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.

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SUPPLEMENTARY MATERIALS

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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.

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SUPPLEMENTARY MATERIALS

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

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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 intensification 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 reanalysis 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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