Solitude as an Approach to Affective Self-Regulation

Thuy-vy T. Nguyen, M.A. [1]

Richard M. Ryan, Ph.D. [1,2]

Edward L. Deci, Ph.D. [1,2,3]

University of Rochester[1]; Australian Catholic University[2];

University College of Southeast Norway[3]

Word count: 9,942

Paper in press at the journal of Personality and Social Psychology Bulletin.
This is the final version that was submitted just prior to it being accepted.

Author Notes

Thuy-vy Nguyen is a Ph.D. candidate in Social Psychology at the University of Rochester, Rochester, New York, USA.

Richard M. Ryan is Professor at the Australian Catholic University in Strathfield, Australia, and Professor of Psychology at the University of Rochester in Rochester, New York, USA.

Edward L. Deci is Professor of Psychology and Gowen Professor in the Social Sciences at the University of Rochester, Rochester, NY, USA, a Professorial Fellow at the Australian Catholic University, Strathfield, Australia, and Professor at University College of Southeast Norway, Honefoss, Norway.

Correspondence concerning this article should be addressed to Thuy-vy T. Nguyen, Department of Clinical and Social Sciences in Psychology, University of Rochester, Rochester, NY 14610. Contact: thuy-vy.nguyen@rochester.edu.

Abstract

In this research we showed that solitude generally has a deactivation effect on people's affective experiences, decreasing both positive and negative high-arousal affects. In Study 1, we found that the deactivation effect occurred when people were alone, but not when they were with another person. Study 2 showed that this deactivation effect did not depend on whether or not the person was engaged in an activity such as a reading when alone. In Study 3, high-arousal positive affect did not drop in a solitude condition in which participants specifically engaged in positive thinking or when they actively chose what to think about. Finally, in Study 4, we found that solitude could lead to relaxation and reduced stress when individuals actively chose to be alone. This research thus shed light on solitude effects in the past literature, and on people's experiences when alone and the different factors that moderate these effects.

Keywords: solitude, affect, self-regulation, motivation, choice

Solitude as an Approach to Affective Self-Regulation

To date research on solitude has yielded mixed results. Some researchers have shown that time spent in solitude tends to be experienced as "slow" and unexciting (Larson, 1990, 1997; Larson, Zuzanek, & Mannell, 1985). Relatedly, the perspective that solitude could be somewhat maladaptive has been explored rather abundantly in the developmental-psychology domain (e.g., Coplan & Bowker, 2014; Coplan, Rose-Krasnor, Weeks, & Kingsbury, 2013; Goossens Lasgaard, Luyckx, Vanhalst, Mathias, Masy, 2009; Wang, Rubin, Laursen, Booth-LaForce, & Rose-Krasnor, 2013). Nonetheless, studies have also revealed benefits for solitude on well-being. For example, Long, Seburn, Averill, and More (2003) found more positive experiences when people used solitude for privacy, relaxation, self-reflection, creative pursuits, and emotional regulation. Thus it is clear that solitude has some varied effects on affective experiences, and the aim of the experiments presented in this paper was to further understand both the valence (positive/negative affect) and activation (high/low arousal) aspects of these effects.

Conceptualization of Solitude

Many scholars have differed in their conceptualizations of solitude. According to Averill and Sundararajan (2014), solitude does not just happen as a stand-alone experience. Rather, solitude is often conflated with other psychological experiences that occur along with the act of being alone, such as social rejection, social withdrawal, social isolation, shyness, or loneliness (Coplan & Bowker, 2014). As such, many researchers focus on the experiences that happen around solitude rather than directly targeting solitude as a phenomenon in and of itself. The present research set out to understand solitude when it is defined as a psychological experience of being alone (Long, Seburn, Averill, & More, 2003; Larson, 1990), without communications, stimuli, activities, or devices that might facilitate virtual communications such as text messaging

or social media. Also, in the present studies, we separated the experience of being alone in solitude from various stimuli that are often present when people are alone. For example, Long, Averill, and More (2003) suggested that solitary activities are qualitatively distinct from one another, so activity could be a factor to study as moderator of solitude. With this approach, future research could go on to explore how other kinds of stimuli such as noise (pleasant or otherwise) or events (e.g., good news) might affect solitude experiences.

As such, in the current research we operationalized solitude as an experience of being alone without any communication with others, without any other activities, and without other types of active stimuli present. We then examined how having other people present, doing activities such as reading, or thinking particular kinds of thoughts might affect people's experiences of being alone. Notably however, our paradigm differs from one introduced in recent experiments by Wilson et al. (2014). In their studies they specifically focused on the effects of telling the person who was alone to think about particular types of thoughts. From our perspective, telling people to think about certain types of thoughts is a stimulus that represents a possible moderator of alone experiences. In fact we look at this question in Study 3.

In all, we performed four experiments. The first compared solitude (i.e., simply being alone without any stimuli or activities) to people's experiences in social interactions. Then, in Experiment 2, we compared solitude to being alone with an activity (viz., reading), and in Experiment 3 we compared solitude to being alone with the internal stimuli of thinking certain types of thoughts. Finally, in Experiment 4 we used a switching-replications experimental paradigm with daily diary data to examine how daily solitude impacts people's affective experiences.

Effects of Being Alone

What about solitude might make it affectively unattractive to people? Larson and colleagues conducted several experience-sampling studies that showed a significant drop in positive affect when people were alone compared to when they were with others (Larson, 1990; Larson, 1997; Larson & Csikszentmihalyi, 1978; Larson, Csikszentmihalyi, & Graef, 1982; Larson et al., 1985). Particularly, in studies by Larson and colleagues, affect was measured with a semantic differential scale that assumes bipolarity of affect states, such as happy versus sad, sociable versus lonely, and alert versus drowsy, in which the positive affects are relatively high-arousal affects. So it appears to be the case that aloneness decreased people's high-arousal positive affects. Given that people often report liking a stimulus more when they are aroused in its presence, which has been consistently shown in research on romantic attraction (cf. Foster, Witcher, Campbell, & Green, 1998), it makes sense that they would like being alone less because it would diminish their high-arousal positive affect.

There are, however, two limitations to the approach to measuring affect in the Larson et al. studies. First, the scale contrasts positive affect with negative affect and treats them as two ends on a continuum. According to Watson, Clark, and Tellegen (1988), positive and negative affect can fluctuate independently and do not always correlate negatively (Watson & Clark, 1997). The second limitation is that the scale used by Larson et al. conflates the hedonic and arousal aspects of affect by comparing high-arousal pleasant affects (e.g., sociable, alert, strong, active, excited) with low-arousal unpleasant affects (e.g., lonely, drowsy, weak, passive, bored). That scale does not include low-arousal pleasant affects (calm, relaxed) nor high-arousal unpleasant affects (e.g., angry, anxious) (Feldman, Barrett, & Russell, 1998).

Whereas it might be inferred from the work of Larson and colleagues that solitude would decrease people's high-arousal positive affects such as excitement and sociability and increase

their low-arousal negative affects such as loneliness and drowsiness, previous research has failed to consider solitude's possible benefits of promoting relaxation and peace (Long & Averill, 2003; Long, More, & Averill, 2007), which are low-arousal positive affects. It is also interesting to consider how solitude might affect high-arousal negative affects, such as anger and anxiety. If solitude is calming, might it reduce these negative affects? In the current research, we focused on teasing apart the effects of solitude on different types of affect that vary on both valence and arousal.

Observing the Effects of Motivation for Solitude on Affective Outcomes

The second aim of this research was to examine whether experiencing autonomy when engaging in solitude would moderate the affective changes associated with it. Little research has examined the role of motivation for solitude in modifying the effects of solitude on subjective well-being. A study by Chua and Koestner (2008) found that when the participants felt forced into spending time alone, the amount of time alone was associated with increased loneliness and decreased life satisfaction, whereas those who spent time alone volitionally did not suffer these effects. Therefore, we examined the role of autonomy in moderating the effects of solitude on affective experiences in Studies 3 and 4, using two different operationalizations. In Study 3, we examined the effects of *making choices* concerning one's solitary experiences by allowing some participants to choose what they would like to think about during the time they sat by themselves, whereas others were yoked to them and assigned what the others had chosen. When people are alone they often report having free-floating thoughts (Larson & Csikszentmihalyi, 1978), yet when they are explicitly told to do sit alone and think people do not generally enjoy it (Wilson et al., 2014). With the choice manipulation, we wanted to investigate whether sitting alone and thinking would yield better experiences when the participants were encouraged to

choose what to think about instead of being instructed to think only about one specific type of thought (e.g., positive or neutral thoughts).

In Study 4, similar to Chua and Koester (2008), we assessed participants' motivations for spending time alone (e.g., Ryan & Connell, 1989); that is, instead of examining participants' choice around what to do when alone, we explored their active motivation for being alone. According to self-determination theory, wanting to do something for its enjoyment and/or its value is referred to as autonomous motivation. Many studies have shown that when individuals perceive their reasons for doing a behavior to be more autonomous, the activities yield more optimal outcomes (e.g., Ryan & Deci, 2017; Kins, Beyers, Soenens, & Vansteenkiste, 2009; Fernet, Austin, & Vallerand, 2012). Therefore, for Study 4, instead of giving the participants explicit choice around what to do in solitude, we measured their experience of autonomy for undertaking a solitude experience and used this as the moderator of the effect of solitude on daily affect. We predicted that a day with solitude would yield better affective outcomes compared to a day without solitude when participants experienced autonomy around their solitude experience.

Study 1 Methods

Participants

We recruited 114 undergraduates (44 males, 68 females, and 1 unspecified) between ages 18 and 29 (M = 20, SD = 1.56). The sample was made up of 47% Caucasian, 31% Asian or Pacific Islanders, 15% Black or African American, and 7% Mixed Race or Other.

Procedures

Participants completed a questionnaire to report demographic information before coming into the lab. When they arrived, they filled out a short survey to report their current levels of affect. Participants were then randomly assigned to one of two conditions: one condition in

which they were instructed to sit alone in a comfortable chair, away from their electronic devices, and not engage in any activities (N = 75) and one in which they were instructed to engage in a social interaction with a research assistant (N = 39). In the social interaction condition, we used the "fast friend" procedure by Aron et al. (1997). The participant and a research assistant of the same gender were given a list of questions to ask one another. (e.g., "What are your favorite classes this semester?" or "Where did you go for Spring Break?"). This condition has been used in the past as a control condition; that is, it is not designed to be a stimulating or entertaining conversation but simple serves the purpose of having the participants engage in a social interaction. After 15 minutes of either solitude or social interaction, a buzzer signaled the participants to fill out an affect survey that was kept in a folder on the desk next to them (Instructions for each condition are included in Appendix B).

Materials

The Positive Affect Negative Affect Schedule (PANAS; Watson et al., 1988) included 20 items that assessed the high-arousal affective states (Harmon-Jones, Harmon-Jones, Abramson, & Peterson, 2009). For high-arousal positive affect, the items are ALERT, EXCITED, DETERMINED, ACTIVE, INTERESTED, STRONG, ATTENTIVE, ENTHUSIASTIC, PROUD, INSPIRED. For high-arousal negative affect, the items are ASHAMED, NERVOUS, HOSTILE, GUILTY, SCARED, UPSET, DISTRESSED, AFRAID, IRRITABLE, JITTERY. The participants rated how much they were experiencing these affects on a 5-point Likert-type scale ranging from 1 = not at all to 5 = extremely. All pre- and post-measures of high-arousal positive affect (Pre: α = .90, Post: α = .94) and high-arousal negative affect (Pre: α = .84, Post: α = .89) showed satisfactory reliability.

Study 1 Results

To examine the change in high-arousal affect over time, we conducted a 2 (within-subject change) x 2 (conditions: solitude vs. social interaction) mixed ANOVA examining whether change in high-arousal affect would depend on the condition of solitude versus social interaction. The results showed significant to marginal decreases on both high-arousal positive affect ($F(1,112) = 4.15$, $p < .05$, $\eta^2_p = .04$) and high-arousal negative affect ($F(1,112) = 3.02$, $p = .09$, $\eta^2_p = .03$). There were also significant change-by-condition interaction effects on both dependent variables (High-arousal positive affect: $F(1,112) = 4.44$, $p < .05$, $\eta^2_p = .04$; High-arousal negative affect: $F(1,112) = 7.29$, $p < .01$, $\eta^2_p = .06$).

High-arousal positive affect significantly decreased only for those in the solitude condition, and not in the social interaction condition. This was consistent with previous studies showing that being in solitude significantly decreased high-arousal positive affect. What has not been shown in previous studies (Larson, 1990, 1997) is the significant decrease of high-arousal negative affect, similarly occurring only in the solitude and not in the social interaction condition (see *Table 1* for estimated changes within conditions). Overall, the results indicated that whereas the participants in the social interaction condition did not experience any change in high-arousal affect after the 15 minutes of interacting with the experimental accomplice, those in the solitude condition experienced significant decreases in both positive and negative high-arousal affect.

Study 1 Discussion

Study 1 examined people's affective experiences after fifteen minutes in either social interactions or solitude. Measuring affect on a semantic differential scale ranging from positive affect to negative affect, Larson and colleagues (1978, 1990, 1997) consistently showed that people felt less positive affect when alone as compared to when with others. Here we used the PANAS, which consists of separate items for positive and negative affect both of which are high

on arousal, finding that participants experienced decreases in both positive and negative high-arousal affect. Thus we saw a general deactivation effect.

For the next study we revised the PANAS to include items that measure both positive and negative affect at both high and low levels of arousal to examine whether solitude would decrease both high- and low-arousal positive affect. If it is true that solitude does indeed make people feel less positive affect as previous research has claimed (Larson, 1990), it should decrease both high- and low-arousal positive affect. We, however, hypothesized that solitude would decrease the high-arousal affects, but might increase low-arousal positive affect because, as some research has suggested, solitude could be calming and relaxing (Long & Averill, 2003). Further, we predicted that we would replicate the effect of solitude decreasing high-arousal negative affect as shown in Study 1. We also predicted that solitude would increase low-arousal negative affect as it has been shown to yield loneliness (Goossens et al., 2009; Long, Seburn, Averill, & More, 2003) and drowsiness (Larson, Csikszentmihalyi, & Graef, 1982).

In Study 2 we compared the same solitude condition used in Study 1 with a condition where solitude was paired with an alone activity—a reading task. The purpose was to determine whether the decreases in positive and negative high-arousal affects found for solitude in Study 1 occurred because of the lack of any external stimuli that would provide participants something to do. If it were the lack of external stimuli that caused the decrease in both positive and negative high-arousal affects, we would expect the affective decreases in the solitude condition but not in the solitude plus reading condition. As in Study 1 we examined for a within- by between-subject interaction. If we found within-subject changes of high-arousal affects but no interaction, it would mean that the effects we observed in Study 1 were not dependent on the provision of an alone activity or not.

Study 2 Methods

Participants

We recruited 108 undergraduate participants, with all but one being between the ages of 18 and 23; 74 identified as female and 31 as male; 46% as Caucasian, 33% as Asian or Pacific Islanders, 6% as Black or African American, and 15% as Mixed Race or Other.

Procedures

Participants reported their demographics and personality traits on-line before coming into the lab. Data on personality traits were not related to the present paper so were not reported. On arrival they completed a brief survey assessing their current levels of affect and were then randomly assigned to sit in solitude (N = 52) or to sit and read a text (N = 56). In the solitude condition, participants simply sat in a comfortable chair for 15 minutes without performing any external activities, replicating the solitude condition in Study 1. In the reading condition participants also sat alone in the same comfortable chair, but were provided a short recreational reading, entitled "Glamorous Crossing: How Pan Am Airways Dominated International Travel in the 1930s." A pilot study showed that this reading should occupy the whole 15 minutes and was moderately interesting. After 15 minutes either being alone or reading alone, a buzzer signaled the participants to fill out another survey on their affect (Instructions for each condition are included in Appendix B).

Materials

For the purposes of Study 2 we revised the PANAS used in Study 1 by adding items that represent different levels of arousal. Factor analysis showed that they loaded onto two separate factors of positive and negative affect. For the interest of this paper, we divided each of the factors into two groups, a high and a low arousal type of affect based on the item's face value.

We measured high-arousal positive affect with 8 items including INTERESTED, ATTENTIVE, ALERT, EXCITED, ENTHUSIASTIC, HAPPY, ENERGIZED, and OPEN (Pre: α = .87, Post: α = .89). High-arousal negative affect was assessed with the 4 items of ANXIOUS, ANGRY, JITTERY, and AFRAID (Pre: α = .53, Post: α = .61). Low-arousal positive affect was measured with CALM, RELAXED, PEACEFUL, AT EASE, and CONTENT (Pre: α = .90, Post: α = .93). Finally, low-arousal negative affect was measured with SAD, LONELY, DEPRESSED, SLUGGISH, BORED, and SLEEPY (Pre: α = .72, Post: α = .70). All affect items were rated on a 5-point scale from 1 = not at all to 5 = very much.

Study 2 Results

To examine the over-time change in affect, we conducted a mixed ANOVA using positive and negative high-arousal affects, and positive and negative low-arousal affects as dependent measures. The results revealed significant within-subject decreases on high-arousal positive affect ($F(1,106) = 13.13$, $p < .001$, $\eta^2_p = .11$), and high-arousal negative affect ($F(1,106) = 3.85$, $p = .05$, $\eta^2_p = .04$). Additionally, the results showed marginal increases in the low-arousal positive ($F(1,106) = 3.75$, $p = .06$, $\eta^2_p = .03$) and low-arousal negative affects ($F(1,106) = 3.38$, $p = .07$, $\eta^2_p = .03$). There were no significant overall change-by-condition interaction effects; in other words, changes in the four types of affect did not occur differently between the solitude and the solitude plus reading conditions. Therefore, consistent with findings in Study 1, we found decreases in both positive and negative high-arousal affect after 15 minutes of solitude, as well as after 15 minutes of being alone with a reading task. This suggested that it was not just the lack of external stimuli that yielded deactivation, as the alone quiet reading conditions showed the same deactivation results as the solitude condition for both positive and negative high-arousal

affects. Further, as in Study 1, solitude increased both low-arousal positive (e.g., calmness) and low-arousal negative (e.g., loneliness) affects.

Study 2 Discussion

Study 2 replicated the effects of a 15-minute solitude episode on high-arousal positive and high-arousal negative affects, such that both types of high-arousal affect showed significant deactivation. The results suggested that this did not require the lack of external stimuli as it also occurred when participants engaged a reading task. We also found marginal increases for low-arousal affects in both conditions, such that the participants became more calm and relaxed but also more lonely and sad after 15 minutes alone. Therefore, it appears that solitude does have effects on affective arousal regardless of affective valence and regardless of whether or not the participants were engaged with an external stimulus or were simply alone.

In study 2, we picked an external stimulus that was relatively neutral for the participants. Perhaps the deactivation effect was due to the lack of mentally engaging stimuli during this time. To continue this exploration, in Study 3, we examine the effects of solitude—that is, being alone without any stimuli—relative to being alone with a mentally engaging stimulus, namely, thinking. Thinking is a quite common past-time activity when people sit alone (Larson & Csikszentmihalyi, 1978; Long, Seburn, Averill, More, 2003; Westgate, Wilson, & Gilbert, 2016). Thinking is also cognitively demanding, which makes it an appropriate internal stimulus with which people can engage (Westgate, et al., 2016).

The aim of Experiment 3 was to continue investigating what it is about the deactivation effects of solitude and their limiting conditions. This time, we explored how actively thinking would affect people's experiences when alone. For those who were given this stimulus, they were instructed to sit alone and think; this was similar to the instruction used for the "just think"

paradigm in Wilson et al.'s studies (2014). In Wilson et al.'s (2014) studies, participants were told to think about positive thoughts, and the authors argued that intentionally thinking positive thoughts would be cognitively taxing and therefore less enjoyable (Westgate, et al., 2016; Wilson et al., 2014). Although their results did show that thinking the positive thoughts yielded decreases in enjoyment, we would argue that it might very well being told what they *had to do* rather than being given choice about what to do that led to the decrease in enjoyment. In fact, typically, when people sit alone thinking, they have choice concerning what to think about, whereas in the experiment they were being directed about what they were to think. As such, in Study 3, in the choice condition participants could choose what type of thoughts to have, whereas in the no-choice condition they were told what type of thoughts to have, much as was the case in Wilson et al. (2014). To manipulate choice, we allowed participants in the choice group to select whether to think about positive thoughts or neutral thoughts. The addition of a neutral thought group was simply for the purpose of having two different options for the participants from which to choose. Then, for the no-choice condition the participants in one no-choice group were told to think about positive thoughts and those in the other group were told to think about neutral thoughts.

To summarize, in Study 3 there were 5 groups—a control group identical to the no-stimulus solitude groups in Studies 1 and 2, two thinking groups with choice about positive or neutral thoughts, and two thinking groups with no choice. The last two groups were told whether to think about positive thoughts or neutral thoughts as a function of a yoking procedure to participants in the previous two groups so there would be the same number of participants in each choice and no-choice groups. We began the analyses by comparing the no-stimulus solitude group to the four thinking groups. The solitude group acted as the true control condition that

allowed us to examine the effects of choice versus no-choice and positive versus neutral thoughts on change in affect. We compared the solitude group to the choice groups and to the no-choice groups, and also to the positive groups and the neutral groups.

Study 3 Methods

Participants

We recruited 343 undergraduates between the ages of 18 and 24 (245 females, 93 males, 1 other) to participate. The sample consisted of 51% Caucasians, 32% Asians or Pacific Islanders, 7% Black or African Americans, and 10% other or mixed races.

Procedure

Upon arriving at the lab, participants completed a short survey to report their current affect. Then they were informed that they would sit alone, with themselves, and were requested to stay awake and not perform any external tasks. They were randomly assigned into one of three conditions. One condition, the solitude control group, was the same solitude condition used in Studies 1 and 2. In the choice condition, participants were told they would be instructed to think during their time alone but that they could choose to think about either positive or neutral thoughts. They chose by selecting one piece of paper from the two that were placed on a table in front of them, one saying “positive” and one saying “neutral.” Of course there were two groups that made up this second “choice” condition. The third condition, the “no-choice” condition, involved yoking participants to the type of thoughts selected by the previous participant in the choice condition. Thus, there were two groups in the no-choice conditions, and the number of participants in the choice-positive group were the same as those in the no-choice-positive group. As such, the participants in the no-choice condition were assigned the types of thoughts rather than making a choice (Instructions for each condition are included in Appendix B).

When the 15-minute solitude period was over, the experimenter signaled the participants with a buzzer to fill out another survey that had been left on the table near the participant. This survey again assessed participants' current high-arousal positive and negative affect and low-arousal positive and negative affect, as well as other experiences during the time they were alone. The scores on the item about neutral thought were standardized and subtracted from the standardized scores on the item about positive thoughts to create a variable that we called positive thought. A positive score on the positive thought variable would mean the participants were thinking more about positive thoughts than neutral events, and a negative score would mean the reverse. Finally, we also included some items borrowed from Wilson et al. (2014), including items that assessed whether participants found the experience enjoyable, entertaining, and boring, and whether they could concentrate on what they were thinking about or found their mind wandering. The first three items were averaged to make up a composite for enjoyment (with boring reverse coded), and the last two were averaged to make a composite for concentration (with mind-wandering reverse coded). After participants finished the second survey, the experimenter re-entered the room and debriefed and dismissed them.

Study 3 Results

Exploratory analyses

There were 89 participants in the solitude control group, 127 in the choice condition, and 127 in the no-choice condition. Most participants in the choice condition chose positive thoughts (97 for positive and 30 for neutral) and there were the same numbers in the groups of the no-choice condition as in the corresponding groups of the choice condition. We performed a one-way ANOVA to compare participants' levels of positive thoughts, enjoyment, and concentration, among the five groups, including one solitude condition, two choice groups, and 2 no-choice

groups. Results indicated significant differences among the five groups on positive thoughts ($F(4,338) = 22.54$, $p < .001$), enjoyment ($F(4,338) = 2.69$, $p < .05$), and concentration ($F(4,338) = 8.75$, $p < .001$). We used Dunnett t-tests to compare various thinking groups with the solitude control group. These t-tests showed that participants in positive-thought groups had more positive thoughts and enjoyed them more than those in the solitude control group, whereas those in the neutral-thought groups did not show any differences on levels of positive thoughts and enjoyment from the control group. Additionally, all thinking groups reported that it was easier to concentrate on their thoughts than those in the solitude control condition; that is, those who were given an internal stimulus during solitude did in fact engage with the stimulus.

Figure 3 depicts the mean difference between Time 1 and Time 2 for five groups. Positive values represent increases from Time 1 to Time 2, and negative values represent decreases from Time 1 to Time 2. If the 95% CI bars do not include zero value, the change is significantly different from 0. Consistent with findings for the solitude condition in previous studies, the solitude control condition in Study 3 showed a significant drop in both high-arousal positive and high-arousal negative affects, and significant increases in both low-arousal positive and low-arousal negative affects. In the choice condition, neither the positive nor neutral thought groups had decreased positive affects or increased negative affects, and both showed the decrease in high-arousal negative affect but only the choice-positive group showed increased low-arousal positive affect. On the other hand, for the neutral and positive thought groups in the no choice condition, those who were assigned neutral thoughts showed no decrease in high-arousal negative and no increase in low-arousal positive affect, but showed significant decrease in high-arousal positive and increase in low-arousal negative affect. However, those who were assigned to the positive thought group in fact received some affective benefits from being alone,

including the decrease in high-arousal negative affect and increase in low-arousal positive affect, and at the same time did not suffer any of the detriments because they showed no change in high-arousal positive affect and low-arousal negative affect (see *Tables 1a & 1b* for mean changes within each group).

Primary analyses

Using mixed-effect models to analyze within-subject changes across groups, we conducted five contrast interactions that examined the interaction between within-subject changes and between-subject contrasts (see syntaxes in Appendix A).

The first contrast examined the difference in within-subject change between the solitude control condition and the thinking conditions. The results suggested that the drop in high-arousal positive affect from Time 1 to Time 2 was significantly greater in the solitude control condition than in the thinking conditions ($t(337) = -3.04$, $p < .01$, 95% CI = [-.97, -.21]). The increase in low-arousal negative affect from Time 1 to Time 2 was significantly greater in the solitude control condition than in the thinking conditions ($t(337) = 2.19$, $p < .05$, 95% CI = [.03, .63]). Solitude control and thinking conditions were not different in their decreases in high-arousal negative affect and their increases in low-arousal positive affect, so there was no difference in change for these two affect outcomes.

The second contrast concerned the difference in change between the solitude control condition and the choice condition. The participants in the choice condition showed significantly less deactivation of high-arousal positive affect than the solitude control condition ($t(337) = 3.52$, $p < .001$, 95% CI = [.17, .61]. The choice condition also yielded a significantly smaller increase in low-arousal negative affect than did the solitude control condition ($t(337) = -2.26$, $p < .05$, 95% CI = [-.37, -.03]), suggesting that participants in the choice condition felt significantly less

lonely and sad than those in the solitude control group. Further, the choice condition showed no difference in drop in high-arousal negative affect and increase in low-arousal positive affect than the solitude control condition.

The third contrast compared change in the solitude control condition and the no-choice condition. The results showed only a marginally smaller decrease in high-arousal positive affect for the no-choice condition relative to the solitude control condition, and there were no differences for the other affect outcomes.

The fourth contrast concerns the difference between the solitude control condition and the positive thought condition. The results indicated that the two positive thought groups showed significantly less drop in high-arousal positive affect than the solitude control condition ($t(337) = 4.52$, $p < .001$, 95% CI = [.25, .63]). Further, the positive thought condition showed significantly less increase in low-arousal negative affect than the control group, suggesting that participants in the positive-thought condition felt significantly less lonely and sad, than the control group ($t(337) = -2.98$, $p < .01$, 95% CI = [-.39, -.07]).

Finally, the fifth contrast compared change in the solitude control condition and the neutral thought groups, and showed no difference on any of the affective outcomes. This suggested that the neutral thought groups had affective experiences similar to those in the solitude control condition.

Study 3 Discussion

Taken together, the data indicate that, consistent with the results in Studies 1 and 2, simply being in solitude (i.e., alone without any stimuli), which was the solitude control condition in Study 3) decreased the positive and negative high-arousal affects, and it increased the positive and negative low-arousal affects, as was found in Study 2. Study 3 further showed

that the presence of mentally engaging stimuli such as positive thoughts could dissipate the deactivation of high-arousal positive affect, although that was not the case when the thoughts were neutral. For those who had chosen to think neutral thoughts, the deactivation of positive affect was significantly diminished, although that was not the case when they were in the no-choice neutral group. Perhaps those who chose to have neutral thoughts would find the thoughts more mentally engaging because they had chosen them, leading them to not experience the deactivation in their high-arousal positive affect.

The findings concerning the moderating effects of making active choices when alone suggests that a deeper exploration of the effects of choice in solitude would be important with respect to the use of solitude for affective self-regulation. Therefore, in Study 4, we investigated the role, on a daily basis, of autonomy for modifying solitude effects on affect. Thus we collected data on participants' affect and well-being at the end of each day over a 2-week period. On some of these days, participants were instructed to spend 15 minutes in solitude, without interference by any other activities. The introduction of solitude into participants' days allowed us to examine whether solitude would have extended effects on daily affect and well-being. Regarding autonomy as a moderator of solitude effects we assessed participants' reports of relative autonomy for each episode of solitude, rather than a focus on making specific choices.

Study 4 Methods

Participants

We recruited 173 undergraduates (136 females, 37 males), all but 5 between 18 and 22 years old. The sample had 51% Caucasians, 35% Asians or Pacific Islanders, 5% Blacks or African-Americans, and 6% Native Americans, Alaska Natives, or other races. They filled out an initial survey and consented to receiving follow-up diary emails in the evening for the

subsequent two weeks, starting on the Monday after the initial survey. The final data set comprised data on 1808 days from 157 individuals after 16 participants were excluded because they did not complete the surveys.

Procedures

To observe the effect of engaging in solitude everyday on daily affect and well-being, we combined the use of a diary design and a switching-replications experimental design (Shadish, Cook, & Campbell, 2002). Participants were randomly assigned to one of two groups. Those in Group 1 (N = 82) were instructed to spend 15 minutes in solitude (i.e., without electronic devices or activities) sometime during each day of the first week of the study and to complete a survey at the end of each of those days. For the second week, Group 1 was asked to complete the survey at the end of each day but not to engage in solitude during that week. Participants in Group 2 (N = 73) were asked to do the same tasks, but the order of the weeks was switched. This switching-replications experimental design allowed us to control for order effect of the weeks on which the activity was performed and to observe both the within-participant effects and the between-participant effects of solitude on affect and well-being (Instructions for 15-minute solitude are included in Appendix B).

Measures

Autonomous motivation for solitude. After completing the 15-minute solitude period, participants were asked to complete an 8-item measure that assessed their motivation for undertaking the solitude task, using items adapted from Self-Regulation Questionnaires that have been widely used in SDT studies in various domains (e.g., Ryan & Connell, 1989). We included 2 items for external regulation (e.g., “Because I was told to be by myself”); 2 items for introjected regulation (e.g., “Because I would feel bad about myself if I didn’t do it”); 2 items for

identified regulation (e.g., “Because I find the time I spend by myself to be important and beneficial for me.”); and 2 items for intrinsic motivation (e.g., “Because I simply enjoy the time to be by myself”). Participants rated their responses on a 7-point Likert scale (1 = Not at all true; 7 = Very true). A Relative Autonomy Index score (RAI) was calculated using the following equation: (Intrinsic × 2) + (Identified × 1) – (Introjected × 1) – (External × 2). RAI scores for solitude on 7 of the 14 days were averaged for each individual, and were standardized such that the value of 0 on this variable represented the sample mean and the value of -1 or +1 represented 1 standard deviation below or above that mean. Therefore, higher RAI would suggest greater experience of autonomy for solitude.

End-of-day survey. During both weeks, a survey was sent out every day after 5PM. On the week when participants were instructed to engage in solitude, the survey was only accessible to the participants once they have completed the activity. In total, the participants took 5 minutes to complete a survey of 41 well-being items each day. Besides the measure of affect similar to ones used in Study 3, the survey also consisted of 5 items adapted from the *Subjective Vitality Scale* (Ryan & Frederick, 1997; α = .91), 5 items of the *Satisfaction with Life Scale* (SWLS; Diener, Emmons, Larsen, & Griffin, 1985; α = .92), 9 items from the shorter form of the *Basic Psychological Needs Satisfaction* scale (La Guardia, Ryan, Couchman, & Deci, 2000; α = .89), and 4 items from the *Perceived Stress Scale* (PSS; Cohen, Kamarck, & Mermelstein, 1983; α = .73). To measure affect, we used items similar to those in Study 3 to assess High-Arousal Negative Affect (α = .74), High-Arousal Positive Affect (α = .89), Low-Arousal Positive Affect (α = .93), Low-Arousal Negative Affect (α = .76).

Study 4 Results

Descriptive Data

In total, 55% of the sample engaged in solitude on all 7 days, 22% did it on 6 of the days, 21% completed between 3 and 5, and 2% of the sample completed only 1 or 2 days of solitude. On average, participants reported more intrinsic (M = 3.97, SD = 1.46) and identified (M = 4.15, SD = 1.48) reasons for being in solitude than introjected (M = 2.87, SD = 1.48) and external (M = 3.36, SD = 1.32) reasons. Participants' autonomy for the solitude did not change significantly during the week. Therefore, we aggregated RAI scores across seven days to obtain the scores that represented how autonomous the participants felt going into solitude that week.

To examine what the participants were doing when they spent time in solitude, two independent trained coders coded the activities that the participants reported doing during this time. The coders read the participants' responses, and indicated yes or no to whether the participants mentioned only thinking, resting, relaxing, etc. Coders had more than 92% agreement on all questions, and the principal investigator resolved wherever the two coders disagreed. The coding showed that most of the time the participants reported sitting with their thoughts, such as planning their days, thinking of weekend activities, or making a to-do list of their schoolwork (66%). The second most frequent activity being reported was doing nothing or lying down (14%), doing some sort of relaxation exercises such as breathing or meditating (12%), or observing their surroundings (10%). If the participants mentioned sleeping, taking a nap, eating a main meal, doing schoolwork or some other tasks such as surfing the net, or interacting with other people remotely or in person, these responses were marked as non-compliant (23% of all responses). We used this indicator as well as the participants' response to a yes-no question on whether they followed the instruction to determine non-compliant days and analyzed our results after excluding these days using each criterion. The findings did not differ appreciably when non-compliant days were excluded. When data were excluded based on either

of those two compliance indicators, the HLM coefficients were slightly larger than when all days were included. In some cases, with non-compliant days excluded, marginal results became significant. Below we report only the findings when all data were included.

Primary Analyses

Each participant had up to 14 rows of data, assigned a number of 1 to 7 to indicate the day of the week when data were collected. We created one variable called WEEK (coded 1 or 2) to represent the week from which the data were collected, one variable called SOLIDAY (coded 0 or 1) to represent whether solitude happened on that day or not, and one variable called WEEKDAY (coded 1 to 7) to represent the day of the week. We conducted multi-level models to examine the main effect of solitude day on affect and well-being outcomes (SOLIDAY), while also accounting for the trend of change over time (WEEKDAY) during the course of each week, and the order in which solitude was introduced (WEEK 1 for Group 1 and WEEK 2 for Group 2). We also observed all 2-way and 3-way interactions.

Table 2 included the coefficients for all main effects and interactions for all affect and well-being outcomes. There was no evidence that solitude had incremental effects on outcomes over the course of the weeks when it was practiced (SOLIDAY x WEEKDAY). The degree of change over a week was significantly different between Week 1 and Week 2 (WEEKDAY x WEEK), for high-arousal negative and low-arousal negative affect and stress levels. Examination of this interaction suggested that there was change over time that occurred in the first week, only for Group 2, but not in the second week. Consistent with previous studies, solitude overall had a deactivating effect on high-arousal positive affect and high-arousal negative affect, as well as vitality (see *Table 2*). Note that vitality is a state that represents energization and activation, so this effect would be consistent with our previous findings that solitude generally deactivates

people. Solitude did not affect any other outcomes besides positive and negative high-arousal affect, and vitality.

Surprisingly, there was also a significant SOLIDAY x WEEK interaction effect on high-arousal positive and high-arousal negative affect (see *Table* 2), suggesting that the within-subject difference between having solitude versus not having solitude differed depending on whether solitude occurred on the first or the second week. Examination of the interactions showed that on the first week when Group 1 had solitude and Group 2 did not, levels of positive and negative high-arousal affect dropped significantly for Group 1, compared to Group 2 (high-arousal positive: $t(1809) = 3.41$, $p < .01$; high-arousal negative: $t(1809) = 3.00$, $p < .01$). From Week 1 to Week 2, Group 2's levels of high-arousal positive and high-arousal negative affect also dropped significantly once they started having solitude everyday (high-arousal positive: $t(1809) = 4.49$, $p < .001$; high-arousal negative: $t(1809) = 4.14$, $p < .001$). However, from Week 1 to Week 2, Group 1's levels of high-arousal positive and high-arousal negative affect remained low as they did not increase back toward baseline even when they no longer had solitude (high-arousal positive: $t(1809) = 1.81$, $p = .07$; high-arousal negative: $t(1809) = .96$, $p = .34$). This could mean not only that solitude decreased people's high-arousal affects, but also that engaging in solitude for a week might have had some extended or spill-over effect on arousal levels, such that it made the group that did it in the first week stay somewhat deactivated for the second week. Another possibility is that there could be a gradual return-to-baseline trend during the second week for Group 1, although the data suggested that as their second week progressed, there was no significant correlation between day of the week, increasing from 1 to 7, with level of affect (see *Figure 1* and *Figure 2* for change from Week 1 to Week 2 for each group).

Regarding the role of autonomy on moderating the effects of solitude on affect and well-being outcomes, we included individual-level RAI scores in the level-2 model to estimate the main effects of having high autonomy for solitude on affect and well-being outcomes as well as the moderation effect of RAI on the effects of solitude. The results indicated that endorsing autonomous reasons for spending time in solitude did not moderate the effect of solitude on high-arousal affect and vitality. This means that overall solitude appears to deactivate everyone in general, whether they experienced high or low autonomy around the experience. Autonomy, however, did moderate the effects of solitude on all other affect and well-being outcomes (see *Table 3*). Examination of the simple slopes showed that those with low autonomy for solitude experienced significantly lower low-arousal positive affect and higher low-arousal negative affect, marginally greater stress, significantly reduced life satisfaction basic psychological need satisfaction on the days that they had solitude (see *Table* 3 for simple effects at high and low levels of RAI). On the other hand, those who had high autonomy for solitude did not experience these negative effects of solitude, but in fact experienced significantly greater low-arousal positive affect and marginally less stress on the day they had solitude. As such, while we did not find the moderation effect of autonomy on the deactivation effect, we found that autonomy for solitude not only buffered against the negative effects of solitude on well-being, but also improved the beneficial effect of solitude on relaxation and stress levels.

Study 4 Discussion

In Study 4, we replicated the deactivation effects of solitude on positive and negative high-arousal affect. We observed the effect at both the day level and the week level. At the week level, high-arousal affect dropped significantly on the week that the participants were instructed to carry out the activity, and for those who did it on the first week, their high-arousal affect

remained low into the second week. However, we did not ask participants who did solitude in the first week whether they continued to practice solitude in the second week, so we need to further study the deactivation effect at the week level.

Regarding moderation of autonomy on the link from solitude to diminished high-arousal affect, we did not find the interaction. Perhaps it is not whether or not one wants to be in solitude that moderates solitude effects, but rather what one wants to do during solitude that is the moderator. This difference between whether one wants to be in solitude versus what one wants to do during solitude might integrate the findings in Studies 3 and 4. That is, maybe people in general chose to be alone to experience deactivation—to rejuvenate and unwind. In that regard, Study 4 found additional evidence for the deactivation effect with vitality for people high and low in autonomy. It seems that autonomy for solitude becomes important primarily for low-activation outcomes, as the interaction indicated that autonomous motivation for solitude led to less loneliness and more calmness.

Meta-analytic summary

We performed a meta-analysis using procedures for a fixed effects model suggested by Rosenthal and Rosnow (2007). Our focus was the deactivation of positive and negative high-arousal affect and the increases in positive and negative low-arousal affect in the solitude condition where participants were alone without engaging in any task. (see effect sizes for within-person changes in *Table 1*). Overall, there was a significant decrease in high-arousal positive affect (combined $z = -.34$, $p < .0001$, $r = -.33$), as well as high-arousal negative affect across studies (combined $z = -.30$, $p < .0001$, $r = -.30$). The overall increases in low-arousal positive affect (combined $z = .20$, $p < .001$, $r = .20$) and low-arousal negative affect in Studies 2 - 4 (combined $z = .14$, $p < .05$, $r = .14$) were smaller but also significant. Overall, the deactivation

effect of solitude was evidenced by significant decreases in both positive and negative high-arousal affect and increases in positive and negative low-arousal affect.

General Discussion

This research focused on solitude, defined as being alone for a period of time with no access to devices, personal interactions, external stimuli, or activities. In all studies the solitude lasted 15 minutes. First we asked how solitude would affect participants' affective experiences, and in four studies we found that solitude decreased positive and negative high-arousal affects and tended to increase positive and negative low-arousal affects. We also had other experimental groups in each study. In the first, the experimental group involved a conversation with another person, and this was compared to solitude. Solitude led to deactivation of positive and negative high-arousal affects, but deactivation did not occur for the group that conversed.

In the second study experimental-group participants engaged in the activity of reading, while alone. We found that being alone in silence yielded deactivation of high-arousal affects and activation of low arousal affects regardless of whether the participants engaged in the silent activity of reading. In the third study, there were four experimental groups, in which participants were given the internal stimulus of thinking either about positive or neutral thoughts and were either given choice about which type of thoughts or were assigned one of the types using a yoking process. Deactivation of both types of high-arousal affect occurred in the solitude condition, as expected, and deactivation also occurred for high-arousal negative affect in the no-choice neutral condition. However, having positive thoughts tended to ameliorate deactivation on high-arousal positive affect, and having choice also tended to be ameliorating for high-arousal positive affect.

This research also indicated that solitude tended to increase low-arousal affect so that participants were more calm and peaceful, although they also tended to be lonely. In Study 3, we found that the increase in low-arousal negative affect could diminish with the presence of positive thoughts and choice. Further research might clarify if there are other ways of having increases in low-arousal positive affect without being accompanied by low-arousal negative affect.

These unexpected findings were interesting because they indicated that, when alone, thinking positive thoughts or having choice about what to think tended to ameliorate the deactivation of high arousal positive affect, therefore providing more options for affective self-regulation. The set of studies thus suggested that people can use solitude, or other variations on being alone, to regulate their affective states, becoming quiet after excitement, calm after an angry episode, or centered and peaceful when desired. The research also suggested that having choice or feeling autonomous is important for having desired affective experiences. In this regard, the research suggested that it would be important to study autonomy further in relation to solitude. Accordingly, the final study examined participants' experiences of autonomy in spending time alone. Using diary data with a switching-replications design, we found, using both within- and between-person analyses, that solitude yielded deactivation of both positive and negative high-arousal affect. There was also indication that if participants practiced solitude on a daily basis for a week, the deactivation effect had some spill-over effect to the following week.

Limitations and Future Directions

There are several limitations to these studies. The first limitation is that the samples were undergraduate students. Considering that people's solitude experiences changes with age (Larson, 1990), our results may not be generalizable to young children, early adolescents, or

older adults. Perhaps solitude would function as an emotional down-regulatory mechanism for young adults who experienced high-arousal affect more frequently (Carstensen, Pasupathi, Mayr, & Nesselroade, 2000), whereas for older people, solitude might serve less of that function. There is little evidence about whether other demographic factors such as education or gender would moderate deactivation. Also, perhaps different cultures value solitude differently (Wang, 2016), so people from different cultures approach solitude differently. Future research could also factor in personality traits such as introversion and examine how they relate to autonomy and solitude. There may also be other individual differences that moderate the effect of solitude on affect.

Another limitation lies in the paradigm we used to study solitude. There are many other experimental factors such as levels of activity and movement, types of activity, amount of noise, the presence of other people without interactions (e.g., private versus public space),that might have moderated solitude effects. Studying all these factors could potentially specify the active ingredients that cause the deactivation effect. The content of thoughts one has during solitude might also be explored as a moderator. In Study 3, we distinguished the effects of having neutral thoughts versus positive thoughts on solitary experiences. Future research could investigate how other thoughts such as mental planning, which is what most of our participants in Study 4 reported doing, would affect solitary experiences differently from, say, having thoughts about loved ones. Finally, future research could also consider the length of time that people spent in solitude. In our studies, the choice of 15 minutes was arbitrary, as it seemed to be a reasonable amount of time that would allow us to pick up variation in people's experiences, but future studies could vary that to see whether it makes a difference.

Conclusion

In conclusion, this research confirmed that solitude decreased high-arousal positive affect such as excitement. Although one might typically not want to decrease positive affect, there are times when one is over energized or excited so that deactivation could be settling and pleasant, for example when one wants to go to sleep. So solitude could be helpful at those times. The studies also revealed that solitude yielded deactivation on high-arousal negative affect, such that it makes people less angry and anxious. Solitude can help in this way as well. And solitude also leaves people more relaxed and calm, depending of course on the situation. While more research needs to be done, the take-home message is that there are benefits and detriments of solitude, but it is clear that solitude can play a role in the self-regulation of affective experiences, and it also appears to be the case that having positive thoughts, and making choices or being volitional in solitude can enhance people's positive experiences.

References

Aron, A., Melinat, E., Aron, E. N., Vallone, R. D., & Bator, R. J. (1997). The experimental generation of interpersonal closeness: A procedure and some preliminary findings. *Personality and Social Psychology Bulletin*, *23*(4), 363-377.

Averill, J. R., & Sundararajan, L. (2014). Experiences of solitude: Issues of assessment, theory, and culture. In R. J. Coplan & J. C. Bowker (Eds.), *The handbook of solitude: Psychological perspectives on social isolation, social withdrawal, and being alone* (90 - 108). Malden, MA: Wiley.

Carstensen, L. L., Pasupathi, M., Mayr, U., & Nesselroade, J. R. (2000). Emotional experience in everyday life across the adult life span. *Journal of Personality and Social Psychology*, *79*(4), 644.

Chua, S. N., & Koestner, R. (2008). A self-determination theory perspective on the role of autonomy in solitary behavior. *The Journal of Social Psychology*, *148*(5), 10.3200/SOCP.148.5.645-648.

Cohen, S., Kamarck, T., & Mermelstein, R. (1983). A global measure of perceived stress. *Journal of Health and Social Behavior*, 385-396.

Coplan, R. J., & Bowker, J. (2014). All alone: Multiple perspectives on the study of solitude. In R. J. Coplan & J. C. Bowker (Eds.), *The handbook of solitude: Psychological perspectives on social isolation, social withdrawal, and being alone* (3-13). Malden, MA: Wiley.

Coplan, R. J., Rose-Krasnor, L., Weeks, M., Kingsbury, A., Kingsbury, M., & Bullock, A. (2013). Alone is a crowd: Social motivations, social withdrawal, and socioemotional functioning in later childhood. *Developmental Psychology*, *49*(5), 861.

Diener, E. D., Emmons, R. A., Larsen, R. J., & Griffin, S. (1985). The satisfaction with life scale. *Journal of Personality Assessment*, *49*(1), 71-75.

Feldman Barrett, L., & Russell, J. A. (1998). Independence and bipolarity in the structure of current affect. *Journal of Personality and Social Psychology*, *74*(4), 967.

Fernet, C., Austin, S., & Vallerand, R. J. (2012). The effects of work motivation on employee exhaustion and commitment: An extension of the JD-R model. *Work & Stress*, *26*(3), 213-229.

Foster, C. A., Witcher, B. S., Campbell, W. K., & Green, J. D. (1998). Arousal and attraction: Evidence for automatic and controlled processes. *Journal of Personality and Social Psychology*, 74, 86-101.

Goossens, L., Lasgaard, M., Luyckx, K., Vanhalst, J., Mathias, S., & Masy, E. (2009). Loneliness and solitude in adolescence: A confirmatory factor analysis of alternative models. *Personality and Individual Differences*, *47*(8), 10.1016/j.paid.2009.07.011

Kins, E., Beyers, W., Soenens, B., & Vansteenkiste, M. (2009). Patterns of home leaving and subjective well-being in emerging adulthood: the role of motivational processes and parental autonomy support. *Developmental Psychology*, 45(5), 1416.

La Guardia, J. G., Ryan, R. M., Couchman, C. E., & Deci, E. L. (2000). Within-person variation in security of attachment: a self-determination theory perspective on attachment, need fulfillment, and well-being. *Journal of Personality and Social Psychology*, *79*(3), 367.

Larson, R. W. (1990). The solitary side of life: An examination of the time people spend alone from childhood to old age. *Developmental Review*, *10*(2), 155-183.

Larson, R. W. (1997). The emergence of solitude as a constructive domain of experience in early adolescence. *Child Development*, *68*(1), 80-93.

Larson, R., & Csikszentmihalyi, M. (1978). Experiential correlates of time alone in adolescence. *Journal of Personality, 46*(4), 677-693.

Larson, R., Csikszentmihalyi, M., & Graef, R. (1982). Time alone in daily experience: Loneliness or renewal? In L. A. Peplau & D. Perlman (Eds.), *Loneliness: A sourcebook of current theory, research and therapy* (pp. 40−53). New York: Wiley.

Larson, R., Zuzanek, J., & Mannell, R. (1985). Being alone versus being with people: Disengagement in the daily experience of older adults. *Journal of Gerontology, 40*(3), 375-381.

Long, C. R., & Averill, J. R. (2003). Solitude: An exploration of benefits of being alone. *Journal for the Theory of Social Behaviour, 33*(1), 10.1111/1468-5914.00204.

Long, C. R., More, T. A., & Averill, J. R. (2007). The subjective experience of solitude. *General Technical Report - Northern Research Station, USDA Forest Service,* 67- 76.

Long, C. R., Seburn, M., Averill, J. R., & More, T. A. (2003). Solitude experiences: Varieties, settings, and individual differences. *Personality and Social Psychology Bulletin 29*(5), 10.1177/0146167203029005003.

Rosenthal, R., & Rosnow, R. (2007). *Essentials of behavioral research: Methods and data analysis*. Boston, MA: McGraw-Hill Humanities/Social Sciences/Languages.

Ryan, R. M., & Connell, J. P. (1989). Perceived locus of causality and internalization: examining reasons for acting in two domains. *Journal of Personality and Social Psychology, 57*(5), 749-761.

Ryan, R. M., & Deci, E. L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychologist, 55*(1), 10.1037110003-066X.55.1.68.

Ryan, R. M., & Frederick, C. (1997). On energy, personality, and health: Subjective vitality as a dynamic reflection of well-being. *Journal of Personality,* 65(3), 529-565.

Scheier, M. F., & Carver, C. S. (1993). On the power of positive thinking: The benefits of being optimistic. *Current Directions in Psychological Science, 2*(1), 26-30.

Shadish, W., Cook, T., & Campbell, D. (2002). *Experimental and quasi-experimental designs for generalized causal inference.* Boston, MA: Houghton Mifflin Company.

Sheldon, K. M., & Lyubomirsky, S. (2006). How to increase and sustain positive emotion: The effects of expressing gratitude and visualizing best possible selves. *The Journal of Positive Psychology*, *1*(2), 73-82.

Wang, Y. (2006). Culture and solitude: meaning and significance of being alone. Unpublished Master's thesis, University of Massachusetts, Amherst.

Wang, J. M., Rubin, K. H., Laursen, B., Booth-LaForce, C., & Rose-Krasnor, L. (2013). Preference-for-solitude and adjustment difficulties in early and late adolescence. *Journal of Clinical Child & Adolescent Psychology*, *42*(6), 834-842.

Watson, D., & Clark, L. A. (1997). Measurement and mismeasurement of mood: Recurrent and emergent issues. *Journal of Personality Assessment*, *68*(2), 267-296.

Watson, D., Clark, L. A., & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: the PANAS scales. *Journal of Personality and Social Psychology*, *54*(6), 1063.

Westgate, E. C., Wilson, T. D., & Gilbert, D. T. (2017). With a little help for our thoughts: Making it easier to think for pleasure. *Emotion,* 15*(*28*).*

Wilson, T. D., Reinhard, D. A., Westgate, E. C., Gilbert, D. T., Ellerbeck, N., Hahn, C., ... & Shaked, A. (2014). Just think: the challenges of the disengaged mind. *Science*, *345*(6192), 10.1126/science.1250830.

Tables

Table 1a. Within-subject change and interaction between change and conditions across 3 lab experiments

	High-arousal positive affect			High-arousal negative affect			Low-arousal positive affect			Low-arousal negative affect		
STUDY 1	*F*	η^2_p	*p*	*F*	η^2_p	*p*	*F*	η^2_p	*p*	*F*	η^2_p	*p*
Change	4.15	.04	.044	3.02	.03	.085						
Solitude vs. Social	5.72	.05	.018	.07	.00	.794						
Change x Condition	4.44	.04	.037	7.29	.06	.008						
	Estimated change for each condition											
	Δ	95% CI		Δ	95% CI							
Solitude	-.28**	[-.44, -.13]		-.24***	[-.36, -.11]							
Social interaction	.01	[-.22, .23]		.05	[-.12, .22]							
STUDY 2	*F*	η^2_p	*p*	*F*	η^2_p	*p*	*F*	η^2_p	*p*	*F*	η^2_p	*p*
Change	13.13	.11	.000	3.85	.04	.052	3.75	.03	.055	3.38	.03	.069
Solitude vs. Reading	.03	.00	.870	.16	.00	.694	1.91	.02	.170	.06	.00	.817
Change x Condition	.43	.00	.512	.36	.00	.549	1.14	.01	.288	.19	.00	.667
STUDY 3	*F*	η^2_p	*p*	*F*	η^2_p	*p*	*F*	η^2_p	*p*	*F*	η^2_p	*p*
Change	5.20	.02	.023	4.42	.01	.036	9.58	.03	.002	3.47	.01	.063
Concentrate	18.81	.05	.000	4.23	.01	.041	12.72	.04	.000	4.66	.01	.032
Group	2.85	.03	.024	.89	.01	.470	1.22	.01	.302	.14	.00	.968
Change x Concentrate	14.05	.03	.000	.60	.00	.600	2.45	.01	.119	7.98	.02	.005
Change x Group	6.44	.07	.000	1.30	.02	.271	1.44	.02	.221	2.65	.03	.033
	Estimated change for each condition											
	Δ	95% CI		Δ	95% CI		Δ	95% CI		Δ	95% CI	
Solitude	- .34***	[-.50, -.18]		-.13*	[-.23, -.03]		.34**	[.14, .53]		.24***	[.12, .37]	
Solitude with Thinking												
Choice - Neutral	-.04	[-.30, .22]		-.23**	[-.40, -.07]		.30†	[-.03, .63]		.06	[-.15, .26]	
Choice - Positive	.14	[-.01, .28]		-.25***	[-.34, -.15]		.46***	[.27, .64]		.03	[-.09, .15]	
No Choice - Neutral	-.35**	[-.60, -.09]		-.09	[-.26, .08]		.05	[-.27, .38]		.21*	[.01, .42]	
No Choice - Positive	.06	[-.08, .21]		-.13**	[-.22, -.04]		.47***	[.29, .65]		-.00	[-.12, .11]	

Table 1b. Mean scores on affective measures before and after solitude in Studies 1 - 3

	High-arousal positive affect		High-arousal negative affect		Low-arousal positive affect		Low-arousal negative affect	
	PRE	POST	PRE	POST	PRE	POST	PRE	POST
STUDY 1								
SOLITUDE (N = 75)	2.77 (.78)	2.49 (.93)	1.57 (.50)	1.33 (.41)				
SOCIAL (N = 39)	2.99 (.75)	2.99 (.89)	1.45 (.59)	1.50 (.75)				
STUDY 2								
SOLITUDE (N = 56)	3.09 (.78)	2.94 (.80)	1.57 (.53)	1.52 (.56)	3.59 (.99)	3.83 (.93)	1.91 (.66)	2.00 (.66)
SOLITUDE with READING (N = 52)	3.15 (.77)	2.93 (.99)	1.56 (.52)	1.46 (.52)	3.45 (.84)	3.52 (1.03)	1.86 (.67)	2.00 (.75)
STUDY 3								
SOLITUDE (N = 89)	2.42 (.86)	2.14 (.76)	1.52 (.53)	1.38 (.44)	3.35 (.89)	3.73 (.86)	1.71 (.62)	1.90 (.65)
SOLITUDE with THINKING								
Choice - Neutral (N = 30)	2.10 (.74)	2.06 (.69)	1.51 (.57)	1.28 (.59)	3.47 (1.03)	3.77 (1.02)	1.85 (.67)	1.91 (.79)
Choice - Positive (N = 97)	2.35 (.70)	2.45 (.84)	1.55 (.65)	1.31 (.44)	3.41 (.86)	3.84 (.82)	1.80 (.58)	1.86 (.63)
No Choice - Neutral (N = 30)	2.55 (.80)	2.21 (.93)	1.36 (.44)	1.27 (.38)	3.47 (.83)	3.52 (.98)	1.70 (.46)	1.91 (.57)
No Choice - Positive (N = 97)	2.39 (.85)	2.44 (.82)	1.44 (.50)	1.32 (.53)	3.42 (.87)	3.88 (.84)	1.81 (.66)	1.82 (.67)

Notes. Standard deviations are reported within the parentheses

Table 2. HLM models investigating the effect of solitude day on outcomes, controlling for trend over time, week effect, and their interactions

	High-arousal PA		**High-arousal NA**		**Low-arousal PA**		**Low-arousal NA**	
	ß	*t*	*ß*	*t*	*ß*	*t*	*ß*	*t*
WEEKDAY	.00	.02	-.11**	-3.06	.01	.27	-.13***	-3.65
WEEK	-.36**	-2.78	-.32**	-2.63	-.22	-1.70	-.26	-2.09
SOLITUDE	-.43**	-3.52	-.36**	3.00	-.12	-.98	-.12	-.94
WEEKDAY x WEEK	.00	.06	.06**	2.77	-.01	-.34	.06**	2.89
WEEKDAY x SOLIDAY	.01	.11	.07	1.43	.04	.68	.11	2.17
SOLIDAY x WEEK	.49*	1.98	.48*	2.06	.19	.78	.27	1.10
WEEKDAY x SOLIDAY x WEEK	-.01	.03	-.04	-1.34	-.02	-.74	-.05	-1.49

	Vitality		**Stress**		**Life satisfaction**		**BPNS**	
	ß	*t*	*ß*	*t*	*ß*	*t*	*ß*	*t*
WEEKDAY	.02	.87	-.08	-2.58	.02	.90	-.01	-.28
WEEK	-.16	-1.26	-.02	-.18	-.06	-.44	-.15	-1.07
SOLITUDE	-.26	-2.01	-.04	-.27	-.09	.14	-.20	-1.44
WEEKDAY x WEEK	-.01	-.67	.05*	2.36	-.01	-.62	.01	.57
WEEKDAY x SOLIDAY	-.04	-.86	.00	.06	-.02	-.63	-.02	-.53
SOLIDAY x WEEK	.16	.64	.07	.26	.09	.31	.20	.73
WEEKDAY x SOLIDAY x WEEK	.02	.73	.00	.03	.00	.15	.00	.10

Table 3. HLM models investigating the interaction of level-2 RAI and level-1 effect of solitude day on outcomes

	High-arousal PA		**High-arousal NA**		**Low-arousal PA**		**Low-arousal NA**	
	ß	*t*	*ß*	*t*	*ß*	*t*	*ß*	*t*
RAI	.11	1.71†	-.14	-2.42*	.11	1.77†	-.19	-3.26**
SOLIDAY	-.19	-6.04***	-.12	-3.55**	-.02	-.80	.02	.78
SOLIDAY x RAI	.04	1.37	-.02	-.50	.11	3.78***	-.07	-2.21*
Conditional effect of SOLIDAY on outcomes at high and low levels of RAI								
+1SD RAI					.09	2.13*	-.04	-1.02
-1SD RAI					-.14	-3.15**	.09	2.06*

	Vitality		**Stress**		**Life satisfaction**		**BPNS**	
	ß	*t*	*ß*	*t*	*ß*	*t*	*ß*	*t*
RAI	.16	2.47*	-.22	-3.51**	.16	2.26*	.20	2.94**
SOLIDAY	-.18	-5.76***	.00	.05	-.05	-2.11*	-.10	-4.01***
SOLIDAY x RAI	.00	.15	-.08	-2.74**	.04	2.00*	.09	3.49**
Conditional effect of SOLIDAY on outcomes at high and low levels of RAI								
+1SD RAI			-.08	-1.93†	-.00	-.11	-.01	-.43
-1SD RAI			.08	1.91†	-.09	-2.84**	-.19	-4.19***

Figures

Figure 1. Graph of change in high-arousal positive affect as a function of Solitude week

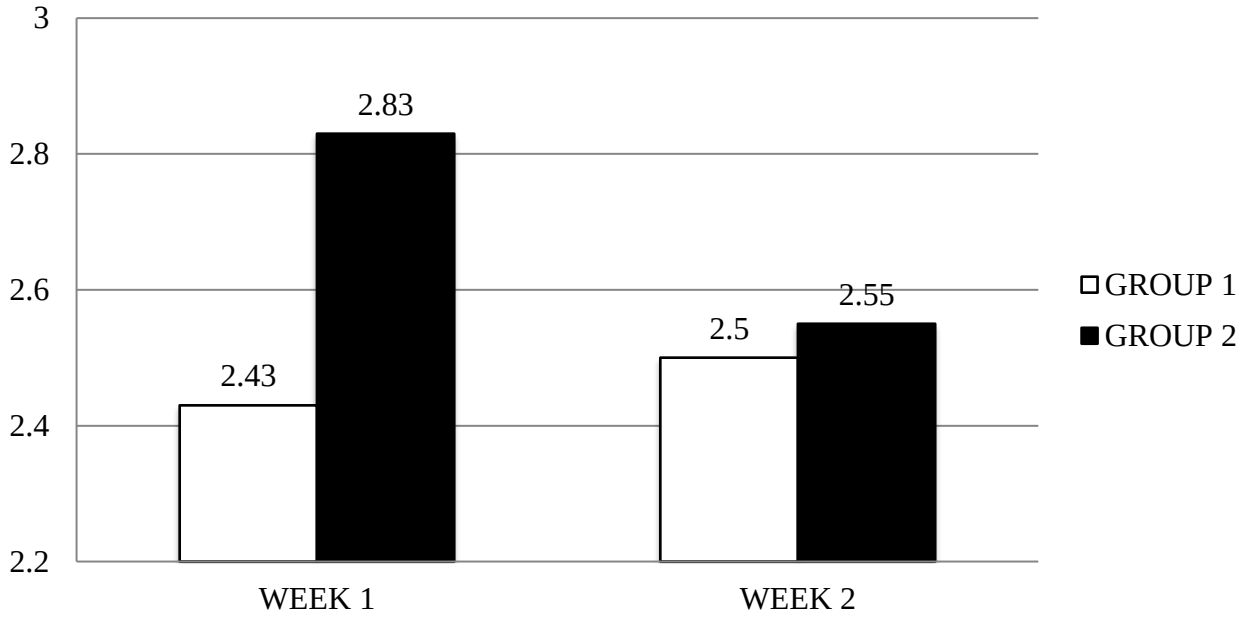


Figure 2. Graph of change in high-arousal negative affect as a function of Solitude week

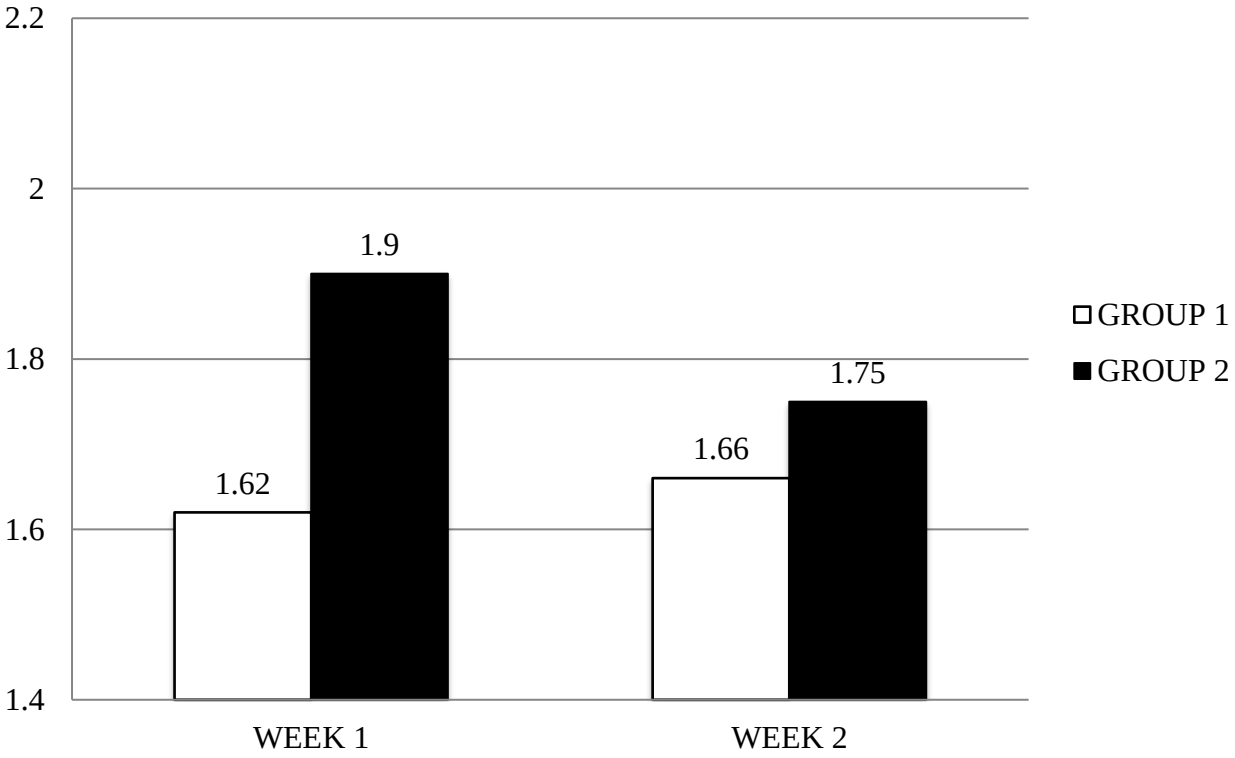
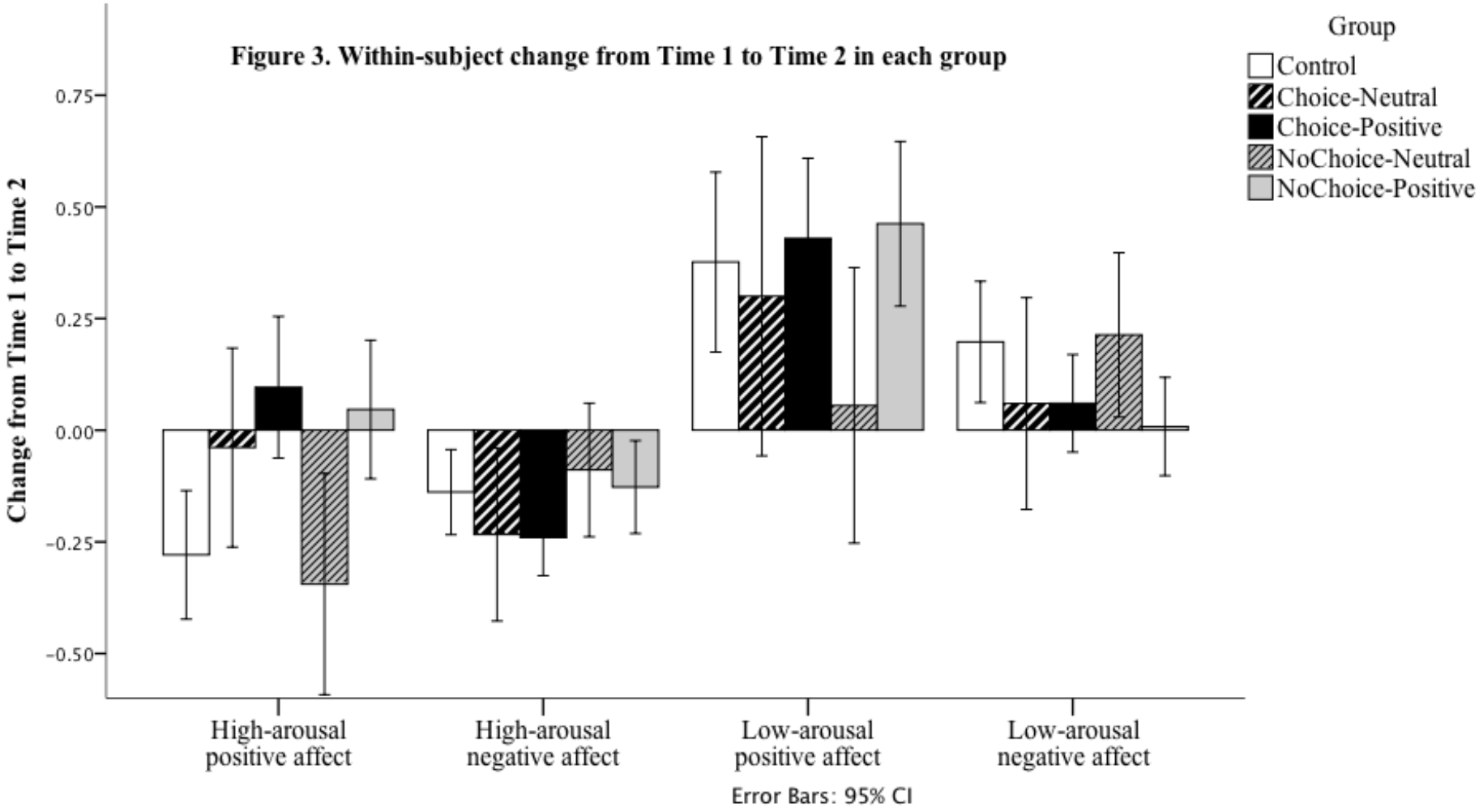


Figure 3. Within-subject change from Time 1 to Time 2 in each group



APPENDIX A

Syntaxes for Study 3 analyzing change from Time 1 to Time 2 across group, controlling for levels of concentration

```
mixed ACTPA by Time Group WITH concentr
  /fixed =   Time Group Time*Group Time*concentr
  /repeated = Time | subject(LabID) covtype(ar1)
  /test = 'solitude vs. just think' Time*Group 2 -.5 -.5 -.5 -.5 -2 .5 .5 .5 .5
  /test = 'Solitude vs. choice' Time*Group 1 -.5 -.5 0 0 -1 .5 .5 0 0
  /test = 'Solitude vs. no choice' Time*Group 1 0 0 -.5 -.5 -1 0 0 .5 .5
  /test = 'Solitude vs. positive' Time*Group 1 0 -.5 0 -.5 -1 0 .5 0 .5
  /test = 'Solitude vs. neutral' Time*Group -1 .5 0 .5 0 1 -.5 0 -.5 0 .

mixed ACTNA by Time Group WITH concentr
  /fixed =   Time Group Time*Group Time*concentr
  /repeated = Time | subject(LabID) covtype(ar1)
  /test = 'solitude vs. just think' Time*Group 2 -.5 -.5 -.5 -.5 -2 .5 .5 .5 .5
  /test = 'Solitude vs. choice' Time*Group 1 -.5 -.5 0 0 -1 .5 .5 0 0
  /test = 'Solitude vs. no choice' Time*Group 1 0 0 -.5 -.5 -1 0 0 .5 .5
  /test = 'Solitude vs. positive' Time*Group 1 0 -.5 0 -.5 -1 0 .5 0 .5
  /test = 'Solitude vs. neutral' Time*Group -1 .5 0 .5 0 1 -.5 0 -.5 0 .

mixed LOWPA by Time Group WITH concentr
  /fixed =   Time Group Time*Group Time*concentr
  /repeated = Time | subject(LabID) covtype(ar1)
  /test = 'solitude vs. just think' Time*Group 2 -.5 -.5 -.5 -.5 -2 .5 .5 .5 .5
  /test = 'Solitude vs. choice' Time*Group 1 -.5 -.5 0 0 -1 .5 .5 0 0
  /test = 'Solitude vs. no choice' Time*Group 1 0 0 -.5 -.5 -1 0 0 .5 .5
  /test = 'Solitude vs. positive' Time*Group 1 0 -.5 0 -.5 -1 0 .5 0 .5
  /test = 'Solitude vs. neutral' Time*Group -1 .5 0 .5 0 1 -.5 0 -.5 0 .

mixed LOWNA by Time Group WITH concentr
  /fixed =   Time Group Time*Group Time*concentr
  /repeated = Time | subject(LabID) covtype(ar1)
  /test = 'solitude vs. just think' Time*Group 2 -.5 -.5 -.5 -.5 -2 .5 .5 .5 .5
  /test = 'Solitude vs. choice' Time*Group 1 -.5 -.5 0 0 -1 .5 .5 0 0
  /test = 'Solitude vs. no choice' Time*Group 1 0 0 -.5 -.5 -1 0 0 .5 .5
  /test = 'Solitude vs. positive' Time*Group 1 0 -.5 0 -.5 -1 0 .5 0 .5
  /test = 'Solitude vs. neutral' Time*Group -1 .5 0 .5 0 1 -.5 0 -.5 0 .
```

APPENDIX B

STUDY 1

Solitude condition:
In this study, we are looking at people's experiences during social interactions and while being alone. You are in the "alone condition". Your task is just to spend time by yourself in this room.

During this time you will not have access to any cellphones, laptops, or electronic devices, as you are spending the time alone.

During this period you can do whatever you like. You can relax, sit with yourself, stretch, or explore the room if you want. We simply ask that you stay awake, and not fall asleep or leave the room.

Social interaction condition:
In this study, we are looking at people's experiences during social interactions and while being alone. You are in the "social interaction" condition. Your task is just to spend time interacting with a partner, who is one of our research assistants. I will bring that person in after this instruction.

During this time you will not have access to any cellphones, laptops, or electronic devices, as you are spending the time interacting with the other person.

In other to help facilitating your interaction, we've arranged a set of questions that you can ask each other. Here is a set of slips, each with a question written on it. One of you will choose a slip that you like and read it aloud, and then BOTH answer the question, starting with the person who read the slip aloud. When you are both done, go on to the second slip – one of you reading it aloud and both answer the question. Alternate who goes first with each new slip. While one person is answering the question, it would be appreciated if the other person just listened. It is not important to finish all the slips, so take plenty of time with each slip. Your partner has been given the same instruction.

STUDY 2

Solitude condition:
In this study, we are looking at people's experiences while being by themselves.

We ask that you spend this lab session to be by yourself, and experience it in and of itself, NOT along with other activities. Just take this time to be with yourself, your thoughts and feelings, so we can ask you about your experience with this activity later. Please **stay awake** and don't use any electronic devices that might facilitate social interactions, or any activities that might distract you from your experience with yourself.

Reading alone condition:
In this study, we are looking at people's experiences while being by themselves.

We ask that you spend this lab session to be by yourself, reading an article that we are about to provide to you. Just take this time to read as much of the article as possible, even if you might not finish all of it, so we can ask you about your experience with this activity later. Please stay awake and stay away from any electronic devices that might facilitate social interactions, or any activities that might distract you from your experience with the reading.

STUDY 3:

Solitude condition:
For this study, you will be asked to sit by yourself here in this room, without falling asleep, engaging in any social interactions via electronic devices, or performing any tasks or activities that might distract you from this experience of just being alone.

Solitude with Instructed thinking – Choice condition:
For this study, you will be asked to sit by yourself here in this room, without falling asleep, and without engaging in any social interactions via electronic devices, or performing any tasks or activities that might distract you from this experience of just being alone. The idea is that you can choose how to spend your time thinking. Please choose to spend your time either thinking about positive things that are likely to make you feel good, or alternatively spend the time thinking about more neutral things that are likely to make you feel neutral rather than feeling either positive or negative. So please choose to spend the time engaging yourself either with positive thoughts or else with neutral thoughts, which ever you'd like. Which of those two types of topics would you like to think about? [allow the participant a few seconds to pick]. [Then after they tell you, repeat it by saying "OK, so you have chosen to spend your time here in the room thinking about positive thoughts (about neutral thoughts).]

Solitude with Instructed thinking – No choice condition:

(A) POSITIVE THOUGHT: For this study, you will be asked to sit by yourself here in this room, without falling asleep, and without engaging in any social interactions via electronic devices, or performing any tasks or activities that might distract you from this experience of just being alone. The idea is that you can choose how to spend your time thinking. However, we would like you to spend the time thinking about positive things that are likely to make you feel good. That is, your goal should be to have a pleasant experience, as opposed to spending the time focusing on everyday activities or negative things.

(B) NEUTRAL THOUGHT: For this study, you will be asked to sit by yourself here in this room, without falling asleep, and without engaging in any social interactions via electronic devices, or performing any tasks or activities that might distract you from this experience of just being alone. The idea is that you can choose how to spend your time thinking. However, we would like you to spend the time thinking about more neutral things that are likely to make you feel neutral rather than feeling either positive or negative. That is, your goal should be to have a neutral experience, as opposed to spending the time focusing on everyday activities or negative things.

STUDY 4

For this exercise, you will be asked to spend time by yourself for 15 minutes. In those 15 minutes, we ask that you stay awake, stay away from *any electronic devices that might facilitate social interactions*, simply be by yourself and experience this time IN AND OF ITSELF, NOT along with any other activities, that is, NOT when you are eating, watching TV, exercising, reading, or studying, etc.

Therefore, you can find any time and place that is convenient for you, where you are the least likely to be distracted.