

or by postsynthesis treatments (28, 29). By contrast, separations such as H_2/C_3H_8 that involve a fast-permeating species are not appreciably affected by membrane defects. IMMP is also inherently a modular and parallel approach that should allow independent and simultaneous processing of membranes in multiple fibers. To test this hypothesis, we applied IMMP to the simultaneous processing of three hollow fibers. The total bore flow rate was increased by a factor of 3 so that the flow rate through individual fibers was maintained. The ends of the module were capped with PDMS, as described earlier. Figure 3, C and D, shows that the H_2/C_3H_8 and C_3H_6/C_3H_8 separation behavior is essentially identical to the single-fiber case, demonstrating the potential for scalability of IMMP. Given the overall importance of tunable ZIF materials for a range of hydrocarbon and light-gas separations, the membrane-processing approach reported here overcomes many limitations of current processes and is a notable step toward realizing scalable molecular sieving MOF membranes.

REFERENCES AND NOTES

- J. Gascon *et al.*, *Chem. Mater.* **24**, 2829–2844 (2012).
- K. Varoon *et al.*, *Science* **334**, 72–75 (2011).
- M. Shah, M. C. McCarthy, S. Sachdeva, A. K. Lee, H. K. Jeong, *Ind. Eng. Chem. Res.* **51**, 2179–2199 (2012).
- M. G. Buonomenna, *RSC Advances* **3**, 5694–5740 (2013).
- M. Tsapatsis, *Science* **334**, 767–768 (2011).
- T. C. Pham, H. S. Kim, K. B. Yoon, *Science* **334**, 1533–1538 (2011).
- J. Choi *et al.*, *Science* **325**, 590–593 (2009).
- Y. Pan, B. Wang, Z. Lai, *J. Membr. Sci.* **421–422**, 292–298 (2012).
- J. A. Thompson *et al.*, *Chem. Mater.* **24**, 1930–1936 (2012).
- K. S. Park *et al.*, *Proc. Natl. Acad. Sci. U.S.A.* **103**, 10186–10191 (2006).
- A. Huang, W. Dou, J. Caro, *J. Am. Chem. Soc.* **132**, 15562–15564 (2010).
- A. J. Brown *et al.*, *Angew. Chem. Int. Ed.* **51**, 10615–10618 (2012).
- R. Ameloot *et al.*, *Nat. Chem.* **3**, 382–387 (2011).
- M. Pera-Titus, R. Mallada, J. Llorens, F. Cunill, J. Santamaria, *J. Membr. Sci.* **278**, 401–409 (2006).
- K. Li *et al.*, *J. Am. Chem. Soc.* **131**, 10368–10369 (2009).
- K. S. Jang *et al.*, *Chem. Mater.* **23**, 3025–3028 (2011).
- Materials and methods are available as supplementary materials on Science Online.
- K. Nakayama, K. Suzuki, S. Yoshida, K. Yajima, T. Tomita, U.S. Patent 7,014,680 (2006).
- M. Gummalla, M. Tsapatsis, J. J. Watkins, D. G. Vlachos, *AIChE J.* **50**, 684–695 (2004).
- Y. Pan, T. Li, G. Lestari, Z. Lai, *J. Membr. Sci.* **390–391**, 93–98 (2012).
- H. Bux *et al.*, *Chem. Mater.* **23**, 2262–2269 (2011).
- Y. Pan, Z. Lai, *Chem. Commun.* **47**, 10275–10277 (2011).
- H. T. Kwon, H. K. Jeong, *Chem. Commun.* **49**, 3854–3856 (2013).
- R. P. Lively, J. A. Mysona, R. R. Chance, W. J. Koros, *ACS Appl. Mater. Interfaces* **3**, 3568–3582 (2011).
- I. Pinnau, Z. He, *J. Membr. Sci.* **244**, 227–233 (2004).
- Y. Shi, C. M. Burns, X. Feng, *J. Membr. Sci.* **282**, 115–123 (2006).
- C. Zhang *et al.*, *J. Phys. Chem. Lett.* **3**, 2130–2134 (2012).
- W. V. Chiu *et al.*, *J. Membr. Sci.* **377**, 182–190 (2011).
- J. M. S. Henis, M. K. Tripodi, *Science* **220**, 11–17 (1983).

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F.R. Permeation modeling was carried out by S.N. and A.J.B. All authors contributed to manuscript writing and editing. We thank W. Qiu, R. P. Lively, and A. Rowan (all at Georgia Institute of Technology) for helpful discussions. The Supplementary Materials includes a detailed description of materials and methods, details of the IMMP reactor, time-dependent flow profiles and synthesis cases, SEM images of ZIF-8 membranes, XRD patterns of membranes, schematics of permeation apparatus and gas bypass effects, EDX mapping of the ZIF-8 membrane, permeation modeling equations, and gas permeation data. A patent application related to this work has been filed [U.S. patent application 61/820,489, filed 7 May 2013; S. Nair *et al.*, Flow processing

and characterization of metal-organic framework (MOF) membranes in tubular and hollow fiber modules].

SUPPLEMENTARY MATERIALS

www.sciencemag.org/content/345/6192/72/suppl/DC1
Materials and Methods
Supplementary Text
Figs. S1 to S11
Tables S1 to S4

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SOCIAL PSYCHOLOGY

Just think: The challenges of the disengaged mind

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In 11 studies, we found that participants typically did not enjoy spending 6 to 15 minutes in a room by themselves with nothing to do but think, that they enjoyed doing mundane external activities much more, and that many preferred to administer electric shocks to themselves instead of being left alone with their thoughts. Most people seem to prefer to be doing something rather than nothing, even if that something is negative.

“The mind is its own place, and in it self/
Can make a Heav'n of Hell, a Hell of Heav'n.”

– John Milton, *Paradise Lost*

The ability to engage in directed conscious thought is an integral part—perhaps even a defining part—of what makes us human. Unique among the species, we have the ability to sit and mentally detach ourselves from our surroundings and travel inward, recalling the past, envisioning the future, and imagining worlds that have never existed. Neural activity during such inward-directed thought, called default-mode processing, has been the focus of a great deal of attention in recent years, and researchers have speculated about its possible functions (1–5). Two related questions, however, have been overlooked: Do people choose to put themselves in default mode by disengaging from the external world? And when they are in this mode, is it a pleasing experience?

Recent survey results suggest that the answer to the first question is “not very often.” Ninety-five percent of American adults reported that they did at least one leisure activity in the past 24 hours, such as watching television, socializing, or reading for pleasure, but 83% reported they spent no time whatsoever “relaxing or thinking” (6). Is this because people do not enjoy having nothing to do but think?

Almost all previous research on daydreaming and mind wandering has focused on task-

unrelated thought, namely cases in which people are trying to attend to an external task (such as reading a book), but their minds wander involuntarily (7, 8). In such cases, people tend to be happier when their minds are engaged in what they are doing, instead of having wandered away (9, 10). A case could be made that it is easier for people to steer their thoughts in pleasant directions when the external world is not competing for their attention. We suggest, to the contrary, that it is surprisingly difficult to think in enjoyable ways even in the absence of competing external demands.

To address these questions, we conducted studies in which college-student participants spent time by themselves in an unadorned room (for 6 to 15 min, depending on the study) after storing all of their belongings, including cell phones and writing implements. They were typically asked to spend the time entertaining themselves with their thoughts, with the only rules being that they should remain in their seats and stay awake. After this “thinking period,” participants answered questions about how enjoyable the experience was, how hard it was to concentrate, etc.

Table 1 summarizes the results of six studies that followed this procedure. Most participants reported that it was difficult to concentrate (57.5% responded at or above the midpoint of the point scale) and that their mind wandered (89.0% responded at or above the midpoint of the scale), even though there was nothing competing for their attention. And on average, participants did not enjoy the experience very much: 49.3% reported enjoyment that was at or below the midpoint of the scale.

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Perhaps the unfamiliar environs of the psychological laboratory made it difficult for people to become lost in and enjoy their thoughts. In study 7, we instructed college-student participants to complete the study at home, by clicking on a link to a Web program when they were alone and free of external distractions. Many participants found it difficult to follow these instructions: 32% reported that they had “cheated” by engaging in an external activity (such as listening to music or consulting their cell phones) or getting up out of their chair. Furthermore, there was no evidence that participants enjoyed the experience more when they were in the privacy of their homes. The mean reported enjoyment was lower when they were at home than when they were in the laboratory [$t(188) = 2.47, P = 0.014$], and participants reported that it was harder to concentrate on their thoughts when they were at home [$t(188) = 2.87, P = 0.005$] (Table 1). These differences must be interpreted with caution, because we did not randomly assign participants to a location, but they suggest that just thinking is no easier at home than it is in the laboratory.

Would participants enjoy themselves more if they had something to do? In study 8, we randomly assigned participants to entertain themselves with their own thoughts or to engage in external activities (such as reading a book, listening to music, or surfing the Web). We asked the latter participants not to communicate with others (e.g., via texting or emailing), so that we could compare nonsocial external activities (such as reading) with a nonsocial internal activity (thinking). As seen in Table 1, participants enjoyed the external activities much more than just thinking [$t(28) = 4.83, P < 0.001$], found it easier to concentrate [$t(28) = 4.16, P < 0.001$], and reported that their minds wandered less [$t(28) = 3.61, P = 0.001$].

To see whether the difficulty with “just thinking” is distinctive to college students, in study 9 we recruited community participants at a farmer’s market and a local church. The participants ranged in age from 18 to 77 (median age = 48.0 years). As in study 7, they completed the study online in their own homes, after receiving instructions to do so when they were alone and free of any external distractions. The results were similar to those found with college students. There was no evidence that enjoyment of the thinking period was related to participants’ age, education, income, or the frequency with which they used smart phones or social media (table S2).

There was variation in enjoyment in our studies, and we included several individual difference measures to investigate what sort of person enjoys thinking the most (summarized in table S3). The variables that consistently predicted enjoyment across studies were items from two subscales of the Short Imaginal Process Inventory (11). The Positive Constructive Daydreaming subscale (e.g., “My daydreams often leave me with a warm, happy feeling”) correlated positively with enjoyment, and the Poor Attentional Control subscale (e.g., “I tend to be

easily bored”) correlated negatively with enjoyment. None of the other correlations exceeded 0.27 (table S3).

So far, we have seen that most people do not enjoy “just thinking” and clearly prefer having something else to do. But would they rather do an unpleasant activity than no activity at all? In study 10, participants received the same instructions to entertain themselves with their thoughts in the laboratory but also had the opportunity to experience negative stimulation (an electric shock) if they so desired. In part 1 of the study, participants rated the pleasantness of several positive stimuli (e.g., attractive photographs) and negative stimuli (e.g., an electric shock). Participants also reported how much they would pay to experience or not experience each stimulus again, if they were given \$5. Next, participants received our standard instructions to entertain themselves with their thoughts (in this case for 15 min). If they wanted, they learned, they could receive an electric shock again during the thinking period by pressing a button. We went to some length to explain that the primary goal was to entertain themselves with their thoughts and that the decision to receive a shock was entirely up to them.

Many participants elected to receive negative stimulation over no stimulation—especially men: 67% of men (12 of 18) gave themselves at least one shock during the thinking period [range = 0 to 4 shocks, mean (M) = 1.47, SD = 1.46, not including one outlier who administered 190 shocks to himself], compared to 25% of women (6 of 24; range = 0 to 9 shocks, $M = 1.00, SD = 2.32$). Note that these results only include participants who had reported that they would pay to avoid being shocked again. (See the supplementary materials for more details.) The gender difference is probably due to the tendency for men to be higher in sensation-seeking (12). But what is striking is that simply being alone with their own thoughts for 15 min was apparently so aversive that it drove many participants to self-administer an electric shock that they had earlier said they would pay to avoid.

Why was thinking so difficult and unpleasant? One possibility is that when left alone with their thoughts, participants focused on their own shortcomings and got caught in ruminative thought cycles (13–16). Research shows, however, that self-focus does not invariably lead to rumination (17), a finding that was confirmed in our studies. At the conclusion of the thinking period, we asked participants to describe what they had been thinking about, and we analyzed these reports with linguistic analysis software (18). There was no relationship between the extent of self-focus (as assessed by the use of first-person personal pronouns) and participants’ use of positive-emotion words, negative-emotion words, or reported enjoyment of the thinking period correlations = 0.033, 0.025, and 0.022, respectively; 218 participants, ns) (see table S4 for other results of the linguistic analyses).

Another reason why participants might have found thinking to be difficult is that they simultaneously had to be a “script writer” and an “experiencer”; that is, they had to choose a topic to think about (“I’ll focus on my upcoming summer vacation”), decide what would happen (“Okay, I’ve arrived at the beach, I guess I’ll lie in the sun for a bit before going for a swim”), and then mentally experience those actions. Perhaps people would find it easier to enjoy their thoughts if they had time to plan in advance what they would think about. We tested this hypothesis in studies 1 to 7. Participants were randomly assigned to our standard “thinking period” condition (the results of which are shown in Table 1) or to conditions in which they first spent a few minutes planning what they would think about. We tried several versions of these “prompted fantasy” instructions (summarized in table S1) and found that none reliably increased participants’ enjoyment of the thinking period. Averaged across studies, participants in the prompted fantasy conditions reported similar levels of enjoyment as did participants in the standard conditions [$M = 4.97$ versus 4.94 (SDs = 1.80, 1.84), $t(450) = 0.15, ns$].

There is no doubt that people are sometimes absorbed by interesting ideas, exciting fantasies,

Table 1. Reactions to the “thinking period” under different conditions.

Measure		Studies 1 to 6: In the lab (n = 146)	Study 7: At home (n = 44)	Study 8: At home	
				Standard thought instructions (n = 15)	External activities (n = 15)
Enjoyment*	SD	1.77	1.95	2.23	1.91
	M	5.12	4.35	3.20	6.87
Hard to concentrate†	SD	2.23	1.72	2.28	2.01
	M	5.04	6.09	6.07	2.80
Mind wandering‡	SD	1.92	1.85	1.80	2.66
	M	6.86	7.14	6.67	3.67

*Mean of three items, each answered on nine-point scales: How enjoyable and entertaining the thinking period was and how bored participants were (reverse-scored). Cronbach’s alpha = 0.89. †Extent to which participants reported that it was hard to concentrate on what they chose to think about (nine-point scale; the higher the number, the greater the reported difficulty). ‡Extent to which participants reported that their mind wandered during the thinking period (nine-point scale; the higher the number, the greater the reported mind-wandering).

and pleasant daydreams (19–21). Research has shown that minds are difficult to control (8, 22), however, and it may be particularly hard to steer our thoughts in pleasant directions and keep them there. This may be why many people seek to gain better control of their thoughts with meditation and other techniques, with clear benefits (23–27). Without such training, people prefer doing to thinking, even if what they are doing is so unpleasant that they would normally pay to avoid it. The untutored mind does not like to be alone with itself.

REFERENCES AND NOTES

1. M. E. Raichle *et al.*, *Proc. Natl. Acad. Sci. U.S.A.* **98**, 676–682 (2001).
2. R. L. Buckner, J. R. Andrews-Hanna, D. L. Schacter, *Ann. N. Y. Acad. Sci.* **1124**, 1–38 (2008).
3. J. R. Andrews-Hanna, *Neuroscientist* **18**, 251–270 (2012).
4. M. H. Immordino-Yang, J. A. Christodoulou, V. Singh, *Perspect. Psychol. Sci.* **7**, 352–364 (2012).
5. M. F. Mason *et al.*, *Science* **315**, 393–395 (2007).
6. American Time Use Survey, Bureau of Labor Statistics, U.S. Department of Labor: www.bls.gov/tus/home.htm#data (2012).
7. R. L. McMillan, S. B. Kaufman, J. L. Singer, *Front. Psychol.* **4**, 626 (2013).
8. J. Smallwood, J. W. Schooler, *Psychol. Bull.* **132**, 946–958 (2006).
9. M. A. Killingsworth, D. T. Gilbert, *Science* **330**, 932 (2010).
10. M. S. Franklin *et al.*, *Front. Psychol.* **4**, 583 (2013).
11. G. J. Huba, J. L. Singer, C. S. Aneshensel, J. S. Antrobus, *Short Imaginal Processes Inventory: Manual* (Research Psychologists Press, Port Huron, MI, 1982).
12. J. W. Roberti, *J. Res. Pers.* **38**, 256–279 (2004).
13. S. Duval, R. A. Wicklund, *A Theory of Objective Self-Awareness* (Academic Press, San Diego, CA, 1972).
14. R. F. Baumeister, *Escaping the Self* (BasicBooks, New York, 1991).
15. M. Leary, *The Curse of the Self* (Oxford Univ. Press, New York, 2004).
16. S. Nolen-Hoeksema, B. E. Wisco, S. Lyubomirsky, *Perspect. Psychol. Sci.* **3**, 400–424 (2008).
17. N. Mor, J. Winquist, *Psychol. Bull.* **128**, 638–662 (2002).
18. J. W. Pennebaker, R. J. Booth, M. E. Francis, *LWOC2007: Linguistic Inquiry and Word Count* (LWOC.net, Austin, TX, 2007).
19. J. L. Singer, *Daydreaming: An Introduction to the Experimental Study of Inner Experience* (Random House, New York, 1966).
20. J. L. Singer, *Am. Psychol.* **30**, 727–738 (1975).
21. E. Klinger, *Daydreaming* (Tarcher, Los Angeles, CA, 1990).
22. D. M. Wegner, *Psychol. Rev.* **101**, 34–52 (1994).
23. P. Grossman, L. Niemann, S. Schmidt, H. Walach, *J. Psychosom. Res.* **57**, 35–43 (2004).
24. S. G. Hofmann, P. Grossman, D. E. Hinton, *Clin. Psychol. Rev.* **31**, 1126–1132 (2011).
25. A. G. Harvey, S. Payne, *Behav. Res. Ther.* **40**, 267–277 (2002).
26. B. Baird *et al.*, *Psychol. Sci.* **23**, 1117–1122 (2012).
27. J. W. Schooler *et al.*, *Psychol. Learn. Motiv.* **60**, 1–33 (2014).

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SUPPLEMENTARY MATERIALS

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Materials and Methods

Additional Analyses across Studies

Fig. S1

Tables S1 to S4

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CLIMATE CHANGE

Climate change and wind intensification in coastal upwelling ecosystems

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In 1990, Andrew Bakun proposed that increasing greenhouse gas concentrations would force intensification of upwelling-favorable winds in eastern boundary current systems that contribute substantial services to society. Because there is considerable disagreement about whether contemporary wind trends support Bakun's hypothesis, we performed a meta-analysis of the literature on upwelling-favorable wind intensification. The preponderance of published analyses suggests that winds have intensified in the California, Benguela, and Humboldt upwelling systems and weakened in the Iberian system over time scales ranging up to 60 years; wind change is equivocal in the Canary system. Stronger intensification signals are observed at higher latitudes, consistent with the warming pattern associated with climate change. Overall, reported changes in coastal winds, although subtle and spatially variable, support Bakun's hypothesis of upwelling intensification in eastern boundary current systems.

In eastern boundary current systems (EBCSs), coastal upwelling fuels high productivity, supporting vast and diverse marine populations. With a surface area of only ~2% of the global oceans, EBCSs provide upward of 20% of wild marine-capture fisheries (1) as well as essential habitat for marine biodiversity (2). Understanding upwelling variability is also key to assessments of marine ecosystem health, influencing factors such as ocean acidification and deoxygenation (3–5). Although the ecological relevance of upwelling is clear, the future of upwelling under anthropogenic climate change is not (6–8). In 1990, Andrew Bakun hypothesized that global warming could result in steeper temperature and sea-level pressure gradients between the oceans and the continents, causing alongshore upwelling-favorable winds to intensify (6). Although the increase in global temperatures is unquestioned (7), its influence on upwelling-favorable winds remains uncertain. In an attempt to resolve disagreement in the literature concerning the intensification of upwelling winds, we conducted a “preponderance of evidence” meta-analysis on results from previous studies that tested Bakun's wind intensi-

fication hypothesis. Our meta-analysis focused on the outcome of Bakun's purported mechanism: upwelling-favorable wind intensification over the past 6+ decades.

We synthesized results from 22 studies published between 1990 and 2012, 18 of which contained quantitative information on wind trends. Our resulting database contains 187 non-independent wind trend analyses based on time series ranging in duration from 17 to 61 years [tables S1 to S3 (9)]. We tested whether the evidence from these studies was consistent (increasing winds) or inconsistent (weakening winds) with the Bakun hypothesis. Bakun proposed that winds would intensify in the upwelling or warm season; i.e., May to August in the Northern Hemisphere and November to February in the Southern Hemisphere. Therefore, we categorized each trend based on the months averaged for its calculation: “warm season” or “annual” (all months). Bakun surmised that there would be latitudinal variation in wind trends and predicted that the most substantial intensification would be in the “core” of each EBCS. Therefore, to test for spatial heterogeneity in wind trends, we included absolute latitude in our models (9). We compared results from observational data and model-data re-analysis products, because previous research has shown different trends among these data types (10, 11).

We used logistic regression to model the consistency of wind trends with the Bakun hypothesis. Although all studies included in our analysis undertook formal statistical analysis, they used different analyses and statistical approaches and also used a range of significance levels (0.01 to 0.10), many of which were reported only categorically (9). Consequently, we used a qualitative approach (table S3) in which we down-weighted nominally nonsignificant trends to half the weight

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Supplementary Materials for

Just Think: The Challenges of the Disengaged Mind

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This PDF file includes:

Materials and Methods
Additional Analyses Across Studies
Fig. S1
Tables S1 to S4
References (28–40)

Studies 1-6: Standard Instructions versus Prompted Fantasy Instructions

Participants. Participants were 413 undergraduate university students (211 female, 162 male, 40 unspecified) who participated for course credit or pay. Four participants were dropped from the analyses of Study 1 due to experimenter error. For example, one person in the control condition was inadvertently left with a pen and wrote a to-do list during the fantasy period, and another was inadvertently left with an instruction sheet, which he used to practice origami during the time he was alone.

Procedure. Participants completed the study individually in a sparsely-furnished room in a psychology building. In Studies 1-4 instructions and dependent measures were presented on paper; in Studies 5-6 they were delivered on a computer via a Qualtrics program (Qualtrics, Provo, UT). In each study participants were randomly assigned to a standard instructions condition or one or more prompted fantasy conditions. The specific instructions participants received in these conditions are described in Table S1. Other procedural differences across studies are noted in Table S1; for example, participants in Studies 1-2 were told how long the thinking period would be and asked to follow the time on a clock, whereas participants in Studies 3-6 were given an estimate of the time (e.g., “10-15 minutes) and there was no clock in the room. The length of the thinking period ranged from 6 to 15 minutes (see Table S1). In addition to the main dependent measures reported in Table 1, we included a variety of exploratory measures, such as how much people were letting their thoughts flow and how much they were trying to control their thoughts. A list of these measures, and the data from all studies, are available at <https://osf.io/cgwdy/files/>.

Results. The mean reported enjoyment of the thinking period is displayed in Table S1 for each condition. There were no significant differences between prompted fantasy and standard instruction conditions in any study.

Study 7: Just Thinking at Home

Participants. As described below, there were two parts to the study, an initial session and then the experiment that participants completed in their homes. Two hundred college students participated in the first session; 192 of them (96%) visited the web site for the experimental session; and 169 (85%; 98 female, 67 male, 4 unspecified) completed the experimental session with usable data. Participants received partial course credit for each session.

Procedure. Participants first attended a session in the psychology building at which they completed individual difference scales and received instructions about the second part of the study. The experimenter explained that they would receive an email with a link to a web program that would administer the study, and that they should complete Part 2 in their apartment or dorm room at a time when they did not feel rushed and were free of all distractions. The experimenter emphasized that Part 2 should be completed only after participants turned off phones, televisions, and any music devices, and put aside any reading materials such as magazines or books. When participants clicked on the link they were connected to a Qualtrics survey software program that gave instructions identical to those in our lab studies, namely that they should spend the “thinking period” (12 minutes in this case) entertaining themselves with their thoughts, without falling asleep or getting up from their chair. Participants were reminded to turn off all electronic devices and to avoid other external distractions such as reading materials.

Participants were randomly assigned to one of four conditions in a 2 (Standard vs. Prompted Fantasy Instructions) x 2 (No Task vs. Minimal Monitoring Task Condition). The former manipulation was identical to the one used in Studies 5-6. For the latter manipulation, half of the participants received no instructions about an additional task whereas the other half were told that reminder instructions would appear on the computer screen during the thinking period two times, and that when they did they should click on them and continue with their thoughts. The reminder instructions, which appeared at the 4 and 8 minute marks of the 12 minute thinking period, repeated what participants had been told earlier about what to think about (see below, under the section “Scanner Hypothesis,” for a discussion of the results in this condition). After the thinking period participants completed the dependent measures (which were the same as in the previous studies). Twenty-six participants were dropped from the analyses because they spent more than 13 minutes on the Thinking Period, suggesting that they were not paying attention or following instructions. The results are very similar if all participants are included in the analyses or if a stricter criterion is used.

Study 8: Comparing Just Thinking to External Distractions

Participants. Participants were 30 undergraduate psychology students (15 female, 14 male, 1 unspecified) who participated for course credit.

Procedure. The procedure was identical to Study 7. Half of the participants were randomly assigned to the standard instructions-no monitoring task condition and half were assigned to a new external activities condition. Participants in the latter condition were instructed to entertain themselves with one or more activities from a list that included watching a television show or movie, reading an enjoyable book or magazine, working on a puzzle (e.g., a crossword or Sudoku puzzle), looking at web pages (e.g., Facebook, Youtube), playing a videogame, and

listening to music on the radio. Participants were told that they could switch from one activity to another if they wanted, with the goal of “finding something enjoyable to do.” They were further instructed not to communicate directly with anyone else during the free time period, such as texting or talking on the phone. “The goal,” they read, “is to find something entertaining to do by yourself.” Participants then wrote down on a piece of paper the three activities from the list that they thought they would do, asked to keep that list nearby for reference, though they did not have to do all of them. Thus, participants in the standard instructions condition received our usual instructions to entertain themselves with their thoughts, whereas participants in the external activities condition received instructions to entertain themselves with one or more external activities. All participants then completed the same dependent measures as in Study 7.

Study 9: Community Sample

Participants. We recruited participants in two ways. First, research assistants stood at a table at a farmers’ market with a sign that read, “On-Line Psychology Study.” Interested passersby were told that they would receive a \$5 gift certificate if they participated in an on-line study in their homes. They were given written and verbal instructions similar to those received by participants in Study 7, namely that they should complete the study at home at a time when they did not feel rushed and were free of all distractions. The research assistant emphasized that the study should be completed only after participants turned off phones, televisions, and any music devices, and put aside any reading materials such as magazines or books. On two separate days, a total of 118 people gave us legible email addresses. Of these, 54 (46%) visited the web site and 47 (40%; 33 female, 14 male) completed the study. Second, we visited a local Methodist church at a social hour following a Sunday service and delivered the same written and verbal instructions as people received at the farmers’ market. Of the 24 people who provided us with

their email addresses, 21(88%) visited the web site and 19 (79%; 13 female, 6 male) completed the study. Combining the two samples, a total of 66 people completed the study (46 females, 20 males). We dropped from the analyses the data from four college student participants who said they had participated in one of our other studies and one person who stopped participating after being assigned to one of the experimental conditions, restarted the program, and was assigned to the other experimental condition. The resulting sample consisted of 61 participants (42 female, 19 male), who ranged in age from 18 to 79 ($M = 49.16$, $Mdn = 58.0$) and had a median income of \$75,000. The highest degrees obtained were high school (5%), some college (10%), a two-year college degree (7%), a four-year college degree (30%), and a post-graduate degree (49%). (Note that the demographic data reported in the main text are for the control condition only; these figures include both conditions, as described below.)

Procedure. The procedure was an exact replication of Study 7 (standard instructions only) except for these changes: As in Study 7 we randomly assigned participants to a no task or minimal monitoring task condition. In the minimal monitoring task condition, however, instead of presenting people with reminder instructions at the 4 and 8 minute mark of the thinking period, the phrase, “Please continue with the Thinking Period” was displayed. We made this change to rule out an alternative explanation of the results of the monitoring condition of Study 7, namely that giving them reminder instructions reminded them of what they were supposed to be doing and got them back on track.

Unlike in Study 7, participants did not complete any individual difference measures before completing the study. After the main dependent measures they completed the Need for Cognition scale (30), the single-item measure of the Big 5 personality traits, questions about their use of smart phones, social media, and demographics. The smart phone questions asked

participants to rate how frequently they used a smart phone to read and send email, read and send texts, browse the web, listen to music, watch videos, and other, all on 7-point scales, where 1 = *never* and 7 = *daily*. We summed people's responses to these questions to create an index of smart phone use. The social media questions asked participants how often they used Facebook, Twitter, Youtube, LinkedIn, and an email program, on the same 7-point scale. We summed people's responses to these questions to create an index of social media use.

Results. Here we report the results in the no task condition; see the section, "Analysis across Studies: Scanner Hypothesis" below for the results in the minimal monitoring condition. Similar to our college students participants in Study 7, our community participants found it difficult to follow the instructions: 54% reported that they had "cheated" by engaging in an external activity (e.g., consulting their cell phones, writing/doodling) or getting up out of their chair during the thinking period. Their reported level of enjoyment of the thinking period was higher than our student sample; $M_s = 5.81$ vs. 4.35 ($SD_s = 1.84, 1.95$), possibly because of self-selection. After learning about the study, fewer community participants (46%) than students (85%) completed the study on-line at home. Thus, it may be that a higher percentage of community members who would have disliked the study opted not to do it. And, it should be kept in mind that more than half of the community members who completed the study cheated by seeking external distractions.

As mentioned in the main text, the reported level of enjoyment of the thinking period was unrelated to participants' age, education, income, or the frequency with which they used smart phones or social media. It was correlated with participants' scores on the Need for Cognition scale and the Openness to Experience item from the Big 5 (see Table S2 for details).

Study 10: Shock Study

Participants. Participants were 55 undergraduate students (31 female, 24 male) who participated for course credit or pay.

Procedure. Participants were informed that the purpose of the study was to learn how people rate various external stimuli and how they are able to pass the time with their thoughts. The study would be in two parts, they learned, and they would complete parts both on a computer. The instructions said that the first part would involve rating the pleasantness or unpleasantness of a variety of stimuli, including sounds, pictures, and a mild electric shock. “The shock is designed to be unpleasant but not painful,” participants read, “nothing more than you would experience from a static shock.” Part 2, they learned, would involve sitting by themselves for 10-20 minutes. During this time, participants read, “You will also be given the opportunity to experience one or more of the stimuli you had previously rated.” Participants were then asked to sign a consent form that included the statement, “You will be asked to do one or more of the following: think about topics of your choice while sitting by yourself, work on a problem solving task, rate various stimuli as to how pleasant or unpleasant they are (e.g., pictures, sounds, mild electric shocks).” All participants signed the consent form and agreed to participate.

The experimenter then attached two Ag-AgCl shock electrodes to the participant’s ankle, which were connected to an isolated physiological stimulator (Coulbourn Instruments, Allentown, PA). Participants were told that at a certain point the computer program would ask them to deliver a shock to themselves, which they could do by pressing the number 5 on a numeric keyboard. The keyboard and shock apparatus were connected to a computer in the next room that recorded the number of times participants administered shocks.

Participants were then left alone in a sparsely-furnished room, where they received instructions and answered questions on a computer running a Qualtrics program. After rating

their current emotional state on items from the PANAS (28) and other filler questions, participants read instructions reiterating the purpose and procedures of the study. Then they completed the first part of the study, which involved rating three negative stimuli (the sound of a knife rubbing against a bottle, the electric shock, a color photo of a cockroach) and three positive stimuli (guitar music, a color photo of a river scene, a color photo of a bird). Participants rated the pleasantness of each stimulus on a 9-point scale ($1 = \textit{very unpleasant}$, $9 = \textit{very pleasant}$). They also were asked to imagine that the experimenter gave them \$5, and indicated the amount (if any) they would pay to see/hear/experience the stimulus again in the second part of the study and the amount (if any) they would pay NOT to see/hear/experience the stimulus again in the second part of the study.

All participants delivered the shock to themselves in this first part of the study. Thus, in Part 2 of the study, when people had the opportunity to shock themselves again, everyone knew what the shock entailed and how painful it was. We initially set the intensity of the shock at the same level, 4 milliamperes (mA), for men and women. In pilot testing we discovered, however, that women rated the shocks as more painful than men, which is consistent with research showing that women have a lower threshold of pain tolerance (29). We thus reduced the level for women to 2.3 mA whereas men continued to receive 4mA. With this procedure there was no significant difference in the pleasantness ratings of the shock, $t(52) = 1.40$, $p = .167$ (men rated the shocks as somewhat less pleasant).

Participants then read the instructions to Part 2 of the study, which were very similar to those given in the standard control condition of our previous studies. Specifically, participants learned that they would be asked to sit by themselves in the room without getting up from their chair or falling asleep. They were told that they could think about whatever they wanted, with the

goal of “entertaining yourself with your thoughts as best you can. That is, your goal should be to have a pleasant experience, as opposed to spending the time focusing on everyday activities or negative things.” In preparation for the thinking period, they were then asked to describe three activities they might enjoy thinking about. “You don’t have to think only about these items that you write down,” they read, “but these can be starting points if you want.”

Participants then read that during the thinking period they “can also experience one of the stimuli (sounds, shock, pictures) you rated earlier, but only if you want to. Different participants may get different stimuli in Part 2.” They were asked to wait a few seconds for the computer to display the stimulus that would be available to them. All participants learned that the electric shock would be available during the thinking period, that they could experience it again if they wanted to, but that “Whether you do so is completely up to you--it is your choice.” Participants were quizzed with two questions to make sure they understood the instructions and asked to call for the experimenter, who came in and answered any questions. Participants then were left alone for 15 minutes. During this time the computer in the next room recorded how many times (if any) they opted to shock themselves. Following the thinking periods participants answered questions on the computer, similar to our previous studies, about how much they enjoyed the thinking period, etc.

Results. It is important to remove from consideration participants who did not find the shocks to be unpleasant. In the main text we thus reported the results for the 42 participants (out of 55) who reported in Part 1 of the study that they would pay not to receive the shock again. The results are similar if we include all 55 participants: 71% of the men and 26% of the women gave themselves at least one shock during the thinking period. When we use a stricter criterion, including only those who were willing to pay to avoid the shocks again and who rated the

pleasantness of the test shock below the midpoint of the scale (resulting in an n of 27), 64% of the men and 15% of the women gave themselves at least one shock during the thinking period.

We analyzed participants' reported enjoyment of the thinking period with a 2 (male vs. female) x 2 (did not shock themselves, did shock themselves) analysis of variance (ANOVA). There was a significant main effect of gender, $F(1, 38) = 11.59, p = .002$, reflecting the fact that men reported higher enjoyment than women, $M_s = 5.35$ vs. 3.89 ($SD_s = 1.67, 1.48$). Participants who shocked themselves reported less enjoyment than those who did not, $M_s = 4.46$ vs. 4.56 ($SD_s = 1.63, 1.80$), but this difference was not significant, $F(1, 38) = 2.55, p = .118$. The interaction was not significant, $F(1, 38) = < 1, ns$. It should be noted that this is the only study in which we found a gender difference in reported enjoyment of the thinking period.

Analysis across Studies: Individual Differences in Enjoyment of Just Thinking

We assessed the relationship of several individual difference measures to reported enjoyment of the thinking period. Some of these measures were assessed in an on-line pretesting session conducted by the Department of Psychology prior to participation in our study; some were completed in initial sessions prior to our study; and others were completed at the end of our studies. The correlations between these measures and enjoyment of the thinking period are reported in Table S3, along with the results of two regression models that entered different measures simultaneously.

Test of Person-Situation Fit Hypotheses (Studies 1-7)

We collapsed across all studies that randomly assigned participants to the standard or prompted fantasy instructions (Studies 1-7) and conducted regression analyses to see whether individual difference variables moderated the effects of the instructional manipulations. Three of the Big 5 personality traits, conscientiousness, emotional stability, and conscientiousness, were

significant or nearly-significant moderators: Condition x Agreeableness $t(365) = -3.48, p = .001$; Condition x Emotional Stability $t(365) = -2.62, p = .009$, and Condition x Conscientiousness $t(364) = -1.909, p = .057$. When we entered agreeableness, emotional stability, conscientiousness, and all interactions into a regression, the only significant effects were a main effect of Agreeableness, $t(351) = 2.43, p = .02$, and the Condition x Agreeableness interaction, $t(351) = -2.68, p = .008$. In the standard control condition, participants who were high in agreeableness enjoyed themselves more than did participants who were low in agreeableness (see Figure S1). Perhaps agreeable participants were more willing to go along with the instructions to entertain themselves with their thoughts than were disagreeable participants. When given more specific instructions and time to prepare (in the prompted fantasy condition), disagreeable participants enjoyed themselves as much as agreeable participants. Put differently, when situational demands were low, individual differences in agreeableness predicted enjoyment, but in a more structured situation, they did not.

Study 11: Forecasters

We investigated whether people are aware of the conditions under which they enjoy thinking the most. Participants read a description of either the standard instruction or prompted fantasy condition of Study 6 and then predicted how much they would enjoy the thinking period.

Participants. Participants were 66 undergraduate students (49 female, 17 male) who participated in return for a \$5 gift certificate to Amazon.com. An additional 25 participants (21 female, 4 male) participated but indicated that they had taken part in one of our earlier studies and were thus not included in the analyses.

Procedure. We emailed an invitation to students who had indicated a willingness to participate in psychology studies. Those who chose to participate clicked on a link that took them

to a Qualtrics program. These participants were asked to imagine that they had participated in a psychology experiment and to predict how they would respond. They were asked to complete the study only if they had the time to read the materials carefully, and told that there would be questions at the end testing their recall of the material presented. After reading a consent form and agreeing to continue, participants read a detailed description of either the standard instructions condition or prompted fantasy condition of Study 6. They then completed the dependent measures of Study 6 as they thought they would if they had been a participant in the study. After that participants completed the brief Big 5 personality measure (the same ones completed by participants in Study 6) and five questions testing their recall of the details of the study they read about.

Results. We conducted the same regression analyses used to test the person-situation fit hypothesis in the main text (see Figure S1). Specifically, participants' predicted enjoyment of the thinking period was regressed on the condition they read about (standard instructions, prompted fantasy), the standardized agreeableness or conscientiousness scores, and the interaction between condition and standardized agreeableness or conscientiousness. There were no significant effects in the regression assessing agreeableness, $t_s(62) = -1.39, p = .17$. This could be a power issue, of course, given that we had substantially fewer participants in the forecaster study than we did in the studies shown in Figure S1. However, the pattern of the interaction among forecasters did not match the pattern shown in Figure S1. Instead, participants low in agreeableness predicted that they would enjoy the prompted fantasy condition more than did participants high in agreeableness, whereas they made very similar predictions about how much they would enjoy the standard control condition.

Analysis Across Studies: What Topics Are Enjoyable To Think About?

It is not enough to have the cognitive resources to engage in directed thinking and to know the conditions that best match one's personality—one has to know what to think about. To see what kinds of thoughts predicted enjoyment, we analyzed participants' written descriptions of their thoughts with the Linguistic Inquiry and Word Count (LIWC) program (18). The thought categories that best predicted enjoyment of the thinking period are displayed in Table S4. Not surprisingly, there was a tendency for the use of negative emotions words to predict less enjoyment. Writing about work (probably schoolwork, in our student population) also correlated negatively with enjoyment. Of greater interest, the more social and inclusion words people used the more enjoyment they reported. This variable is the sum of social words (a large category that includes all non-first-person-singular personal pronouns, verbs that express human interaction, such as "talk," and nouns referring to close others, such as "friend" and "family") and inclusive words (such as "with," "close," and "around"). Also, the more people wrote about the future relative to the present, the greater their enjoyment. Together, these analyses suggest that people enjoyed thinking about future activities with close others. It is well-known that the frequency and quality of contact with other people is a major predictor of happiness (31). Our results suggest that when people are by themselves with no external distractions, they enjoy creating virtual social contact in their heads (32).

Analysis across Studies: Scanner Hypothesis

In addition to the experimental conditions reported in the main text, we have investigated whether participants would enjoy the thinking period more if they were given a minimally engaging task to do at the same time. Our reasoning was that when people have nothing to do, the mind might search the environment for something worthy of attention--but because it can't find anything to "lock onto," it keeps searching, using up resources that could be devoted to

thinking. Paradoxically, it might be easier to sustain an internal line of thought in the presence of minimal external stimulation than no stimulation, because in that case the scanner stops searching for something to lock onto (26). This would explain why our participants find it difficult to entertain themselves with their thoughts in a barren environment, and yet people often report that they daydream when minimally engaged in a task, such as driving a car or listening to music.

We tested the scanner hypothesis in Study 4 by randomly assigning half of the participants to a “fidget” condition, in which they were given a rubber band and asked to “manipulate it or play with it in any way you would like” during the thinking period. We hypothesized that having an object to fidget with would occupy the scanner enough to make it easier to generate pleasant thoughts. Contrary to this hypothesis, however, there was no significant effect of the fidget manipulation on reported enjoyment of the thinking period, $F(1, 72) < 1$, *ns*. (The data reported in Table S1 for Study 4 are for the no fidget condition only.) We tried a different approach in Studies 7 and 9: Some participants were randomly assigned to the standard condition in which they were asked to entertain themselves with their thoughts in the absence of any external distractions, whereas others were assigned to do the same thing, but also to engage in a minimal monitoring task during the thinking period, as described earlier in the methods sections of the supplementary materials. As it happened, the results were in different directions in these two studies. In Study 7, participants in the monitoring condition reported that it was not as difficult to concentrate on their thoughts (5.13 vs. 6.09, *SDs* = 1.96, 1.72), $t(73) = 2.25$, $p = .03$. They also reported higher enjoyment of the thinking period (*Ms* = 4.94 vs. 4.35, *SDs* = 1.94, 1.95), though this difference was not significant, $t(73) = 1.29$, $p = .20$. In Study 9 (the community sample), however, participants in the monitoring condition reported that it was

slightly harder to concentrate on their thoughts ($M_s = 4.88$ vs. 4.21 , $SD_s = 2.70, 2.33$) and reported less enjoyment of the thinking period than did people in the no monitoring condition ($M_s = 5.09$ vs. 5.81 , $SD_s = 1.57, 1.84$). Neither difference was significant, $t(59) = 1.64$, $p = .11$ and $t(59) = 1.02$, $p = .31$. Thus, to date the idea that people will enjoy thinking more when they are engaged in a minimally engaging task has not received much support.

Table S1: Reported Enjoyment in Standard and Prompted Fantasy Conditions

Study	Min [‡]	N	Standard Condition: M (SD)	Prompted Fantasy Conditions						F	p
				Version 1 ^a M (SD)	Version 2 ^b M (SD)	Version 3 ^c M (SD)	Version 4 ^d M (SD)	Version 5 ^e M (SD)	Version 6 ^f M (SD)		
Study 1*	15	68	4.471 (1.568)	5.333 (1.686)	4.083 (2.119)	5.356 (1.237)				2.391	.08
Study 2*	15	53	4.412 (1.934)	4.510 (1.796)			4.67 (1.18)	4.704 (1.637)		.06	<i>ns</i>
Study 3 [#]	12	84	4.494 (1.562)				4.161 (1.57)	4.857 (1.649)		1.359	.26
Study 4 [#]	12	39	5.267 (1.583)				5.947 (1.758)			1.618	.21
Study 5 [#]	12	63	5.490 (1.745)						5.129 (1.740)	.674	<i>ns</i>
Study 6 [#]	6	65	5.879 (1.756)						5.677 (1.894)	.198	<i>ns</i>
Study 7 ^{#†}	12	79	4.349 (1.946)						4.991 (1.897)	2.206	.14

[‡]Length of the Thinking Period (minutes)

^aVersion 1: Participants picked a topic from a menu of three (going on a hike in a beautiful location, ordering and eating dinner at a fine restaurant, or playing a sport) and were asked to imagine doing it in the future. They wrote a few sentences planning their fantasy and then completed a timeline in which they indicated what they would be fantasizing about each minute of the thinking period. They were also asked to look at clock occasionally during the thinking period to help them imagine the activity in real time.

^bVersion 2: Same as Version 1, except participants were told that if their mind wandered, to return to the point in their fantasy where they left off.

^cVersion 3: Same as Version 1, except participants were told that if their mind wandered, to skip ahead in their fantasy to the proper point on the timeline.

^dVersion 4: Same as Version 1, except participants did not complete a timeline

^eVersion 5: Same as Version 1, except that participants described two “equally pleasant but different” endings to their fantasy and were asked not to choose which one to imagine until they were well into the thinking period.

^fVersion 6: Same as Version 1, except participants were not given a menu to choose from but asked to choose three activities they would enjoy thinking about. For each one they wrote about what they would be doing, where they would be, and who (if anyone) they would be with, and then were asked to spend the thinking period thinking about one or more of their activities, or something different, as long as the topic was pleasant and entertaining.

*Participants in Standard Conditions were told to “think about whatever you want.” All participants were told that Thinking Period would last 15 minutes and there was a clock in the room.

#Participants in Standard Conditions were told to “spend the time entertaining yourselves with your thoughts.” Participants given a range of time for the thinking period (e.g., “10-15 minutes”) with no clock in room.

[†]Study completed in participants’ home.

Table S2. Predictors of Enjoyment in Study 9 (Community Sample)

Predictor Variable	No Task Condition (<i>N</i> = 27 to 28)					Minimal Monitoring Condition (<i>N</i> s = 31 to 33)				
	<i>r</i>	Model 1		Model 2		<i>r</i>	Model 1		Model 2	
		<i>B</i>	<i>SE</i>	<i>B</i>	<i>SE</i>		<i>B</i>	<i>SE</i>	<i>B</i>	<i>SE</i>
Age	-.01	.01	.03	.02	.02	.01	.02	.02	.02	.02
Education	.15	-.06	.41	-.40	.37	-.07	-.12	.26	-.24	.30
Income (log)	-.20	-.22	.61	-.39	.55	-.38*	-1.15*	.47	-.76	.46
Smart Phone Use	-.24	-.05	.03	.00	.03	-.07	.04	.03	.01	.03
Social Media Use	.12	.16	.10	.04	.10	-.06	-.06	.07	-.02	.07
Meditation Experience	.32 [†]					.24				
Engaged in Meditation	.13			-.13	.21	.40*			.22 [†]	.11
Agreeableness	-.06					.40*				
Conscientiousness	.18					-.30 [†]				
Openness to Experience	.45*			.30	.32	.40*			.33	.28
Need for Cognition	.58***			1.49*	.63	.25			.84	.59
<i>R</i> ²		.18		.49 [†]			.20		.47*	
Adjusted <i>R</i> ²		-.01		.26			.04		.28	

[†]*p* < .10 **p* < .05 ***p* < .01 ****p* < .005

Table S3: Correlations between Reported Enjoyment of the Thinking Period with Individual Difference Measures

Variable	Standard Conditions				Prompted Fantasy Conditions					
	<i>r</i> with Enjoyment (<i>N</i>)	Regression Model 1 (<i>N</i> = 116)		Regression Model 2 (<i>N</i> = 114)		<i>r</i> with Enjoyment (<i>N</i>)	Regression Model 1 (<i>N</i> = 95)		Regression Model 2 (<i>N</i> = 95)	
		<i>B</i>	<i>SE</i>	<i>B</i>	<i>SE</i>		<i>B</i>	<i>SE</i>	<i>B</i>	<i>SE</i>
SIPI Pos Daydreaming ^a	.180* (123)	.757*	.308	.838**	.306	.428*** (98)	1.491***	.319	1.452***	.340
SIPI Poor Attention ^a	-.307** (123)	-1.124***	.273	-1.013***	.315	-.218 * (98)	-.735*	.294	-.674*	.320
Big 5: Agreeableness ^b	.204*** (205)	.640**	.188	.594**	.205	-.030 (202)	.003	.178	-.025	.230
Big 5: Emotional Stability ^b	.224* (204)			.094	.186	.012 (203)			.295	.189
Big 5: Conscientiousness ^b	.181* (203)			.149	.179	-.003 (203)			-.180	.226
Big 5: Openness ^b	.184* (185)			.195	.165	.097 (184)			.074	.196
Big 5: Extraversion ^b	-.029 (205)			-.367*	.169	.055 (203)			.015	.187
Engaged in Meditation ^c	.161* (190)					.159* (179)				
ERQ: Reappraisal ^d	.264** (114)					.159 (95)				
ERQ: Suppression ^d	.251*** (114)					.023 (96)				
Prevention ^f	.265*** (116)					.122 (92)				
Promotion ^f	.206* (115)					.186 (95)				
COPE: Suppression ^e	.188 (90)					.197 (67)				
COPE: Pos Reinterp ^e	.097 (90)					.223 (67)				
COPE: Mental Diseng ^e	-.044 (90)					-.188 (67)				
Mindfulness ^g	.258* (76)					.020 (67)				
Reflection ^h	.052 (114)					.198 (95)				
Beck Depression Inv ⁱ	-.183* (117)					-.179 (97)				
Working Mem Storage ^j	.062 (109)					-.051 (98)				
Working Mem Att ^j	.054 (109)					-.041 (98)				
Working Mem Exec ^j	-.089 (109)					.035 (98)				
Initial Positive Affect ^k	.160* (152)					.187 (99)				

Initial Stress ^k	-.166* (152)					-.070 (99)				
Initial Alertness ^k	.103 (152)					-.086 (99)				
Hrs Sleep Night Bef ^k	-.042 (172)					-.126 (118)				
Meditation Experience ^l	.154* (233)					.143* (260)				
Prayer Experience ^l	.122 (191)					.016 (180)				
Engaged in Prayer ^c	.002 (190)					.093 (179)				
Gender ^m	-.052 (232)					-.032 (259)				

* $p < .05$ ** $p < .01$ *** $p < .005$

Note. The N s vary because not all scales were included in all studies. When we added (individually) each of the scales that were significantly correlated with enjoyment to Model 1, none of the resulting standardized betas for these scales were significant, with the exception of the ERQ: Suppression in the standard condition, $\beta = .178$, $p = .03$.

^aItems from the Positive-Constructive Daydreaming and Poor-Attentional Control Scales of the Short Imaginal Processes Inventory (11)

^bSingle-item measures of the Big-Five personality traits (33)

^cQuestion asking participants extent to which they engaged in meditation or prayer during the thinking period

^dSubscales of the Emotion Regulation Questionnaire (ERQ), assessing the extent to which people regulate their emotions with cognitive reappraisal and expressive suppression (34)

^eItems from the Suppression of Competing Activities, Positive Reinterpretation and Growth, and Mental Disengagement subscales of the COPE inventory (35)

^fPromotion and prevention subscales of the Regulatory Focus Questionnaire (36)

^gItems from the Mindfulness Attention Awareness Scale (37)

^hReflection subscale of the Rumination-Reflection Questionnaire (38)

ⁱFour items from the Beck Depression Inventory (39)

^jItems from the three subscales of the Working Memory Questionnaire that assess short-term storage, attention, and executive control (40)

^kParticipants' ratings of positive affect, stress, alertness, and amount of sleep the night before, reported right before the Thinking Period

^lReported experience with the practice of meditation or prayer

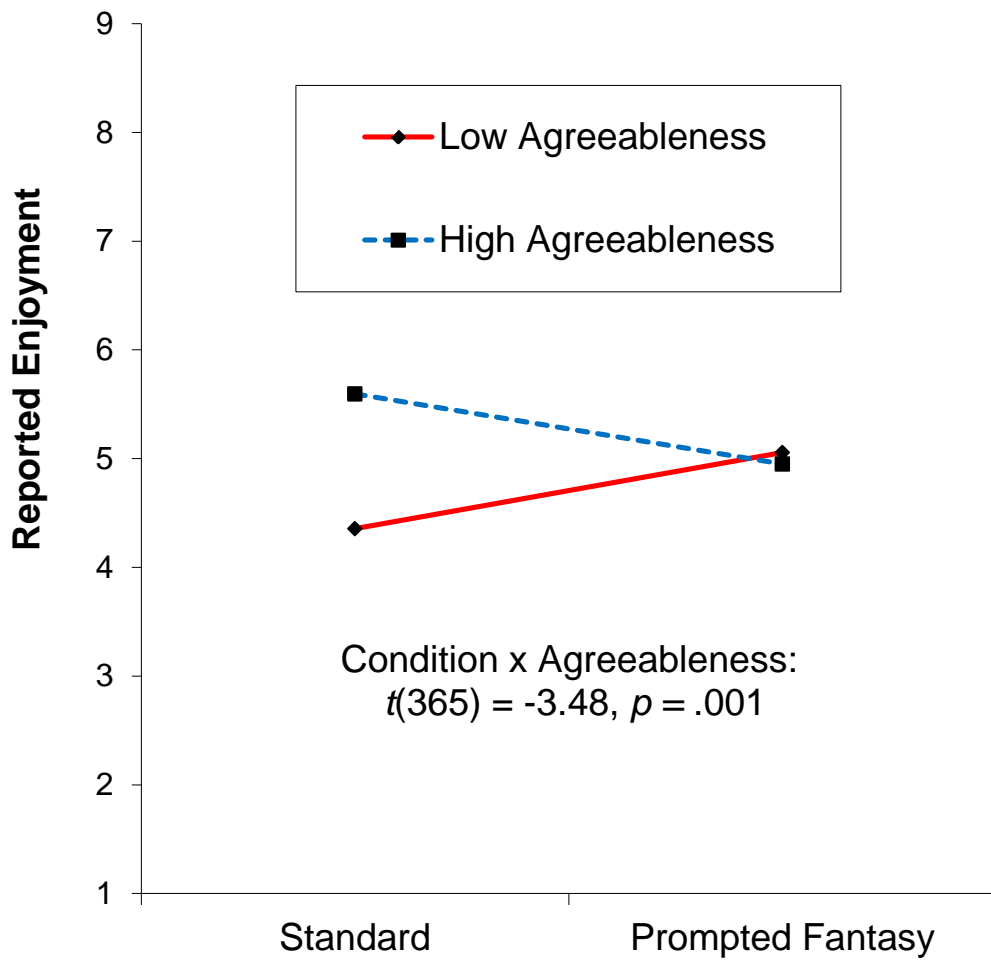
^m1 = male, 2 = female

Table S4. Predictors of Enjoyment of Thinking Period

Predictor Variable	Standard Conditions (<i>N</i> = 218, <i>adj R</i> ² = .169)		Prompted Fantasy Conditions (<i>N</i> = 262, <i>adj R</i> ² = .093)		Combined (<i>N</i> = 480, <i>adj R</i> ² = .123)	
	<i>B</i>	<i>SE</i>	<i>B</i>	<i>SE</i>	<i>B</i>	<i>SE</i>
Negative Emotions	-.116	.083	-.082	.096	-.114 [†]	.063
Work-Related Words	-.056*	.023	-.112***	.036	-.068***	.019
Social & Inclusion Words	.029	.018	.032*	.016	.031*	.012
Future minus Present	.066*	.031	.082***	.028	.067***	.020
Number of Words	.008***	.002	.003*	.002	.006***	.001

[†]*p* < .10 **p* < .05 ***p* < .01 ****p* < .005

Fig. S1. The interaction between dispositional agreeableness and fantasy instructions. These data are averaged over all studies that randomly assigned people to the standard thinking or prompted fantasy instructions (Studies 1-7).



References

1. M. E. Raichle, A. M. MacLeod, A. Z. Snyder, W. J. Powers, D. A. Gusnard, G. L. Shulman, A default mode of brain function. *Proc. Natl. Acad. Sci. U.S.A.* **98**, 676–682 (2001). [Medline doi:10.1073/pnas.98.2.676](#)
2. R. L. Buckner, J. R. Andrews-Hanna, D. L. Schacter, The brain's default network: Anatomy, function, and relevance to disease. *Ann. N. Y. Acad. Sci.* **1124**, 1–38 (2008). [Medline doi:10.1196/annals.1440.011](#)
3. J. R. Andrews-Hanna, The brain's default network and its adaptive role in internal mentation. *Neuroscientist* **18**, 251–270 (2012). [Medline doi:10.1177/1073858411403316](#)
4. M. H. Immordino-Yang, J. A. Christodoulou, V. Singh, Rest is not idleness: Implications of the brain's default mode for human development and education. *Perspect. Psychol. Sci.* **7**, 352–364 (2012). [doi:10.1177/1745691612447308](#)
5. M. F. Mason, M. I. Norton, J. D. Van Horn, D. M. Wegner, S. T. Grafton, C. N. Macrae, Wandering minds: The default network and stimulus-independent thought. *Science* **315**, 393–395 (2007). [Medline doi:10.1126/science.1131295](#)
6. American Time Use Survey, Bureau of Labor Statistics, U.S. Department of Labor: www.bls.gov/tus/home.htm#data (2012).
7. R. L. McMillan, S. B. Kaufman, J. L. Singer, Ode to positive constructive daydreaming. *Front. Psychol.* **4**, 626 (2013). [Medline doi:10.3389/fpsyg.2013.00626](#)
8. J. Smallwood, J. W. Schooler, The restless mind. *Psychol. Bull.* **132**, 946–958 (2006). [Medline doi:10.1037/0033-2909.132.6.946](#)
9. M. A. Killingsworth, D. T. Gilbert, A wandering mind is an unhappy mind. *Science* **330**, 932 (2010). [Medline doi:10.1126/science.1192439](#)
10. M. S. Franklin, M. D. Mrazek, C. L. Anderson, J. Smallwood, A. Kingstone, J. W. Schooler, The silver lining of a mind in the clouds: Interesting musings are associated with positive mood while mind-wandering. *Front. Psychol.* **4**, 583 (2013). [Medline doi:10.3389/fpsyg.2013.00583](#)
11. G. J. Huba, J. L. Singer, C. S. Aneshensel, J. S. Antrobus, *Short Imaginal Processes Inventory: Manual* (Research Psychologists Press, Port Huron, MI, 1982).
12. J. W. Roberti, A review of behavioral and biological correlates of sensation seeking. *J. Res. Pers.* **38**, 256–279 (2004). [doi:10.1016/S0092-6566\(03\)00067-9](#)
13. S. Duval, R. A. Wicklund, *A Theory of Objective Self-Awareness* (Academic Press, San Diego, CA, 1972).
14. R. F. Baumeister, *Escaping the Self* (BasicBooks, New York, 1991).
15. M. Leary, *The Curse of the Self* (Oxford Univ. Press, New York, 2004).
16. S. Nolen-Hoeksema, B. E. Wisco, S. Lyubomirsky, Rethinking rumination. *Perspect. Psychol. Sci.* **3**, 400–424 (2008). [doi:10.1111/j.1745-6924.2008.00088.x](#)
17. N. Mor, J. Winquist, Self-focused attention and negative affect: A meta-analysis. *Psychol. Bull.* **128**, 638–662 (2002). [Medline doi:10.1037/0033-2909.128.4.638](#)

18. J. W. Pennebaker, R. J. Booth, M. E. Francis, *LIWC2007: Linguistic Inquiry and Word Count* (LIWC.net, Austin, TX, 2007).
19. J. L. Singer, *Daydreaming: An Introduction to the Experimental Study of Inner Experience* (Random House, New York, 1966).
20. J. L. Singer, Navigating the stream of consciousness: Research in day dreaming and related inner experience. *Am. Psychol.* **30**, 727–738 (1975). [doi:10.1037/h0076928](https://doi.org/10.1037/h0076928)
21. E. Klinger, *Daydreaming* (Tarcher, Los Angeles, CA, 1990).
22. D. M. Wegner, Ironic processes of mental control. *Psychol. Rev.* **101**, 34–52 (1994). [Medline doi:10.1037/0033-295X.101.1.34](https://pubmed.ncbi.nlm.nih.gov/1011134/)
23. P. Grossman, L. Niemann, S. Schmidt, H. Walach, Mindfulness-based stress reduction and health benefits. A meta-analysis. *J. Psychosom. Res.* **57**, 35–43 (2004). [Medline doi:10.1016/S0022-3999\(03\)00573-7](https://pubmed.ncbi.nlm.nih.gov/1505737/)
24. S. G. Hofmann, P. Grossman, D. E. Hinton, Loving-kindness and compassion meditation: Potential for psychological interventions. *Clin. Psychol. Rev.* **31**, 1126–1132 (2011). [Medline doi:10.1016/j.cpr.2011.07.003](https://pubmed.ncbi.nlm.nih.gov/21107003/)
25. A. G. Harvey, S. Payne, The management of unwanted pre-sleep thoughts in insomnia: Distraction with imagery versus general distraction. *Behav. Res. Ther.* **40**, 267–277 (2002). [Medline doi:10.1016/S0005-7967\(01\)00012-2](https://pubmed.ncbi.nlm.nih.gov/12000122/)
26. B. Baird, J. Smallwood, M. D. Mrazek, J. W. Kam, M. S. Franklin, J. W. Schooler, Inspired by distraction: Mind wandering facilitates creative incubation. *Psychol. Sci.* **23**, 1117–1122 (2012). [Medline doi:10.1177/0956797612446024](https://pubmed.ncbi.nlm.nih.gov/22446024/)
27. J. W. Schooler, M. D. Mrazek, M. S. Franklin, B. Baird, B. W. Mooneyham, C. Zedelius, J. M. Broadway, The middle way: Finding the balance between mindfulness and mind-wandering. *Psychol. Learn. Motiv.* **60**, 1–33 (2014). [doi:10.1016/B978-0-12-800090-8.00001-9](https://doi.org/10.1016/B978-0-12-800090-8.00001-9)
28. D. Watson, L. A. Clark, A. Tellegen, Development and validation of brief measures of positive and negative affect: The PANAS scales. *J. Pers. Soc. Psychol.* **54**, 1063–1070 (1988). [Medline doi:10.1037/0022-3514.54.6.1063](https://pubmed.ncbi.nlm.nih.gov/10631063/)
29. R. B. Fillingim, Sex, gender, and pain: Women and men really are different. *Curr. Rev. Pain* **4**, 24–30 (2000). [Medline doi:10.1007/s11916-000-0006-6](https://pubmed.ncbi.nlm.nih.gov/1191600066/)
30. J. T. Cacioppo, R. E. Petty, The need for cognition. *J. Pers. Soc. Psychol.* **42**, 116–131 (1982). [doi:10.1037/0022-3514.42.1.116](https://doi.org/10.1037/0022-3514.42.1.116)
31. E. Diener, R. Biswas-Diener, *Happiness: Unlocking The Mysteries of Psychological Wealth* (Blackwell, Malden, MA, 2008).
32. R. A. Mar, M. F. Mason, A. Litvack, How daydreaming relates to life satisfaction, loneliness, and social support: The importance of gender and daydream content. *Conscious Cogn.* **21**, 401–407 (2012). [Medline doi:10.1016/j.concog.2011.08.001](https://pubmed.ncbi.nlm.nih.gov/21108001/)
33. S. D. Gosling, P. J. Rentfrow, W. B. Swann Jr., A very brief measure of the Big-Five personality domains. *J. Res. Pers.* **37**, 504–528 (2003). [doi:10.1016/S0092-6566\(03\)00046-1](https://doi.org/10.1016/S0092-6566(03)00046-1)

34. J. J. Gross, O. P. John, Individual differences in two emotion regulation processes: Implications for affect, relationships, and well-being. *J. Pers. Soc. Psychol.* **85**, 348–362 (2003). [Medline doi:10.1037/0022-3514.85.2.348](#)
35. C. S. Carver, M. F. Scheier, J. K. Weintraub, Assessing coping strategies: A theoretically based approach. *J. Pers. Soc. Psychol.* **56**, 267–283 (1989). [Medline doi:10.1037/0022-3514.56.2.267](#)
36. E. T. Higgins, R. S. Friedman, R. E. Harlow, L. C. Idson, O. N. Ayduk, A. Taylor, Achievement orientations from subjective histories of success: Promotion pride versus prevention pride. *Eur. J. Soc. Psychol.* **31**, 3–23 (2001). [doi:10.1002/ejsp.27](#)
37. K. W. Brown, R. M. Ryan, The benefits of being present: Mindfulness and its role in psychological well-being. *J. Pers. Soc. Psychol.* **84**, 822–848 (2003). [Medline doi:10.1037/0022-3514.84.4.822](#)
38. P. D. Trapnell, J. D. Campbell, Private self-consciousness and the five-factor model of personality: Distinguishing rumination from reflection. *J. Pers. Soc. Psychol.* **76**, 284–304 (1999). [Medline doi:10.1037/0022-3514.76.2.284](#)
39. A. T. Beck, C. H. Ward, M. Mendelson, J. Mock, J. Erbaugh, An inventory for measuring depression. *Arch. Gen. Psychiatry* **4**, 561–571 (1961). [Medline doi:10.1001/archpsyc.1961.01710120031004](#)
40. C. Vallat-Azouvi, P. Pradat-Diehl, P. Azouvi, The Working Memory Questionnaire: A scale to assess everyday life problems related to deficits of working memory in brain injured patients. *Neuropsychol. Rehabil.* **22**, 634–649 (2012). [Medline doi:10.1080/09602011.2012.681110](#)