.24], $p < .001$), competence ($\beta = 0.16$, 95% CI [0.08, 0.23], $p < .001$), and relatedness ($\beta = 0.14$, 95% CI [0.08, 0.21], $p < .001$). However, only relatedness was linked to lower loneliness ($\beta = -0.10$, 95% CI [-0.17, -0.03], $p = .004$), with neither autonomy nor competence showing significant associations (both *p-values* > .05). This suggested that while autonomy and competence do not independently contribute to feelings of loneliness, individuals who experience greater feelings of closeness and connection in their social interactions tend to feel less lonely.

Results regarding psychological need satisfaction in solitude were mixed. Only autonomy was found to have significant positive associations with peaceful affect ($\beta = 2.81$, 95% CI [1.71, 3.91], $p < .001$), suggesting that personal agency and self-congruent experience and action experienced in solitude drive daily peaceful mood. Competence ($\beta = 0.86$, 95% CI [-0.41, 2.13], $p = .185$) and relatedness ($\beta = 0.49$, 95% CI [-0.46, 1.44], $p = .314$) did not reach statistical significance.

In terms of day satisfaction, both autonomy ($\beta = 0.08$, 95% CI [0.02, 0.14], $p = .011$) and competence ($\beta = 0.21$, 95% CI [0.13, 0.28], $p < .001$) showed significant positive associations; relatedness ($\beta = 0.04$, 95% CI [-0.02, 0.09], $p = .163$) did not.

Finally, predicting loneliness, only competence need satisfaction was shown to be significant ($\beta = -0.18$, 95% CI [-0.26, -0.10], $p < .001$), suggesting that a sense of mastery in solitude activities helps to mitigate feelings of loneliness. Surprisingly, relatedness during solitude was found not to be significantly associated with loneliness ($\beta = -0.01$, 95% CI [-0.07, 0.05], $p = .739$). In addition, autonomy need satisfaction during solitude did not relate to loneliness ($\beta = -0.03$, 95% CI [-0.10, 0.03], $p = .322$).

Table 3

Key Parameter Estimates

Parameter	Peaceful Affect			Loneliness			Day Satisfaction		
	Est^a	95% CI	*p*	Est^a	95% CI	*p*	Est^a	95% CI	*p*
Social									
Autonomy	1.94	[0.70, 3.17]	**.002**	-0.06	[-0.14, 0.01]	.107	0.17	[0.10, 0.24]	**< .001**
Competence	3.11	[1.80, 4.42]	**< .001**	-0.08	[-0.16, 0.01]	.060	0.16	[0.08, 0.23]	**< .001**
Relatedness	2.37	[1.30, 3.44]	**< .001**	-0.10	[-0.17, -0.03]	**.004**	0.14	[0.08, 0.21]	**< .001**
Solitude									
Autonomy	2.81	[1.71, 3.91]	**< .001**	-0.03	[-0.10, 0.03]	.322	0.08	[0.02, 0.14]	**.011**
Competence	0.86	[-0.41, 2.13]	.185	-0.18	[-0.26, -0.10]	**< .001**	0.21	[0.13, 0.28]	**< .001**
Relatedness	0.49	[-0.46, 1.44]	.314	-0.01	[-0.07, 0.05]	.739	0.04	[-0.02, 0.09]	.163

Note: Bolded estimates are significant at *p* <.05.   [a] Coefficients are unstandardized.

Do need satisfactions in one context compensate for their absence in the other?

To explore whether there is a compensatory effect in needs satisfactions between the two

contexts (social and solitude) (H3), we examined the interactions of each of the three need

satisfactions, with each need in solitude modelled as a moderator with its counterpart in

social contexts. The results are presented in Table 3.

For autonomy, the interaction between social and solitude contexts on loneliness was

significant (β = 0.06, 95% CI [0.03, 0.09], *p* < .001), with individuals with relatively lower

levels of autonomy in solitude often compensating with higher ratings of autonomy in social

contexts, leading to reduced loneliness overall. Likewise, there was a significant interaction

between social and solitude contexts on day satisfaction (β = -0.05, 95% CI [-0.08, -0.02], *p* <

.001), with individuals with relatively lower levels of autonomy in social contexts tending to

compensate with higher ratings of autonomy in solitude, resulting in greater day satisfaction

overall. The interaction between social and solitude contexts for peaceful affect was not significant (β = -0.35, 95%CI [-0.80, 0.10], p < .001).

Regarding competence, only the interaction between social and solitude contexts for day satisfaction was significant (β = -0.04, 95% CI [-0.07, -0.01], p = .003), with individuals experiencing relatively lower feelings of competence in social contexts compensating with higher ratings of competence in solitude, leading to greater day satisfaction overall. The interactions for peaceful affect (β = -0.02, 95% CI [-0.49, 0.45], p = .928), and loneliness (β = 0.01, 95% CI [-0.02, 0.04], p = .373) were not significant, suggesting no further compensatory effects between the two contexts in relation to competence.

For relatedness, the interaction between social and solitude contexts was significant for both loneliness (β = 0.04, 95% CI [0.01, 0.07], p = .003), and day satisfaction (β = -0.04, 95% CI [-0.07, -0.01], p = .010). Individuals experiencing relatively lower levels of relatedness in solitude contexts tended to compensate with greater levels of relatedness in social contexts, leading to lower levels of loneliness overall. Likewise, individuals experiencing relatively lower levels of relatedness in social contexts compensated with higher ratings of relatedness in solitude, leading to greater overall day satisfaction.

Table 4. Compensatory interaction effects.

Key Parameter Estimates

Parameter	Peaceful Affect			Loneliness			Day Satisfaction		
	Est^a	95% CI	p	Est^a	95% CI	p	Est^a	95% CI	p
Autonomy (soc) * Autonomy (sol)	-0.35	[-0.80, 0.10]	.132	0.06	[0.03, 0.09]	**< .001**	-0.05	[-0.08, -0.02]	**< .001**
Competence (soc) * Competence (sol)	-0.02	[-0.49, 0.45]	.928	0.01	[-0.02, 0.04]	.373	-0.04	[-0.07, -0.01]	**.003**
Relatedness (soc) * Relatedness (sol)	-0.07	[-0.55, 0.42]	.783	0.04	[0.01, 0.07]	**.003**	-0.04	[-0.07, -0.01]	**.010**

Note: Models were entered separately. Bolded interaction estimates are significant at p <.05.   [a] Coefficients are unstandardized.

Figure 1. *Interaction effects indicating magnitude of needs in social and solitude contexts.*
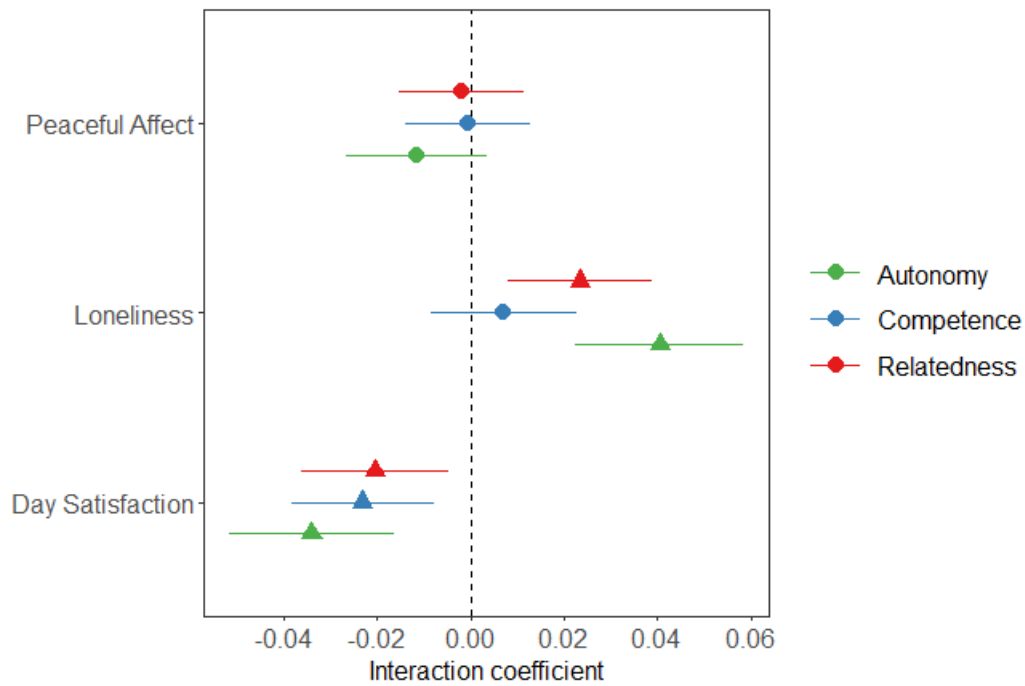
Note. Estimated means of outcome (peaceful, lonely, day satisfaction) as a function of psychological need satisfaction (autonomy, competence, and relatedness) in each of two contexts (solitude, social) with 95% CI. Triangles indicate significant coefficients.

Figure 2. *Interaction effects of needs in social and solitude contexts.*
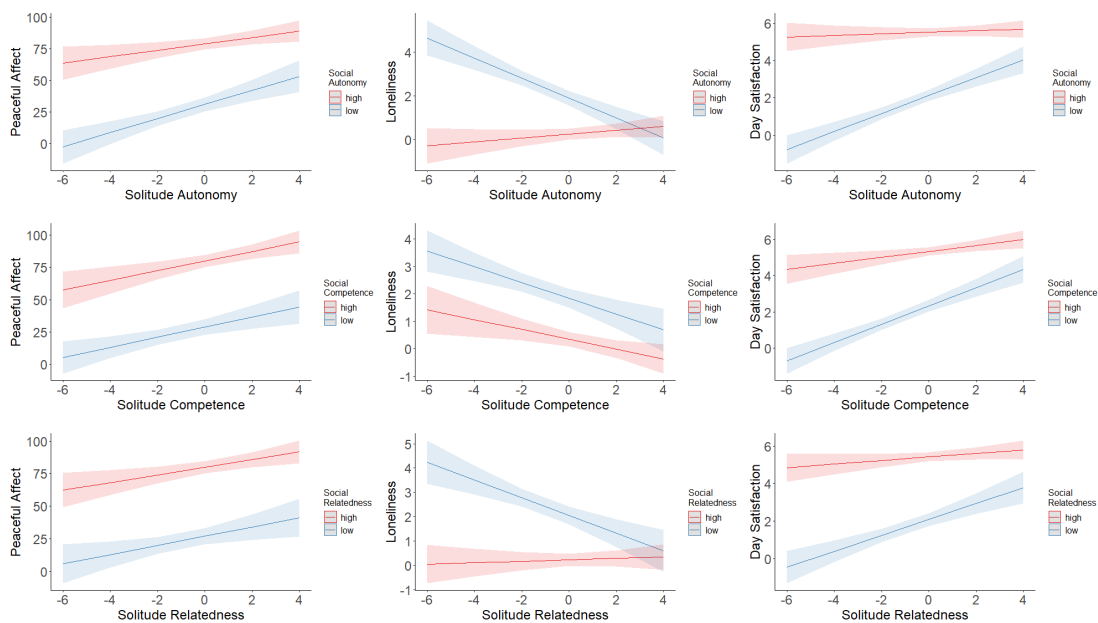
Note. Columns represent outcomes (peaceful affect, loneliness, and day satisfaction), rows represent needs satisfaction (autonomy, competence, relatedness). X-axes represents solitude need satisfaction. Red lines indicate high (+1 *SD*) social need satisfaction, blue lines indicate low (- 1 *SD*) social need satisfaction with 95% confidence intervals. Needs satisfaction scores are centered.

RQ1)   Do psychological need satisfactions in each of two daily contexts (either social or solitude) contribute *disproportionally,* relative to the other, towards daily peaceful mood, lower loneliness, and greater day satisfaction?

Visual inspection of Figure 3 (below) shows that the error bars (95% confidence intervals for the standardized beta estimates) clearly do not overlap in four cases (autonomy - day satisfaction, competence - peaceful affect, relatedness - peaceful affect, and relatedness - day satisfaction). Predicting peaceful affect, the effect size for competence is ~1.5 times larger in social (β = .20) than solitude (β =.13), and the effect size for relatedness is ~1.64 times larger in in social contexts (β = .18) than solitude (β = .11). Within day satisfaction the effect size for autonomy is ~1.69 times larger in the social context (β = .27) than in solitude (β = .16), with the effect size for relatedness ~1.52 times larger in social contexts (β = .23) compared to solitude (β = .15). To test this statistically, we conducted separate t-tests for each of our nine models, applying a Bonferroni correction to account for familywise error (i.e., a corrected alpha level of .00556).

Results indicated a significantly stronger influence of social contexts compared to solitude contexts in four of our models: autonomy need ($t(2538) = 4.07, p < .001$) and relatedness need ($t(2538) = 3.20, p = .001$) predicting day satisfaction, competence need ($t(2538) = 3.03, p = .002$), and relatedness need ($t(2538) = 3.58, p < .001$) predicting peaceful affect.

Figure 3

Effect sizes (standardized betas) for two contexts (social and solitude)
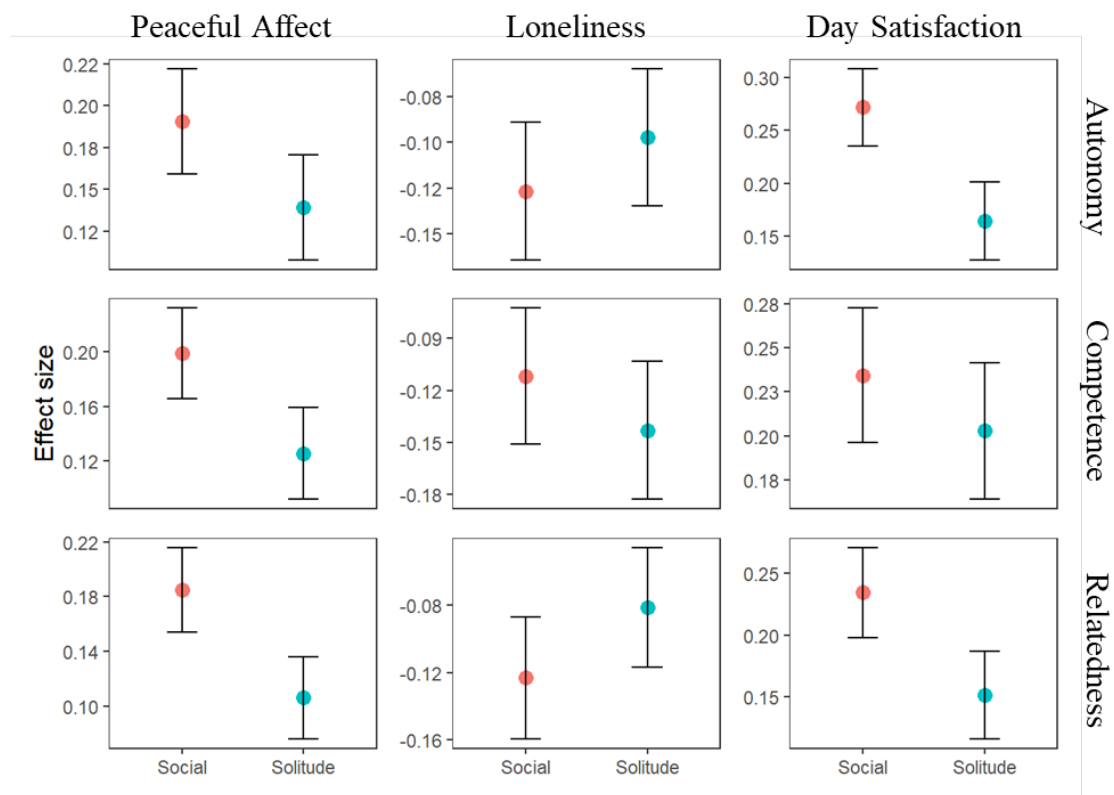
Note. Data points represent the std.beta for both social and solitude contexts for each of our nine models. Error bars represent 95% confidence intervals of the std.beta estimate.

Discussion

The current study aimed to test the contributions of everyday psychological need satisfactions on daily well-being, focusing on three fundamental psychological needs: autonomy (self-congruent and volitional experience and action), relatedness (feeling interpersonally connected), and competence (feeling effective in pursuing activities and goals). It extends previous research linking needs satisfaction and daily well-being (Reis et al., 2000; Sheldon & Bettencourt, 2002) by examining these psychological needs in two distinct everyday contexts: social interactions and solitude. Our primary focus was to investigate how each context contributes to needs satisfaction individually, and to explore the potential for compensatory interactions that influence our daily well-being.

Analyses comparing psychological need satisfactions in social and solitude settings revealed, unsurprisingly, that the relatedness need was more likely to be satisfied in social contexts compared to solitude, with a large effect size. However, what is notable is that even in solitude, relatedness need satisfaction remained relatively high, with participants averaging a rating of approximately 5.0 on a 6.0-point scale. Despite the absence of social interaction, individuals still experienced a meaningful sense of connection, suggesting they carried both the mental representations and affective aspects of socializing with them into solitude. These findings support theoretical expectations of the existence and power of connection during time spent alone, particularly from an attachment perspective (Mikulincer, 1995), and challenge previous views that conflated solitude and isolation, treating them as conceptually interchangeable (Constantian, 1981; Holmes, 1986).

Perhaps more surprisingly, we found autonomy need satisfaction to be lower in solitude than in social contexts. This stands in contrast with previous qualitative analyses suggesting that solitude offers a particular *opportunity* for autonomy need satisfaction by freeing individuals from social demands and allowing them space to engage in genuinely valued and enjoyable activities (Weinstein et al., 2021, 2023). It may have been that, while the opportunity was present, our participants may not have fully utilized solitude time in the service of satisfying their own autonomy. Indeed, previous work has identified that many individuals do not optimize their leisure time for rewarding activities (Beard & Ragheb, 1980; Csikszentmihalyi & LeFevre, 1989). Findings suggest that efforts may be needed to inspire autonomous action during solitude time, for example through targeted self-reflection and planning activities that help individuals select personally meaningful and rewarding actions (or inactions) during their daily solitude moments. Future conceptual and applied work is needed to develop such interventions.

To understand the contributions of daily solitude as well as social psychological need satisfaction, we focused our efforts on three key indicators of daily well-being that are sensitive to both contexts: peaceful affect, a sensitive indicator to the potential well-being contributions that solitude can make as a context for rejuvenation, deactivation, and relaxation (Roberts & Cunningham, 1990); loneliness, an indicator of disrupted relationships and detrimental alone time (Perlman & Peplau, 1981); and day satisfaction, a cognitive evaluation of a successful day (Przybylski et al., 2021). Some need satisfaction effects were observed consistently across well-being indicators, whereas others were specific to certain indicators but not others.

Across indicators, psychological need satisfaction in social contexts emerged as a significant contributor to daily well-being. This set of findings conceptually replicated previous research suggesting that daily relational experiences influence wellness through psychological need satisfaction (Reis et al., 2000). Moreover, the results align with studies of close relationships that suggest individuals feel a greater sense of well-being, including higher positive affect and lower negative affect, when their needs for autonomy, relatedness, and competence are met by their partners and close friends (Demir & Özdemir, 2010; Guardia & Patrick, 2008; Patrick et al., 2007).

Within solitude contexts, specific psychological need satisfactions played dominant roles in conservative models accounting for all three psychological need satisfactions. For instance, only autonomy need satisfaction significantly predicted daily peaceful affect when accounting for autonomy need satisfaction experienced in social contexts. This indicates that when individuals felt at liberty to act authentically and pursue their own volitional actions in solitude, they reported heightened feelings of peacefulness throughout the day. This builds on previous mixed-method findings that suggest autonomy-driven solitude is often the most peaceful (Weinstein et al., 2021), as well as quantitative studies emphasizing the importance

of chosen versus unchosen activities for enjoying solitude (Tse et al., 2022). Yet those existing studies had not addressed whether the benefits of solitude would extend to overall mood across the day when accounting for contributions made by social interactions on that day.

Daily solitude has the potential to foster a sense of peace and calm (Koch, 1994; Nguyen et al., 2018), reflecting the essential role of solitude as a rejuvenating experience that prepares individuals for subsequent social interactions (Littman-Ovadia, 2019). The current suggests that if solitude is to actualize this potential for peaceful mood, autonomy need satisfaction – finding agentic and authentic experiences free from pressure during one's solitude time – is key. Moreover, the current results suggested that the benefit of autonomy need satisfaction for daily well-being extends beyond feeling peaceful; it also contributed to a broad evaluation of the day as satisfying, suggesting more global well-being benefits (Przybylski et al., 2021).

Our findings also showed that competence need satisfaction made independent contributions (to those of social contexts) that resulted in lessened loneliness. This finding parallels previous work suggesting that when individuals feel competent in their actions (i.e., self-efficacy), they feel they can shape important and rewarding aspects of their lives that bridge goals and outcomes, and as a result, they feel less lonely (Lawton et al., 1999). It also builds on indirect evidence found in research on hobbies, which shows that meaningful and fun hobbies protect against loneliness by creating a sense of fulfillment (Arslantaş et al., 2015). As was the case for autonomy need satisfaction, the benefits of competence need satisfaction extended beyond feelings of reduced loneliness to another dimension of well-being. Participants in our study who experienced a greater sense of competence during solitude reported not only a reduction in loneliness but an increased sense of satisfaction with their day.

Regarding potential compensatory effects between the two contexts, our study hints at the multifaceted nature of the interplay between psychological need satisfaction in social and solitude contexts, revealing significant compensatory effects for some, but not all, outcomes. It was evident from our results that solitude has the capacity to compensate for deficits in both autonomy and relatedness need satisfactions experienced in social settings, resulting in reduced loneliness and increased day satisfaction that was on par with having experienced these psychological need satisfactions in social contexts. This finding informs self-determination theory's (Deci & Ryan, 2000) views, which identify both autonomy and relatedness as fundamental psychological needs that must be satisfied (in at least one context) for well-being to occur. Yet our study suggested that psychological need satisfaction in only one of the two contexts (social or solitude) was necessary for attaining the majority of well-being benefits. It may have been that autonomy or relatedness was undermined in social settings when individuals felt pressure and demands from others or if they felt rejected, excluded, or judged by others (Bucher et al., 2019; Wei et al., 2005). Solitude may have also facilitated a sense of self-connection (Thomas, 2021; Weinstein et al., 2021), perhaps compensating for any deficits in both autonomy and relatedness that were absent from social interactions. It also plausible that in solitude individuals reflect on, and appreciate, their existing connections or envision past connections (Weinstein, 2014). In those cases, solitude may have offered individuals a space where they could reclaim a sense of agency and interpersonal connection, at least in memory, with more supportive individuals, freeing them from a reliance on the current social context and thereby diminishing loneliness and increasing their sense of day satisfaction. This inward focus on relationships, despite the absence of social contact, may be a key factor in helping to reduce feelings of loneliness.

Competence, on the other hand, appeared to only have compensatory effects in enhancing day satisfaction. Solitude provides an opportunity to take on activities that are

optimally challenging and intrinsically motivated (Weinstein et al., 2023), reinforcing personal achievements (Long & Averill, 2003), and enhancing daily satisfaction (Ryan & Deci, 2017). In our data, those individuals who did not experience such competence in social contexts felt more satisfied in their day when solitude provided them those opportunities.

It is also noteworthy that the compensatory effects of solitude on peaceful affect did not reach significance across any of the three psychological needs. Rather, it is particularly autonomy needs satisfaction in solitude that contributed to a peaceful mood across the day. Future research may benefit from investigating the underlying mechanisms by which solitude nurtures this peaceful affect, and whether there are specific solitude activities that tease apart this beneficial impact.

Limitations and Future Directions

It is important to consider our findings in light of the following limitations. First, our sample was relatively high-functioning and normative. In more extreme situations, such as when individuals live in conflictual or adverse social environments, solitudinal need satisfaction may become a more significant driver of peace and calm (Birditt et al., 2019), Similarly, individuals who cannot access satisfying social spaces, perhaps because of physical restrictions to their mobility or community access constraints, may benefit more from need satisfaction in solitude (Merchant et al., 2020). Although we consider the fairly broad adult sample a strength of the research for generalizing to the wider population, it limits potential generalization to more specialized populations, who particularly in need for require solitude-enhancing interventions.

Second, although the current study highlights that solitude need satisfaction contributes to well-being, we do not know *why* psychological need satisfaction was experienced. The mechanisms underlying the satisfaction of needs in social contexts are well understood (Chen et al., 2015; Ryan & Deci, 2017; Sheldon & Bettencourt, 2002). However,

it is yet to be determined whether the underlying mechanisms in solitude mirror those in social contexts or operate through distinct processes. Further research is required to explore what activities or experiences drive the fulfillment of psychological needs in solitary contexts.

Third, we don't know the role that technology played in social and solitudinal activities. In the current study, we focused only on social and solitude contexts. However, the predominant use of technology in modern living oftens blurs the boundary between social and solitude time (Halfmann et al., 2021). There is evidence to suggest that computer-mediated communication is an important everyday daily life context that contributes to well-being under ideal conditions (Halfmann et al., 2021), and may further impact psychological need satisfaction (Ang et al., 2014; Halfmann & Rieger, 2019; Hull et al., 2016). Future studies may wish to examine the contribution of three contexts (social, solitude and solitude with connectivity) to shed light on how needs may be satisfied in the context of modern life.

Conclusion

In all, this study emphasizes that both social contexts and solitude contexts contribute to daily well-being across three fundamental psychological needs in a similar manner. This highlights the often-neglected role of solitude in fulfilling needs that have traditionally been associated with interpersonal interactions. Contrary to previous views that conflated solitude with isolation, solitude instead emerges as a crucial part of an individual's day that serves to nurture autonomy, competence, and even relatedness. Importantly, when social needs are unfulfilled, individuals may turn to solitude to derive restorative benefits and offset the deficits experienced in social situations. As such, solitude may act as a means to ensure the balance of our psychological needs are met and contribute to an overall sense of well-being in daily life.

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