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DOES MOOD CHANGE HOW WE ORGANIZE DIGITAL FILES?

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Abstract

Does Mood Change How We Organize Digital Files?

by

Charlotte Massey

Retrieving files from one's computer is done daily and is an essential part of completing most tasks at work, yet surprisingly little research has examined the ways that people structure and organize their files. Management of personal digital information is a challenging task that users approach idiosyncratically. Large individual differences have been observed in the types of hierarchies people generate to organize their digital files, and our understanding of these differences is still extremely limited. This thesis presents two studies testing whether some of these organizational differences can be attributed to changes in mood. Positive moods are associated with flexible and creative thinking styles, and negative mood with systematic and analytical processing. Throughout the day most individuals will experience a variety of emotions and fluctuations in mood. We predicted that these mood differences will modify how people organize their personal digital information. We explored this relationship between information management and mood by asking participants to complete an in-lab digital filing simulation after experiencing an emotionally charged stimulus. As predicted, sad participants made significantly more folders than happy participants, and there is a trending relationship between sad mood and deeper folder depth. However, we found no evidence to suggest that retrieval success was affected by either the mood induced during the initial file organization,

the mood induced in the file retrieval task, or the relationship between organization and retrieval moods. In a follow up study, we explored the relationship between trait emotional tendencies and real world PIM strategies. We found no evidence that participants' trait emotional tendencies were related to their average number folders or folder depth in their personal computer.

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Does Mood Change How We Organize Digital Files

As our personal and work lives become increasingly digital, managing increasing amounts of digital information is a task that we all have to face. One of the most straightforward examples of this is organizing the digital files that one has accumulated on a personal computer in order to retrieve them later. Previous work has demonstrated that there is a huge amount of variability in how people manage their digital files (Boardman & Sasse, 2004; Bergman, Beyth-Marom, Nachmias, Gradovitch, & Whittaker, 2008; Gwizdka, 2004; Jones & Teevan, 2007; Malone, 1983). These differences cannot be explained as resulting from the differences in tasks, content, or even job type (Boardman & Sasse, 2004; Bergman, et al., 2008; Jones & Teevan, 2007; Malone, 1983). Our previous work has explored how differences in personality traits might explain some of these differences (Massey, Tenbrook, Tatum, & Whittaker, 2014), but we found that personality only accounts for a part of that residual variability.

This thesis explores another potential source of variability: changes in mood. Varying moods may lead people to organize information differently. Emotion serves as a powerful indicator of how we should behave in our environment, with positive and negative emotions providing different behavioral signals. The experience of positive emotions can indicate that our current behavioral strategies are working well and should be reinforced, whereas negative emotions can tell us that we need to make strategic adjustments to behavior to improve our current state (Forgas, 1995; Fredrickson & Branigan, 2005; Kensinger, Garoff-Eaton, & Schacter, 2007; Lazarus,

1991). In exploring the cognitive and behavioral outcomes of mood, researchers have found that positive moods lead to more creative and flexible processing styles (Isen & Daubman, 1984; Isen, Daubman, & Nowicki, 1987; Isen & Means, 1983) whereas negative mood tends to cause people to use more detail-oriented, systematic, and analytical processing styles (Basso, Schefft, Ris, & Dember, 1996; Fredrickson & Branigan, 2005; Gasper, 2004; Gasber & Clore, 2002; Schwarz, 1990; Worth & Mackie, 1987). Mood effects could have important implications for digital file management because we manage files regularly enough that we are likely to do so in a wide variety of moods.

In this thesis, I present research that tests the general hypothesis that mood affects digital filing and retrieval behaviors. We conducted a lab study to evaluate the effects that positive and negative moods have on digital information management behaviors. This study tested the organizing strategies participants use for an in-lab filing task when they are put into a positive or negative mood using a mood induction procedure. We then tested whether these differences in organizational strategies have measurable outcomes on participants' ability to re-find these files. In a second study we explore similar hypothesis by examining the effects of emotional traits on real-world digital organization.

Literature Review

Personal Information Management

Throughout our lifetime we all accumulate a massive amount of external information items, like documents, messages, pictures, contact information, etc. More

and more these items are in a digital form and take up space on cloud servers and personal computing devices (e.g., mobile phones, wearable devices, tablets, personal computers). In order to make the most of our external information and function in an increasingly digital world, we are continually required to keep track of what we have, where it's located and how we can re-access it. Personal information management, or PIM, is a field that tries to understand how people manage these information items – paper and digital.

PIM is still a relatively young field and with such a large variety of information items, studies have often focused either paper or digital items. Furthermore, studies looking at digital items are often restricted to specific digital domains (e.g., email, bookmarks, digital files, shared files, etc.) as behaviors in each of these domains can vary for many reasons (Jones, 2010). For example, people's PIM behaviors with email are very different from photos or web pages (Whittaker, 2011).

One behavior that is fundamental to managing information items across many domains, is the act of categorizing. For example, creating folders, naming schemes, generating tags, and even deciding where to physically put things serve as ways to group information together. Grouping things is an important way of managing and making sense of one's information items and it is at the heart of PIM research. Early work looking into paper files (Malone, 1983) explored two types of categorizing strategies in office workers that he labeled filing and piling. Filers generate complex folder hierarchies for incoming files based around complex semantic distinctions,

whereas pilers make less strict folder categories that are often time- or association-based. Pilers also often rely on physical organization by leaving piles of related paper documents on their desktops. Although piling seems less systematic Malone found surprising benefits to piling as a strategy. Pilers benefit from avoiding the cognitively difficult task of categorizing their papers into folders, their items were more accessible, and by leaving piles visible served to remind about pending tasks. Further support for piling as a viable strategy comes from a later study that explored office workers paper files, finding that individuals who employed piling strategies ended up with smaller archives, and accessed their saved information more often (Whittaker & Hirschberg, 2001). One reason for this is 'premature filing' in which filers organize information of dubious value, which they never later access. Because pilers repeatedly revisit a small number of piles, they are more likely to discover and remove such low value information.

Work on digital information management has explored key PIM strategies. In particular, users have to make three high level decisions about information they encounter or generate (Jones & Teevan, 2007; Whittaker, 2011). The first decision centers around *information acquisition*; a user has to decide whether they should keep an item or discard it. For example, users have to make the decision whether to bookmark an interesting webpage, or to retain an unread but potentially valuable email. These keeping decisions can be complex. On the one hand, as storage becomes increasingly inexpensive and technologies for capturing information become ubiquitous, one assumption is that we should 'keep everything' in the hopes of

creating richer sets of personal data that can help us to remember more and learn about ourselves (Bell & Gemmell, 2009). However, keeping low-utility items causes issues, as a larger archive consumes attention and increases the chances of being unable to re-find important information (Whittaker and Sidner, 1996, Jones, 2007, Whittaker, 2011, Bergman, Tucker, Beyth-Marom, Cutrell, & Whittaker, 2009).

Another important decision users make is about how to *organize* items once they have committed to keeping them. At the most basic level, users have to decide whether to actively organize a digital information item or leave it in a pile (as we saw with filers and pilers). Research has shown some benefits for the piling strategy when looking at user's email habits (Whittaker & Sidner, 1996), but there is a compelling argument that digital files on a hard drive don't support the same affordances as piling paper. In particular researchers point out that personal computers require that users categorize digital files immediately in order to save them, and even if users employ a piling strategy, file icons may not be as visually distinguishable as paper files (Bondarenko & Janssen, 2005).

However the key reason to organize information is to support its later retrieval. Researchers have therefore looked at the impact on retrieval success and efficiency for different styles of file organization (Bergman, Whittaker, Sanderson, Nachmias, & Ramamoorthy, 2010). In making decisions about how to organize files there are complex trade-offs. Having fewer items in a folder makes individual items within that folder more accessible. However having smaller folders necessarily implies increasingly deep and complex folder hierarchies. Having to traverse large

and complex structures increases retrieval times and increases the chance of failing to find the target item. Bergman et al (2010), asked users to retrieve files from their hierarchies, and observed the effects of folder structure on retrieval speed and success. They found that to optimize success and efficiency, users should keep no more than 21 items in a given folder. Once a folder contains more than 21 items, the time that one spends scanning through the items becomes greater than the additional time it takes to click through another folder layer. So while there are benefits to imposing organization on digital files, creating overly complex folder hierarchies can have important disadvantages.

The third decision users have to make is how to re-find their digital files. Users can either opt to navigate their digital archive physically, or they can generate a search query. Some researchers have claimed that the availability of search makes complex organization unnecessary, and that as search technologies improve we will no longer need to actively manage our archives to refind our files (Cutrell, Dumais, & Teevan, 2006; Dumais, Cutrell, Cadiz, Jancke, Sarin, & Robbins, 2003). However empirical studies of refinding repeatedly demonstrate that there is an enduring preference for navigation over query-based search. Furthermore, search is often seen as a last resort to be used only when other refinding methods have failed (Barreau & Nardi, 1995; Bergman et al., 2008; Fitchett & Cockburn, 2015; Teevan, Alvarado, Ackerman, & Karger, 2004).

There are also some surprising benefits to navigating when retrieving information. These include reduced cognitive effort, an increased sense of control,

and the potential to be reminded of other pending tasks (Barreau & Nardi, 1995; Bergman, Tene-Rubinstein, Shalom, 2013; Teevan, et al., 2004). Recent work investigating neural correlates suggests that navigation may be preferred and more intuitive because query-driven search relies on neural structures related to linguistic processing whereas navigation relies on structures for real world navigation. This makes navigation a cognitively less demanding retrieval strategy because it relies on more automatic proceduralized forms of memory (Benn, Bergman, Glazer, Arent, Wilkinson, Varley, & Whittaker, 2015).

PIM and individual differences. While studying PIM, researchers often describe behaviors across samples in terms of averages and common strategies. For example many studies present statistics like the average number of files per folder in a given hierarchy, or the average folder depth (Bergman, et al., 2010; Gonçalves & Jorge, 2003). But it has been continually pointed out that PIM behaviors are highly idiosyncratic, so quantifying a single user or a sample of users in terms of such central tendencies can oversimplify complex behaviors. PIM is a task that is undertaken by people multiple times per day, in many different personal contexts, as users access emails, process social media and work on documents. It is therefore likely that PIM is influenced by many of the same things that affect people in their day to day lives. In this thesis, we argue that transitory states like mood may affect PIM behaviors, in contrast to previous work that has explored the relationship between PIM and more stable individual traits. For example, Gwidzka (2004) found that differences in fundamental cognitive abilities reliably predicted whether his

participants used one of two general email strategies. And several studies have noted that beyond differences one would expect from job type, information type, and retrieval context, some of the idiosyncrasies seen in PIM behaviors appear to be personal or personality based preferences (Boardman & Sasse, 2004; Bergman et al., 2008; Malone 1983; Whittaker & Sidner, 1996, Whittaker & Hirschberg, 2001). Extending this, our recent work looked at the relationship between organizational strategies and Big Five personality traits, and we found a modest relationship between strategy and individuals levels of conscientiousness and neuroticism (Massey, et al., 2014).

Like personality, emotions are a central aspect of human psychology that is often overlooked in technological approaches. I'll now review both computational approaches to emotion, and then theories about the relationship between emotions and cognition.

Affective computing

Affective computing explores the relationship between user emotions and interactions with technology. Researchers in this field aim to develop systems capable of recognizing user's affective states (Picard, 1995). For example, many systems use computational vision processing methods to identify different emotions (Picard, 2011), with so far mixed results. Other work has developed text processing methods to identify emotions in online text (Barbosa & Feng, 2010; Pang, Lee, & Vaithyanathan, 2002; Thelwall, Buckley, Paltoglou, Cai, & Kappas, 2010). Another area of research focuses on developing empathic and expressive computational agents

that are intended to interact with humans. Such agents have been shown to reduce frustration and increase likeability and trustworthiness compared with more traditional computer interfaces (Brave, Nass, Hutchinson, 2005; Hone, 2006; Klein, Moon, & Picard, 2002). More recently, affective computing has also sought to explore the complexity of emotional interaction by acknowledging the situation, cultural context, and social interaction between the user and the system (Boehner, DePaula, Dourish, Sengers, 2007). The goal of this much broader approach is to move beyond the simple documentation of user's affective states to a more interactive and interpretive experience of emotion. Overall this technical work is developing new interaction methods that detect and express emotions, as well as new interactive systems that can communicate about emotional states. In the future, such work may provide interesting insights for how we might develop new technologies should we determine there is an effect of emotion on PIM, but it is otherwise only tangentially related to what we explore here.

There is little previous research examining the interaction between users' mood and PIM. The two main exceptions relate to information seeking and tagging. For example Kuhlthau's (1991) model of the Information Search Process (ISP), describes 6 stages of information search and describes the emotions that are likely to occur at each stage. According to the ISP model feelings during search range from initial anxiety during search initiation, to feelings of optimism, satisfaction, and confidence, or frustration and disappointment based on the outcomes at each stage of one's search. The negative emotions associated with these stages can hinder search

ability (Wang, Hawk, & Tenopir, 2000). One application for this research is that it can be used to design systems that identify the stages of search a user is currently in (Moshfeghi & Jose, 2013). By developing intent aware systems designers can potentially assist users with difficulties they come up against during information seeking, which may help to reduce frustration.

There is also other related work that looks at users' tagging behaviors. For example, users' social bookmarking and tagging are not always informational, rather some relate to their personal emotional connection to the item (Kipp, 2007). For example, the use of the tag "Fun" was often seen despite the fact that this tag does not help to classify the subject of an item. Instead a tag like "Fun" signals one's personal emotional reaction to the content. The fact that users classify according to emotional reactions indicates a need for systems to support this behavior. Similarly designers have suggested that the use of automatic tagging of users' behavior could include analysis of users' affect (e.g., facial expressions) to generate some automated affective tags (Pantic & Vinciarelli, 2009).

Emotion and Cognition

Emotion can have important effects on cognition. Even when studied in a lab environment, cognitive processes like memory, categorization, and processing style can be affected by one's emotional state. Cognitive psychology's acknowledgment of the importance of emotion has increased since the 80's (Norman, 1980), but there are many unanswered questions about when and how emotion affects other kinds of

mental events. But aside from the above studies, there has been little PIM research on the effects of emotion on digital management behaviors.

Emotion and memory. Emotion researchers have explored two types of effects that emotion can have on memory – mood congruency and mood dependency. Mood congruent memory describes the bias to recall events with an emotional valence that is consistent with one's current state. For example, one might be more likely to recall negative events when in a negative mood and vice versa. Isen and colleagues showed that participants had better memory for the positively valenced words in a list when they were in an induced positive mood (Isen, Shalker, Clark, & Karp, 1978). Many studies have found similar effects (Bower, 1981; Forgas, Bower, & Krantz, 1984; Laird, Wagener, Halal, & Szegda, 1982). Bower (1981) for example argues that mood congruent memory has adaptive benefits, for example retrieving events that triggered similar emotions can help individuals respond appropriately to a similar current experience.

Nevertheless, mood congruent memory does not occur in every context. Indeed, sometimes people will strategically recall inconsistent affective information in order to regulate extreme emotion, e.g., recalling a positive experience when feeling lonely or depressed (Wildschut, Sedikides, Arndt, & Routledge, 2006). Erber & Erber (1994) conducted a two study experiment to demonstrate the presence of mood incongruent memory. In their first study they demonstrated that the strength of induced positive and negative moods were attenuated by the recall of an incongruent autobiographical memory. In the second study they induced either positive or

negative moods in students and asked them to recall events either at the beginning or the end of a class. They found that mood congruence occurred for positive participants regardless of when the recall occurred. However, students in the negative mood condition who recalled at the beginning of class recalled mood incongruent memories. They argued that the students were aiming to regulate their bad mood in anticipation of the upcoming challenging task. Such mood regulation could be accomplished by recalling mood incongruent positive information. Similar effects of context were found in the lab when participants were anticipating having to work with a stranger as opposed to alone (Erber, Therriault, & Wegner 1996). Participants in this study were put into a positive or negative mood, and then were asked to select news materials for the task they would be conducting. If they were told they would be completing this task with a stranger they were more likely to select news articles that were incongruent with their current state. This indicates that even when there aren't clear social expectations for how one should behave emotionally (like at a funeral), the mere presence and need to work with others can encourage one to moderate one's feelings to appear more neutral.

Mood congruent memory describes the tendency to recall material that matches current mood. In contrast, mood dependent memory describes the tendency to remember specific materials better when current mood matches one's mood when those materials were first learned. Bower, Monteiro, & Gilligan (1978) asked participants to learn two different word lists while in a happy or sad mood, and found that congruent conditions led to better recall. When there is potential for interference

(i.e., between two word lists) the emotional state serves as a cue for the learned items. However, mood dependent memory has been a tricky effect to replicate with potential difficulties arising from the susceptibility of individuals to an induced mood (Bower & Mayer, 1985; Brown & Taylor, 1986). Despite these issues, a handful of studies have found similar mood dependent memory effects (Leight & Ellis, 1981; Schare, Lisman, & Spear, 1984) and newer studies have documented some possible neural correlates between memories encoded and retrieved while in positive or negative moods (Lewis, Critchley, Smith, & Dolan, 2004). One aim of the present study was to explore such effects for PIM, and see if retrieval of organized files was worse when mood was incongruent with the mood one had during a lab simulated PIM task.

Emotion and categorization. Emotion also appears to affect cognitive tasks like categorization, which is a key element of PIM. In their initial work exploring categorization and mood, Isen et al. (1978) showed that people are more likely to group similarly emotionally valenced items in a word list together when they are in a mood congruent with that valence. So if a participant is put in a positive mood, they are more likely to generate categories based around a positive emotion than a non-emotional category. But more importantly for this thesis, prior work shows that emotions also affect cognitive style, with positive and negative emotions inducing different organizational schemas. For example, participants put into positive moods generated more inclusive categories regardless of the emotional valence of the individual items they were grouping (Isen & Daubman, 1984). So, a participant whose mood was positively induced would be more likely to generate categories that

contained less prototypical exemplars, meaning that participant saw more connections between items than did control participants. The authors provide several interpretations for this finding, including that positive mood may cause participants to view all items more positively, leading them to naturally see groupings they wouldn't otherwise. Another suggested interpretation is that positive mood leads individuals to use more heuristic processing, exploiting associations that come easily to mind or re-using strategies that have worked previously (Isen & Daubman, 1984). In this interpretation, individuals in a positive mood are likely to continue relying on categories that they generated initially as opposed to creating more categories. In other words, positive affect suggests that current categories are effective and there is no need to broaden analytic scope to explore new categories and relationships.

Emotion and processing style. Another well demonstrated relationship between emotion and cognition concerns the relationship between positive and negative emotions and processing style. Research shows that individuals experiencing negative emotions are more likely to engage in analytic processing, whereas individuals experiencing positive emotions are more likely to engage in flexible and creative thinking styles. There are several lines of research that support this claim. For example, many researchers looking at social judgments have shown that individuals are more likely to interpret neutral social interactions with others as positive when in a positive mood, but are equally likely to balance observations as positive or negative when they are in a negative mood (Forgas, Bower, & Krantz, 1984; Forgas & Bower, 1987; Forgas, Bower, & Moylan, 1990). These results

indicate that social judgements may be more easily biased by positive mood than negative. And similarly, Worth & Mackie (1987) found that when in a positive mood, participants were more susceptible to persuasive messaging even when the message had reduced overall quality, which the researchers took to mean that positive mood led to less systematic processing.

Another program of research that supports a difference between processing style for positive and negative mood explores the effect of mood on memory accuracy. Several studies have shown that negative emotion appears to enhance memory accuracy (Kensinger, 2007; Kensinger et al., 2007; Levine & Bluck, 2004). For example, Levine & Bluck (2004) looked at the likelihood of memory distortions, or "memory malleability," for real world events surrounding the O.J. Simpson trial. They found that participants who were happy about the outcome recalled more events that did not happen, despite having a high level of confidence in these erroneous memories. The authors conducted a signal detection analysis that showed that positive participants were using a lower threshold for judging whether or not an event occurred, as opposed to negative participants who were more conservative. Kensinger et al., (2007) found a similar effect for participants trying to distinguish between items that were the same or just similar to an item studied previously. They found that overall negative items were remembered in better detail than positive *and* neutral items. One argument to make sense of this benefit for negative memories is that it is adaptive to have more detailed memory for events that are potentially threatening (Lazarus, 1991).

Research looking at decision making strategies also shows mood dependent processing styles. Isen & Means (1983) asked participants in a positive or neutral mood to select between a set of cars, in a simulated purchasing task. In that task, the two mood groups made similar choices but employed different strategies in making their decision. Participants in the positive condition made faster decisions, readily ignored information that they deemed irrelevant, and were quicker and more decisive about eliminating options when compared to participants in the neutral condition. This indicates that positive mood may lead to more top down, rapid decisions based on previously used heuristics.

Taken together, these results may be taken to support the interpretation that positive mood leads to imprecise cognitive processes and stereotype driven thinking, but other research indicates that this is an oversimplification, as there are situations where there are advantages for cognitive processes that are influenced by positive mood. For example, in a creative thinking study, requiring people to generate remote associates, Isen et al., (1987) found that participants in an induced positive state showed more creative problem solving than those in negative moods, and more creative problem solving than those in states of high arousal but neutral mood.

And finally, there are also numerous studies showing that visual processing while in a happy mood tends to focus on global elements, while visual processing in a sad mood tends to be local (Basso et al., 1996; Fredrickson & Branigan, 2005; Gasper 2004; Gasper & Clore, 2002). For example, Fredrickson & Branigan (2005) asked participants in positive, neutral, or negative moods to complete a global-local visual

processing task which asked participants to judge similarity of patterns compared to an exemplar. Participants in a positive mood were more likely to use global features to determine similarity as opposed to focusing on local pattern features. The opposite was true of participants in negative and neutral moods.

Theories to explain effects of emotion. These results indicate that the relation between emotion and cognition is complex. Research has clearly documented a relationship between mood and memory (Bower, 1981), categorization (Isen et al., 1978), and processing style (Forgas 1987). Several theories which aim to explain these results can be grouped into two categories – motivational theories and informational theories. While both address questions of how emotions change behavior, motivational theories argue that individuals change their behavior in order to achieve a desired mood. Informational theories in contrast assume that individuals change their behavior to accomplish a goal and that their mood can provide information about their progress towards, or approach to that goal. The difference between these two approaches is subtle, particularly because the theories often predict similar outcomes, but their main differences follow from what they assume the individual change in behavior is focused on – affecting one's mood (motivational) or affecting one's larger goals (informational).

For example, if I'm feeling sad at work the research shows that I may be more likely to focus on executing my work tasks carefully and thoroughly. Motivational theories would argue that my careful, systematic approach is due to my larger desire to feel happy. My current sad mood serves as an indication that my current behavioral

strategies are leading to a situation that is causing me to be sad so I modify my behavior and tactics to fix my sad mood. In contrast, informational theories view mood as indicating how well my task goals are proceeding. I pay attention to affect because it signals whether I am making progress on work goals. In contrast to motivational theories they would instead say that I am modifying my behavior when in a sad mood because I want to improve task performance. I feel sad, so that must mean my work isn't going well and I should change my behavior to fix what isn't working.

This example illustrates another important contrast between these two theories. In fact, motivational theories need not predict that I would be more careful and systematic with my approach to my work tasks. Instead motivational theories might argue that if in a sad mood, I will use analytic processing to realize that the task I'm doing is making me sad. I may therefore try to get through the task as quickly as possible and ignore all the details in an effort to get to a task that is likely to improve my mood. Again, the goal for motivational theories is to improve my mood not improve my task progress, so the predictions are slightly more nuanced.

Now let's say I'm at work and feeling happy. The research now would suggest that I may be more likely to get through tasks efficiently because I can use the readily-available solutions I have that are already working. And I might even think more creatively about how my tasks are all generally related in the larger picture because I am using less cognitive effort on the smaller tasks at hand. The motivational theories would argue that my behavior is being guided by heuristics

because my mood is already in the state I want it to be in, so whatever I've been doing must be working. The informational theories would argue that my mood is an indication that my goals are being met, so I continue using previously used strategies. In this case these two theories are likely to predict the same behaviors, but again because of different objectives.

Motivational. Motivational theories assert that emotion effects on cognitive thinking styles arise from people's desire to change their mood. The most straightforward motivational theory, colloquially known as Mood Repair (Isen, 1984; Erber & Erber, 2001), assumes that people generally want to be in good moods, and behaviors that occur during emotional states follow from a desire to achieve or maintain this mood. When in a positive mood individuals aim to maintain that state, so they engage in mood congruent thinking and employ a heuristic processing style because whatever strategies they've been using are clearly working. On the other hand, individuals experiencing a negative mood want to change their state, so they remember mood incongruent things to improve their mood and employ more systematic processing so as to determine a better strategy to alter their mood.

Erber & Erber (2001) refined this basic model in proposing the Social Constraints Model of Mood Regulation and Processing. According to the Social Constraints model, the situation affects whether or not people want to change their mood. In contrast to the Mood Repair model, which argues that a negative mood will always induce change, the Social Constraints model argues that whether or not people

change their mood depends on the situation. In particular if there is no situational requirement to change a negative mood, then people will not aim to change it.

In the Social Constraints model people change their mood to be consistent with what is required for the situation. Some situations demand certain types of mood. For example, in a situation where a certain mood is called for socially (e.g., a wedding, or a funeral), during a cognitively difficult task, or even in the presence of others, one may try to control a highly positive or negative mood so as to appear more neutral. In this case people would remember memories that are mood incongruent and may use systematic processing in order to accomplish this. On the other hand, if someone is in an unconstrained situation (e.g., alone at home), there are no situational demands on mood. As a result people will maintain their mood, even if it is negative, leading to mood congruency and lower level processing (heuristic). While it may seem initially counterintuitive that one may want to maintain a negative mood, Erber & Erber (2001) argue that negative moods can provide individuals with beneficial reflective periods. This is intended to explain the desire people often have to experience sad stimuli when in a sad mood, like watching a sad movie or listening to sad music while feeling blue.

Informational. Informational models claim that affective states act as information that people use to determine how they should behave. The Affect as Information model asserts that individuals use affective states as information about the current task. So when facing a task or decision individuals will ask themselves "How do I feel about…?" whatever they are doing (Clore, Gasper, & Garvin, 2001;

Schwarz, 1990). If they feel positively they will continue their current strategy, but if they feel negatively they will increase their effort leading them to become more analytical in order to find a better approach. Let's say for example that I have to make a decision about whether I believe a stranger is trustworthy. According to this model I would ask myself "How do I feel about this person?" and my current mood would serve to inform the judgment I make. Mood in this context acts as informational for whatever situation one is in, and it is assumed that one's current feelings are relevant to that situation. However, research has shown that mood can still affect behavior even when it is unrelated to one's current situation, so this model notes that when moods are unappraised they can result in misattribution to the current situation. When moods are misattributed they should similar effects as seemingly relevant moods. This gives rise to the "Immediacy Principle" namely the unconscious association of things occurring close together in time as being related, a trick often exploited in filmmaking. According to the Immediacy principle, one's current affective state is easily misattributed to whatever is in one's current focus (Schwarz, 2013).

The Affect as Input model (Martin, Ward, Achee, & Wyer, 1993) builds on the basic assumptions of the Affect as Information model, but argues that the effects of affect on cognition are contextually determined. Its proponents agree that individuals use affect as source of information by asking "How do I feel about ….?" but these theorists argue that people also ask "What does that feeling mean in this context?" So for example, if you are in a positive mood, but are doing a detail oriented task like counting inventory it will not cause you to stop carefully counting

items. Another example might be that if you are in a negative mood and trying to decide whether you trust and will behave positively towards a new boss. In this case, your negative mood will serve as information but it may not cause you to be more critical and antisocial with your boss. The importance of this theoretical addition is that like the Social Constraints model, it attempts to acknowledge that mood effects do not have a default setting. The Affect as Input model argues that negative mood should not always lead to systematic processing and positive mood should not always lead to flexible and creative processing. Instead the affects mood are context dependent. According to this model the situation could lead positive or negative mood to have a different effects. Additionally this theory adds that moods can still influence judgments made even when the individual is conscious that their current emotional state is not a direct reaction to what they are judging.

Predictive informational model: Affect Infusion Model (AIM). The Affect Infusion Model (Forgas, 1995; Forgas & George, 2001) develops the informational theories of emotion and seeks to make predictions about when and why mood should lead to changes in behavior – or infuse. Specifically the AIM predicts that affect is more likely to infuse when the task requires open-ended and generative or constructive processing. Forgas (2013, p.101) defines affect infusion as "the process whereby affectively loaded information exerts an influence on, and becomes incorporated into cognitive and judgmental processes, entering into a person's deliberations and eventually coloring the outcome." The AIM describes four types of

processing strategies and the predicted level of affect infusion for each one. These include: direct access, motivated, heuristic, and substantive processing.

Direct access strategies refer to strategies used in contexts in which the task or target is highly familiar, and a previously used strategy is easily drawn upon. So for example, if a seasoned chef is asked to dice an onion then they will likely have an easily recalled and pre-stored strategy that they can quickly decide to employ for accomplishing that task. The AIM asserts that direct access strategies are less susceptible to affect infusion because the previously stored response should be ingrained enough to resist the effects of mood. *Motivated processing strategies* are strategies used when an individual has a strong motivational desire for a specific outcome to occur. For example, when applying to a highly sought after job, a person is likely to be very selective with the strategies they use to accomplish this task. Motivated processing strategies are also categorized as resilient to affect infusion by the AIM, with the argument that motivation for the desired outcome will trump any potential infusion from mood that might lead to a negative outcome.

Heuristic processing strategy refers to strategies used in situations where there isn't a clear, previously used strategy to call upon, and there isn't a very strong motivational goal driving one to choose a given strategy. In this context the AIM predicts that affect infusion will be much more likely because the individual has little information to go on and so they may rely on their current affect to inform their strategy choice. We can use a PIM example to describe this strategy. Let's say for example you have to complete a group project with a fellow student and they ask you

generate a file that you will share with them and work on together. If this is the first time you've generated a file that will be worked on collaboratively you may not have any previous strategies for how to manage that collaborative task. If you happen to be in a sad mood when you create and organize this file, the AIM might predict that you should be very clear and precise in how you name the document and what shared folders you generate to put it into. But if you are in a happy mood, you may be more likely to treat the file label and folders creatively which in turn could lead to potential ambiguity for your collaborator.

Substantive processing refers to the strategies that occur for demanding tasks that require an individual to learn and process extensive new information. In this context it is important that the individual has enough capacity to meet the demands of the situation, but that the situation is complex enough to require some amount of elaborative processing. In these contexts, the AIM predicts that affect infusion will also be high. The argument is that because these contexts require individuals to construct ideas and interpretations for ambiguous and new information, they will be forced to rely on integrating the new information into a pre-existing framework. Their mood is likely to infuse (i.e., change behavior) in this situation because when generating these pre-existing frameworks their mood will serve as primes for strategies and ideas that are congruent, in addition to unconsciously providing information for how an individual may appraise the situation.

In considering these various AIM strategies, we believe that PIM behaviors fall into several of these categories. For example, some PIM behaviors can become

quite routine which should lead to more direct access strategies with low levels of affect infusion. But often PIM strategies will likely fall into the heuristic processing and the substantive processing categories depending on the context. PIM behaviors are likely to produce heuristic processing strategies when users are faced with managing digital information items that are novel and their current PIM strategies do not have an obvious way to incorporate that item. In addition, during more cognitively demanding work tasks that involve learning and processing many new digital information items, individuals may be more likely to employ substantive processing strategies to accommodate new digital information items. Because both of these strategies are predicted to lead to a high level of affect infusion, we predict that PIM behaviors may be strongly affected by a user's current mood state.

Research Questions

Individual differences and variability are very common in PIM. However such differences are relatively under-explained by existing research (Boardman & Sasse, 2004; Gwidzka, 2004; Malone, 1983; Massey et al., 2014). While some of this variability can be understood by considering dispositional differences in personality and cognitive style, we seek to further explain this variance by considering the effects of temporary emotional states, even when those emotions are not directly tied to the PIM task. Emotion has been shown to affect memory, categorization, and processing style, and several theories have been developed to try and explain these effects. In this study, we used the framework from the Affect Infusion Model (Forgas, 1995) to predict that PIM behaviors often involve both heuristic and substantive processing

and should therefore have a high level of affect infusion. Because PIM induces a high level of affect infusion, we should see different behavioral consequences depending on mood valence. We should expect negative affect to trigger vigilant and analytic processing and positive affect to induce a more creative thinking style.

At the heart of successful PIM, is that the personal organization of information made during encoding matches one's future retrieval needs (Bergman et al., 2008; Jones, 2010; Jones & Teevan, 2007; Whittaker, 2011). However emotion is variable, with an individual experiencing a range of positive and negative affective states throughout any given period of time. Within a single day, individuals often go through multiple emotional states (Adan & Sánchez-Turet, 2001; Natale, Alzani, & Cicogna, 2003; Stone, Schwartz, Schkade, Schwarz, Krueger, & Kahneman, 2006; Wood & Magnello, 1992). Emotion may affect the PIM structures that individuals generate and lead to information being organized very differently depending on one's mood. Additionally, mood dependency (Bower, 1981) may also have consequences for PIM, making it easier to recall information that was stored when one is in a similar mood. Based on this research, we developed three sets of hypotheses that make predictions about the effects of mood on PIM. The first set predicts how mood will affect the structures that people generate when initially categorizing digital information items. The second set predicts mood effects on retrieval of previously organized digital information, and the final set predicts how mood congruence between organization and retrieval will affect retrieval.

We explored several options to test these hypotheses. One obvious approach is to use naturalistic methods to look at the relationship between PIM behaviors and emotion. We would therefore analyze individual's personal computers and determine if their affective states at a given time predict the style of file organization they created at that time. However, emotional states can vary and it may be difficult to accurately detect emotions at the time that information was organized. We would also have to rely on participant's memory for their previous emotional states, and these judgments may be inaccurate. Additionally, as we have seen, there are other factors that contribute to folder organization independent of emotions, such as job characteristics, types of files saved, and fluctuations in personal levels of busyness (Whittaker, 2011). It would be difficult to determine any sort of causality using such an approach. Finding careful structuring of a user's file hierarchy might be explained by being organized during a time of generally low moods. However such careful organization might also have arisen because the files are directly related to a specific project that was critical for a job related task. Thus, it would be impossible to disentangle the effect of emotion on structure while controlling for task and job characteristics.

Because looking at real-world PIM behaviors makes inference difficult, we instead opted to use a simulated PIM task (Civan, Jones, Klasnja, & Bruce, 2008; Ma & Wiedenbeck, 2009; Voit, Andrews, & Slany, 2012). Using this approach, we induced positive or negative moods and examined the effects these emotional states have on the PIM tasks of organizing and retrieving. In order to induce mood in a lab

setting, we used a modified version of a Mood Induction Procedure (MIP) recommended for use in lab settings (Robinson, Grillon, & Sahakian, 2012). This original MIP uses a combination of musical stimuli, Velten sentences, and a visual analogue mood scale (a self-report scale for participant's mood). Velten sentences are a common method for inducing mood that asks participants to consider a set of emotionally charged sentences one at a time (Clark, 1983; Velten, 1968). However, we decided to modify the Velten stage of the procedure to use musical stimuli, an *emotionally charged film clip*, and the visual analogue mood scale. We made this modification because researchers reviewing the relative strengths of MIPs using a meta-review found that Film MIPs often lead to stronger outcomes (Westermann, Stahl, & Hesse 1996).

In Study 1, participants were asked to organize a set of files containing short facts on topics related to the scientific study of dinosaurs or the study of classical music. Before beginning the file organization, participants underwent a mood induction procedure designed to put them in a happy or sad mood state. After organizing the set of 60 files, participants were then put through another mood induction procedure and then asked to re-find a subset of the files they organized. Mood was either consistent between organization and retrieval (mood congruent) or inconsistent (mood incongruent). We predicted that sad mood should lead to analytical and vigilant processing, likely leading to highly structured folder hierarchies, and happy mood should lead to more flexible and inclusive hierarchies. At retrieval we predicted that people will retrieve both faster and more accurately

when mood is negative at the time of organization and when mood is consistent between organization and retrieval.

It should be noted that prior research leads to conflicting predictions about how mood at organization will affect retrieval performance. PIM research indicates that deep and complex folder hierarchies lead to less efficient retrieval times (Bergman et al., 2010). Given our prediction that sad participants will make more structured hierarchies, the PIM research would predict that sad mood at organization should lead to less efficient retrieval performances. In contrast, research on emotion has shown that negative mood is related to increased memory accuracy and fewer memory distortions (Kensinger, 2007; Kensinger et al., 2007; Levine & Bluck, 2004). In light of these contrasting perspectives we opted to select the hypothesis built from previous work on the effects of emotion to keep consistent with our other hypotheses. We therefore predicted an improved retrieval performance for participants who organized while sad.

Study 2 was conducted as a follow-up to explore whether this relationship between mood and PIM behaviors also occurs in more naturalistic settings. Participants in this study were characterized using validated scales on their tendencies towards positive and negative emotions. They were also required to bring in their personal computer so that we could analyze their PIM behaviors. Using this approach we assessed whether participants who tended towards more negative emotions were managing their personal information differently than participants who tended towards more positive emotions. The use of emotional tendencies is slightly different than our

approach in Study 1 where we looked at more transitory mood states. This choice was made to reduce the need to rely on participants' memory for their previous mood states.

The following were our specific hypotheses for Study 1:

Inducing negative mood during an information organization task will lead to:

Hypothesis 1: More structured hierarchies – i.e., more folders,

Hypothesis 2: Longer time spent organizing and reading files

Hypothesis 3: More layers of folder depth

Induced negative mood during organization will produce:

Hypothesis 4: Reduced retrieval times

Hypothesis 5: Fewer retrieval errors

Mood incongruence between organization and retrieval will:

Hypothesis 6: Increase retrieval times

Hypothesis 7: Increase retrieval errors

Study One: Effects of Mood on a Simulated PIM Task

Method

In this study, participants were asked to simulate a normal PIM filing activity by organizing a set of digital files containing short facts on topics related to the scientific study of dinosaurs or the study of classical music (for an example, see Figure 3). This organization task required that participants read each fact and then determine how to categorize the new file in the context of the other files they had

already organized. Participants were told that they should organize information in order to retrieve it successfully later.

Our interest was in the effects of mood on organization. So, before beginning the file organization task, participants underwent a mood induction procedure using film and music stimuli that was designed to put them in a positive or negative emotional state. This mood induction approach was modified from a recommended lab protocol for mood induction (Robinson et al., 2012). After organizing a set of 60 files, participants underwent another mood induction procedure and were then asked to re-find a subset of the files they had previously organized. The induced moods for retrieval were either consistent between organization and retrieval (mood congruent), or inconsistent (mood incongruent). The entire study duration was typically between 1.5-2 hours and is in Figure 1.

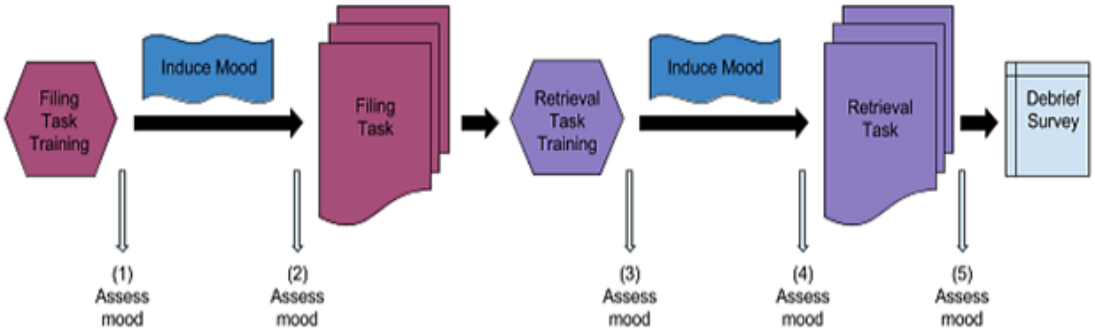

Figure 1. Study 1 procedure diagram.

Participants

161 undergraduate students recruited from psychology courses participated in the experiment (M=48, F =113). Based on the completed responses (n=91), to

optional demographics questions, our sample demographics are roughly: 26.4% Asian, 26.4% White/Caucasian, 27.5% Hispanic/Latino, 13.2% Mixed race, 2.2% Black/African-American, and 4.4% Other. Ages ranged from 18-26 years old (mean age=19.81, SD=1.72).

Procedure

Prior to arrival in lab participants were randomly assigned to 1 of 4 different mood conditions that vary by congruence and valence – happy-happy, happy-sad, sad-happy, and sad-sad. Upon arrival, participants were prompted to read over and sign a consent form that included general orienting information about the study. Before starting the main filing task, the experimenter asked the participant some background questions. These included a question about which operating system they are more familiar with (Mac or PC), and what level of familiarity they have with classical music and dinosaurs. The rest of the procedure (see Figure 1) followed the following general format (explained in more detail below):

1. Filing task training,
2. Mood induction 1,
3. Filing task,
4. Retrieval task training,
5. Mood induction 2,
6. Retrieval task,
7. Debrief survey.

Training for the Filing and Retrieval Tasks was done prior to the mood inductions to ensure that the emotional state held during the tasks themselves were a result of the mood induction and kept free of interference from interaction with the experimenter.

Prior to the Filing task, participants were instructed about the type of files they would see, told that they would be expected to organize those files into folders after they had read the file content and were instructed to make as many folders as they wanted. They were also told that their organization should help them retrieve those files during a later retrieval task. The following script was read:

> *"For the file organization part of the experiment we will be asking you to organize a set of files that each contain a piece of information. Each file will either contain a fact related to the study of dinosaurs or classical music. We want you to categorize these files into folders that you create. At any point you can re-organize your folders and the files within them as you see fit. Please feel free to make as many folders as you would like. And while you can label your folders in any way that makes sense to you, we ask that you do not change any of the file names.*
>
> *At the end of the study we will be asking you to answer some questions relating to the information in these files. In order to answer the question you will need to re-find a specific file, but you won't be given the file name. So it is crucial that open each file and read the fact that it contains and then organize the file into folders in a way that you think will help you find them again."*

Participants were clearly told that it was important to read the content of each file because they would be expected to re-find a subset of these files again without having access to the file name. This meant that at retrieval participants had to rely on the organizational structure they had created to re-find the file. During the retrieval task participants would be asked a set of 12 trivia style questions that each required them

to re-find one particular file from the set of sixty. Participants were given a practice file to open and read, and were then asked a question about that file to expose them to the requirements of the Retrieval task.

Once participants understood the filing and retrieval tasks, the experimenter began the first mood induction. This took the form of an initial mood probe, exposure to a mood inducing stimulus, followed by a second mood probe that assessed whether mood induction succeeded. The mood induction procedure relied on self report mood ratings using Visual Analogue Mood Scales, or (VAMS) (see Figure 2 below). To assess baseline mood, the experimenter briefly explained to participants how to fill out the VAMS form, instructing them that "the most important thing is to be completely honest because there are no right answers." The VAMS form asked participants to draw a single vertical line along three different axes to indicate their current emotional state with regards to happiness, sadness, and boredom (see Figure 2). After completing their first baseline VAMS judgment, the experimenter read a short script. The script was as follows:

> *"Before we get you started on the filing task, you are going to watch a short clip. While you watch it, I want you to try and put yourself into a negative/positive mood…*
>
> *This video clip is intended to help you invoke a negative/positive mood, but we ask that while watching it you do whatever you can to get into a negative/positive mood as well. Prior to the clip starting the screen will be blank for a while. Use this time to clear your mind of all thoughts, feelings, and memories. As it begins, try to get into the mood suggested by this film clip and relate it to situations in your own life. Imagine how you would feel if a similar event was happening to you and try to focus on a specific individual who is important in your life. Feel free to outwardly display the emotions evoked.*

The duration of this part of the experiment will be fairly short so you are encouraged to get as deeply into the emotion as possible. Once the video clip has ended we will begin playing a piece of music intended to assist you in maintaining the mood of this clip. This song will continue to play while you complete the next part of the study."

Participants were told that the video clip they would be watching was intended to help them invoke a negative or positive mood, but that they also need to do what they could to get into the mood as well. Previous research has shown that explaining to the participant the intent of the Mood Induction Procedure (MIP) leads to better results (Westermann et al., 1996). The participants were then left to watch the mood induction clip. To enhance mood inducement, the room was also arranged so that participants felt a sense of privacy when watching the video clip. After watching the film clip, the experimenter assessed the effects of the mood induction by re-evaluating mood. Mood was re-evaluated by asking the participant to fill in another VAMS form (which was identical to the first) using the same orienting instructions. This second VAMS served as a manipulation check to determine how the participant was affected by the mood induction by comparing the difference between the scores pre- and post-mood induction. After completing the second mood assessment, the procedure continued by asking the participant to listen to a musical composition intended to maintain their induced mood. This song played throughout the next task to maintain the mood as much as possible throughout the organization task.

Participants were then instructed to open their first file and begin the filing task. The filing task required the participant to read and organize 60 files (30 from each category of dinosaurs and classical music). After completing the filing task,

which typically took about 40 minutes, the experimenter asked the participant to get up from the computer to take a short break. During this 3-5 minute break the experimenter set up the Retrieval task. Upon the participants return, the experimenter then began the Retrieval task training. To reduce the interaction between the experimenter and the participant, the retrieval task was conducted automatically using a computer program. The experimenter first instructed the participant on how to use the retrieval program. Once the participant understood the retrieval task, the experimenter then instigated a second mood induction. The second mood induction procedure replicated the first one, although the induced emotional valence depended on the experimental condition. It again involved assessment of current mood using VAMS, mood induction using a video clip, and a second VAMS evaluation to serve as manipulation check. After watching the film clip and completing the 4th VAMS form, the experimenter began the second piece of music to maintain mood and instructed the participant to begin the file retrieval task (typical duration: 15 minutes). After the retrieval task, participants were asked to complete a short debriefing survey which asked them about their performance in the task. This survey was administered by computer and took less than 5 minutes.

Mood Induction Procedure

PIM behaviors are highly variable showing strong individual differences (Boardman & Sasse, 2004; Bergman, Beyth-Marom, Nachmias, Gradovitch, & Whittaker, 2008; Gwizdka, 2004; Jones & Teevan, 2007; Malone, 1983). Our participants also underwent two separate inductions. As a result we needed to reduce

variance arising from differences in the induced mood and also to maximize our sample size given these other sources of uncontrolled variance. We first present statistical analyses of our mood inductions to ensure they were successful overall. After which we describe how we chose a threshold to determine the success of mood induction. In the interests of maintaining as large a sample size as possible we use a less conservative threshold than has been used in related work. The criterion for inclusion in this study was a 5% shift in mood in the expected direction (positive or negative depending on condition). This both ensured that the participants included in our analyses actually experienced the anticipated change in mood, but maximizes our sample size.

This method combines two common approaches used in prior mood induction studies (Teasdale & Fogarty, 1979; Zelman, Howland, Nichols, & Cleeland, 1991). One method involves running group level statistical tests comparing the mood induced group to either their baseline mood or a neutral mood condition to see if their mood is significantly different (e.g., Macht & Mueller, 2007; Zelman et al., 1991). If this is the case, all participants in the mood induced condition are included in the analyses regardless of how their mood changed individually. The other method is to use a threshold criterion based on whichever measure of mood the procedure uses (e.g., Teasdale & Fogarty, 1979). Threshold values for change in mood are typically between a 10-20% change in mood in the direction predicted (e.g., Kenealy, 1997; Newman & Sears, 2015; Teasdale & Fogarty, 1979). This leads to many procedures including only a subset of their participants, where they were confident that specific

subset had experienced a change in mood. Typical rates of mood induction success for these studies range widely, but for procedures using thresholds there can be a 47-74% success rate for the mood induction (Westermann et al., 1996). Given that a large numbers of participants might be excluded using this approach we opt for our less conservative cutoff criteria of 5% to increase the sample size across our two mood induction.

Mood Induction Cutoff Criteria. Mood induction success was measured using the Visual Analogue Mood Scale (described below). We considered two criteria for mood induction success. One was to assess whether mood inductions worked by comparing pre- and post- self report measures to see if mood had shifted in the appropriate direction. This would require looking at only the relevant mood axis (sad or happy only). For example, if a participant was given a happy mood induction, we would determine that the mood induction was successful based on whether they reported having an increase in happy feelings post mood induction. The other approach was to focus on post mood induction scores only and to look at the difference between happy and sad scores. In this method we would treat whichever score was higher as the dominant feeling as long as it was at least 5% higher.

While the first method has been used in the literature (Teasdale & Fogarty, 1979) we have two concerns with this approach. One clear limitation with this method is that it relies on participants' memory of prior mood which is known to be fragile (Loftus & Palmer, 1996; Mitchell, Thompson, Peterson, & Cronk, 1997; Walker, Skowronski, & Thompson, 2003). The other limitation is that it ignores

oppositely valenced emotions. For example, if a participant was in the happy mood condition, then their sad evaluations would be ignored even if they reported more sad than happy feelings. Inspection of our data suggested that overlooking oppositely valenced emotions again leads to exclusion of participants whom the procedure seemed to have affected appropriately.

Based on these concerns, our criteria for mood change are focused on participants' post mood induction mood ratings. To be included, we require that participants indicate having a larger amount of happy feelings than sad feelings if in a positive mood induction, or vice versa for the negative mood induction. As discussed above the threshold for this difference has to exceed 5% (measured as 5mm along the 100mm line)

Materials

In this study participants completed a number of short questionnaires. These included the "Visual Analogue Mood Scale (VAMS)," and the "Debrief Survey." They also viewed two film clips and listened to two musical compositions detailed further below.

Visual Analogue Mood Scale. As described above, before and after each mood induction participants were asked to self-report their mood using a measure called the Visual Analogue Mood Scale (VAMS, see figure 2). The VAMS form asked participants to self-report about three different emotional states – happy, sad, and bored feelings. The form includes a single axis for each emotion and participants were asked to draw a single vertical line along each axis to indicate their current

emotional state. A line drawn on the left side of an axis indicated a neutral state with regard to that emotion, and a line drawn on the far right would have indicated a strong emotional state (e.g., extremely happy feelings). The VAMS measure was adapted from a mood induction procedure used in previous research (Robinson et al., 2012).

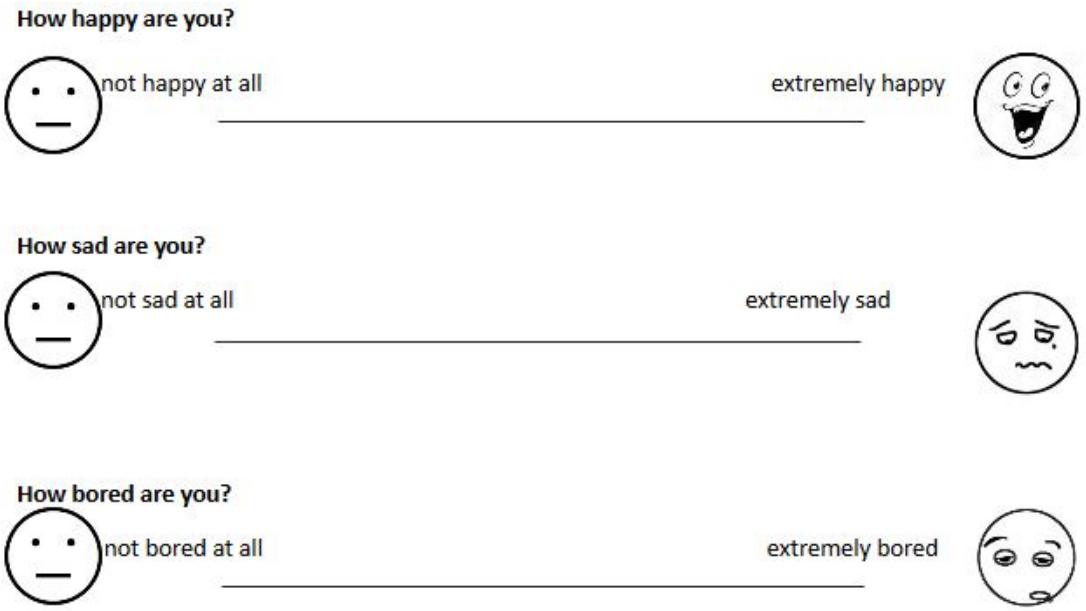

Figure 2. Visual Analogue Mood Scale – Self report mood measure.

Mood Induction Media. Participants experienced two mood induction procedures (MIP) during the study. These were intended to help the participant invoke a happy or sad mood state. The media for these MIPs included 4 video clips and 4 pieces of music. Each participant only saw two of the videos and heard two of the audio clips (depending on condition). Two of the video clips were intended to be sad and two were intended to be happy. The first sad clip was from a movie called The Champ (1979) and it includes a scene where a young boy realizes that his father has died and reacts (runtime: 2 minutes, 52 seconds). The second sad clip was from a

movie called My Girl (1991), and includes a scene where a young girl is attending her friend's funeral and gets upset (runtime: 2 minutes, 28 seconds). The two happy clips were videos of animals. One was from the BBC documentary Deep Blue (2003), and is a short clip of dolphins diving through the ocean (runtime: 2 minutes, 37 seconds). The second happy clip was an edited excerpt from the documentary Christian: the Lion at World's End (1971) which was posted to YouTube in 2008. In this clip an adult lion that was raised by two men and eventually released into the wild is reunited with the two men that raised him one year later (runtime: 3 minutes, 5 seconds).

The music stimuli included 4 classical compositions that were recommended for positive and negative mood induction (Robinson et al., 2012). The songs recommended for invoking a happy emotional state were *Piano Concerto No. 4, Op. 58 in G Major: III. Rondo: Vivace by Ludwig van Beethoven* and *Serenade No. 13 KV 525 G-Major: I. Serenade. Allegro by Wolfgang Amadeus Mozart*. The songs recommended for the induction of negative mood were *Adagio for strings, Op. 1_1 by Samuel Barber* and *Adagio in G Minor by Tomaso Albinoni* (Robinson et al., 2012).

Filing Task Materials. Participants were shown short digital files that contained a short set of facts related to one of two topics: dinosaurs or classical music. Files on these topics were generated using Wikipedia pages. The content of each original Wikipedia file was shortened to include only a few sentences and most files included a small image. The title of each file was the title of the Wikipedia article, which made them reasonable labels. See Figure 3 for an example.

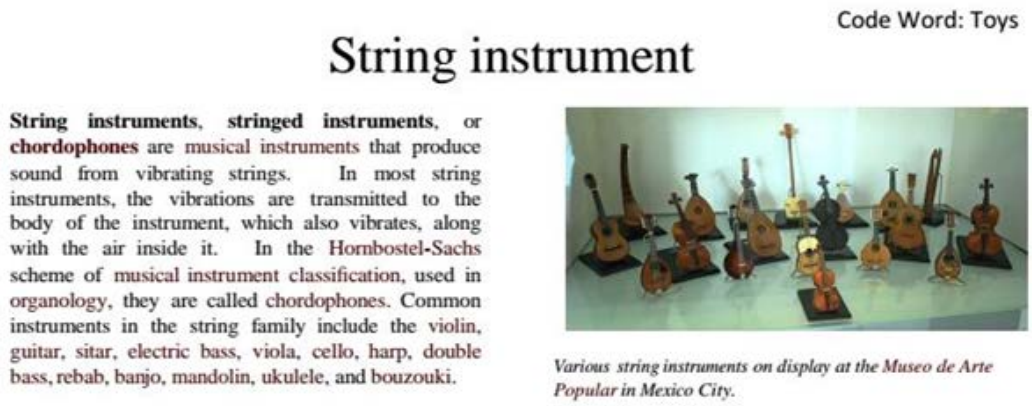

Figure 3. Example of file for organizing – Title: String instrument.pdf

Retrieval Task Materials. Participants answered a series of 12 questions during the retrieval task. To answer them, participants needed to access the file containing the relevant information. Each question was careful to not mention the file name (i.e., the Wikipedia article title). For example, one question asked "What kind of musical device can be divided roughly into two types, Flutes and Reeds?" To answer this question, participants needed to traverse their file hierarchy to re-find the original file named "Woodwind instruments." Questions were designed to be of varying difficulty, and only one file was relevant to each question as the question text is taken directly from the target file text. In order to ensure that participants actually went back to and opened the target file (instead of just answering the question from memory), the participants were required to answer the question by finding the right file and entering the code word listed in the top right corner. In the example above (Figure 3), this would be the words 'toys'. Participants were not told about how the code words would be used until just before the retrieval task. This was done to avoid

having them try to memorize which code words belonged to which article. Generating the correct code word was how the computer program measured retrieval success. The time to complete each retrieval was also analyzed after the study using screen recordings. This was calculated as the time from when the retrieval question first appeared on the screen to the time that the participant located the correct file.

File Debrief Survey. Participants were also asked a set of exit questions. Questions included demographics, self-assessments of their enjoyment and effort level during the task, assessments of the organizational task they completed and their performance during it, and a rating of the difficulty for the task.

Programs. The two main tasks during the study were automated using two python scripted programs that participants interacted with. This was done to reduce interference with induced mood by having increased interaction with the experimenter. The first program was "File at a time" which ran the file organization part of the study. The second was "Retrieval task" which ran the file retrieval at the end of the study. Once participants completed the study the experimenter used a third small python program called the "Directory Crawler" designed to determine the structure of the folder hierarchy that participants generated during the first part of the study.

Filing Task Program – "File At a Time." During the file organization task participants used a program that presented the experiment files for them to read and organize one at a time without experimenter intervention. This is done to avoid any unnecessary mood effects of interacting with the experimenter. Files were sent to the

participant one at a time into an empty folder. Following experimental instructions, participants were prompted to read each file and then organize it (so that they would later be able to retrieve it) by creating a folder structure in an open My Documents window. Participants were also instructed that they could re-arrange their folder structure during the procedure as they encountered more files. For the exact script, see the procedure section.

Participants received the files in a semi-random order. We wanted to make the presentation as random as possible but we also felt that it was important that the participant saw these files in a semi-realistic way. While working with files on a computer, it's likely that one would look through multiple files from a similar topic and not randomly switch between two distinct categories. We therefore designed the program to randomize small batches of the files for presentation to the participants. Each batch contained five of the dinosaur files or five of the classical music files. This ensured that the participants would still receive one file at a time but they would always see five consecutive files from the same high level category. Again, this was done to try and replicate some consistency with working on a task in the real world. Over the course of the filing task, participants were given a total of 60 files (30 from each category) that they were instructed to organize in folders. They were told they could generate as many folders as they like, and name them however they saw fit, but we asked that the participants preserve the pre-generated file labels, i.e. they did not relabel the file names. As we have described, participants were motivated to carefully

read the files and organize, because they were made aware that they would need to organize to optimize performance in the final retrieval task.

Retrieval Task. Following the filing task, participants were asked to re-find 12 of the 60 files that they had organized. They did not know in advance which files they would be asked to find, nor how many file retrievals would be required. Participants were told prior to the filing task that retrieval involved them answering questions which required them to re-find a specific file they had read and organized but they would not be given the file name. This was done to ensure that when creating their organization, they thought about how each file's content was related to the other files and organized the files in a way that would assist them in later re-finding.

During the retrieval task, the program walked participants through a series of 12 retrieval questions, each related to a single file within their hierarchy. The question order was randomized automatically. Participants were instructed to open the file they thought answered the question, find the code word (see Figure 3 for example) written in the top right corner of each file, and enter that code word into the form provided by the program. If participants located the correct code word the program told them that they had successfully answered the question, if they entered an incorrect code word it prompted them to try again. At any point participants had the option to enter the phrase 'I give up,' which allowed them to move on to the next question. The program was designed to both time the duration of participants' retrieval and record any errors that were made. However to check accuracy we also screen recorded each retrieval

task. These videos were coded afterwards and the coder timed each retrieval and recorded any errors made (in the form of opening the wrong file).

Directory Crawler. After participants completed the study, a file hierarchy analysis tool we developed (Massey et al., 2014) was used to measure objective properties of the hierarchy that participants generated during the organization component of the study. Directory Crawler maps out the participant's folder hierarchy and provided us with general information like user generated folder names, average number of files per folder, distribution of files across folder depths, etc. These structural properties were used as dependent measures when evaluating our hypotheses.

Results

The results are separated into two sections. The first section describes the results for all participants who successfully completed the first mood induction. These results describe the outcomes for the first task – organizing a set of files. The second section describes the results for the participants who completed both mood inductions and describes the outcomes for the second task – retrieving files from one's organizational structure.

Part 1: Organization Task

Participants. 167 undergraduate students recruited from psychology courses participated in the experiment. These participants all completed 2 mood inductions, both of which proved to lead to statistically significant changes in mood (see Table 1 and Table 2). Of these participants, 142 met the criteria for having a large enough

effect for mood induction 1 (described in detail in methods). A further 18 of these participants were excluded for non-compliance, technical failure, or other behavioral concerns (e.g., falling asleep, erratic behavior, etc.). This left our final count at 124 participants for the organization task (N=124, Male=38, Female=86, Conditions: Happy=67, Sad=57).

Mood Induction Results. There was a significant effect of mood induction on reported mood pre- and post- induced mood in the direction expected. A paired-samples t-test was conducted for each of the mood inductions at time 1 and 2, presented in Table 1 and 2. Participants who experienced a sad mood induction showed a decrease in happy feelings and increased sad ones. Conversely, participants experiencing a positive mood induction increased in happy feelings and showed a decrease or neutral effect on sad feelings. These results gave us high confidence that our mood inductions were successful. To ensure that all individual participants included in the final analyses did achieve the appropriate mood (happy or sad), we enforced the cut-off criteria described in detail in our methods section. Participants needed to report having at least 5% more happy than sad feelings, or vice versa depending on condition, post mood induction. This led to the removal of 27 participants from the organization analyses who did not meet this criterion, and 22 additional participants from the retrieval analyses who did not meet this criterion for the second mood induction. Combining these two approaches, statistical verification and a cut-off, we have high confidence that participants included (N=124) were successfully induced into the mood required in each condition (happy or sad).

Table 1

Results of paired t-test and Descriptive Statistics of Happy and Sad Feelings for Validating Experimental Procedures of Mood Induction 1

	Mood Induction 1					
	Sad Induction		Paired t-test	Happy Induction		Paired t-test
	Pre	Post	t(81)=	Pre	Post	t(86)
Happy Feeling	4.5	2.5	-10.1**	4.2	6.0	10.9**
Sad Feeling	2.2	5.0	10.6**	1.5	1.5	-.23
Difference[a]	-2.4	2.5	12.4**	2.7	4.4	7.9**

[a]Difference scores are calculated based on induction type (e.g., sad induction is the difference ("Sad Feelings" - "Happy Feelings")).
* p <.01, ** p <.001

Table 2

Results of paired t-test and Descriptive Statistics of Happy and Sad Feelings for Validating Experimental Procedures of Mood Induction 2

	Mood Induction 2					
	Sad Induction		Paired t-test	Happy Induction		Paired t-test
	Pre	Post	t(83)	Pre	Post	t(83)=
Happy Feeling	3.7	2.7	-6.9**	3.5	5.1	6.6**
Sad Feeling	1.9	4.3	10.3**	1.7	1.3	-2.6*
Difference[a]	-1.7	1.9	10.5**	1.8	3.8	6.0**

[a]Difference scores are calculated based on induction type (e.g., sad induction is the difference ("Sad Feelings" - "Happy Feelings")).
* p <.01, ** p <.001

General Organization Observations. Participant's self-generated organizational hierarchies were inspected for the composition of folders that were generated. Each hierarchy was coded to determine the number of folders generated exclusively for dinosaur related files, music related files, and mixed content folders (folders containing both dinosaur and music files). In addition, we coded the number of folders generated that were purely structural. Structural folders were any folders that contain only subfolders.

In general participants tended to create slightly more dinosaur folders than music folders. The average hierarchy across conditions contained 46.5% dinosaur folders, 43.6% classical music folders, 0.9% mixed folders, and 15.0% structural folders. When split by condition (organizing happy vs sad), these proportions held stable and there were no statistically significant differences between the two groups on folder composition. Changes to folder composition had no effect on retrieval performance.

By inspecting the composition of these hierarchies it also became clear that the most common strategy for organizing the files was to keep only two folders at the first layer of folder depth – one for Classical Music and Dinosaurs. From there, participants typically generated a set of subfolders for each of these two main folder branches. Across conditions 60.2% of the hierarchies were identified as using this two-split strategy in their first layer of folders. Participants who did not use the two-split strategy tended to generate a larger set of files at the top level, but their hierarchies tended to remain relatively shallow. Those hierarchies that incorporated

the two-split strategy tended to be deeper (M =3.03, SD=.98), M =-1.35, 95% CI [-1.71, -1.0], $t(121) = -7.55$, $p < .001$, $d = 1.39$, than the other strategies (M=1.67, SD=.98). The two-split hierarchies also tended to have more folders (M=19.86, SD=9.56), M =-5.93, 95% CI [-9.0, -2.86], $t(121) = -3.82$, $p < .001$, $d = 0.73$, than the other strategies (M=13.94, SD=6.29). There was no statistically significant difference between the two organization conditions (happy and sad) and use of the two-split strategy. The use of the two-split strategy did not affect retrieval performance.

Organization Task Hypothesis Testing. To recap, our hypotheses were:

Hypothesis 1: Negative mood induces more analytic thought which generates more structured hierarchies and more folders overall.

Hypothesis 2: Negative mood and analytic thought leads to deeper folder structures

Hypothesis 3: Negative mood and more analytic thought will lead to longer task times

We conducted a set of independent samples t-tests comparing happy and sad participants on the number of folders they generated, maximum folder depth, and the total time they spent organizing. Each variable was inspected to determine any outliers or violations of normality. Number of folders had 4 significant outliers and also appeared to violate the assumption of normality based on inspection of q-q plots. We removed the 4 outliers from our dataset to run our analysis. All four outlier participants made an unusually large number of folders – 2 from the happy condition and 2 from the sad condition. These outliers were not the result of a measurement error and there didn't appear to be anything unusual about these participants except

Table 3

Results of t-test and Descriptive Statistics for Number of Folders, Maximum Hierarchy Depth, and Total Task Time by mood

	Mood Induction						95% CI for Mean Difference		
	Happy Mood Induction			Sad Mood Induction					
	M	SD	n	M	SD	n		t	df
Folder	15.06	5.66	65	18.2	7.67	55	0.72, 5.55	2.57*	118
Depth	2.22	1.04	65	2.60	1.13	55	-0.01, .78	1.94	118
Time	39.50	14.05	65	40.15	12.64	55	-4.22, 5.52	0.27	118

* $p < .05$

for the large number of folders they generated. After outlier removal, the folder variable improved to acceptable levels of normality as assessed by q-q plot. Confirming our first hypothesis, sad participants created more folders (M = 18.2, SD = 7.67) than happy participants (M = 15.06, SD = 5.66), M = 3.14, 95% CI [0.72, 5.55], $t(118) = 2.574$, $p = 0.011$, $d = 0.47$. See Figure 4. Results were more ambiguous for our second hypothesis that sad participants would produce deeper folder hierarchies (M = 2.60, SD = 1.13) than happy (M = 2.22, SD = 1.04). This effect was trending, M =0.38, 95% CI [-0.01, .78], $t(118) = 1.940$, $p = 0.055$, d = 0.36. See Figure 5. There was no evidence for our final hypothesis that sad participants would take longer to organize (M = 40.15, SD = 12.64) than happy participants (M = 39.50, SD = 14.05). This difference was not statistically significant, M =0.65 , 95% CI [-4.22, 5.52], $t(118) = 0.266$, $p = 0.791$. See Table 3 for summary.

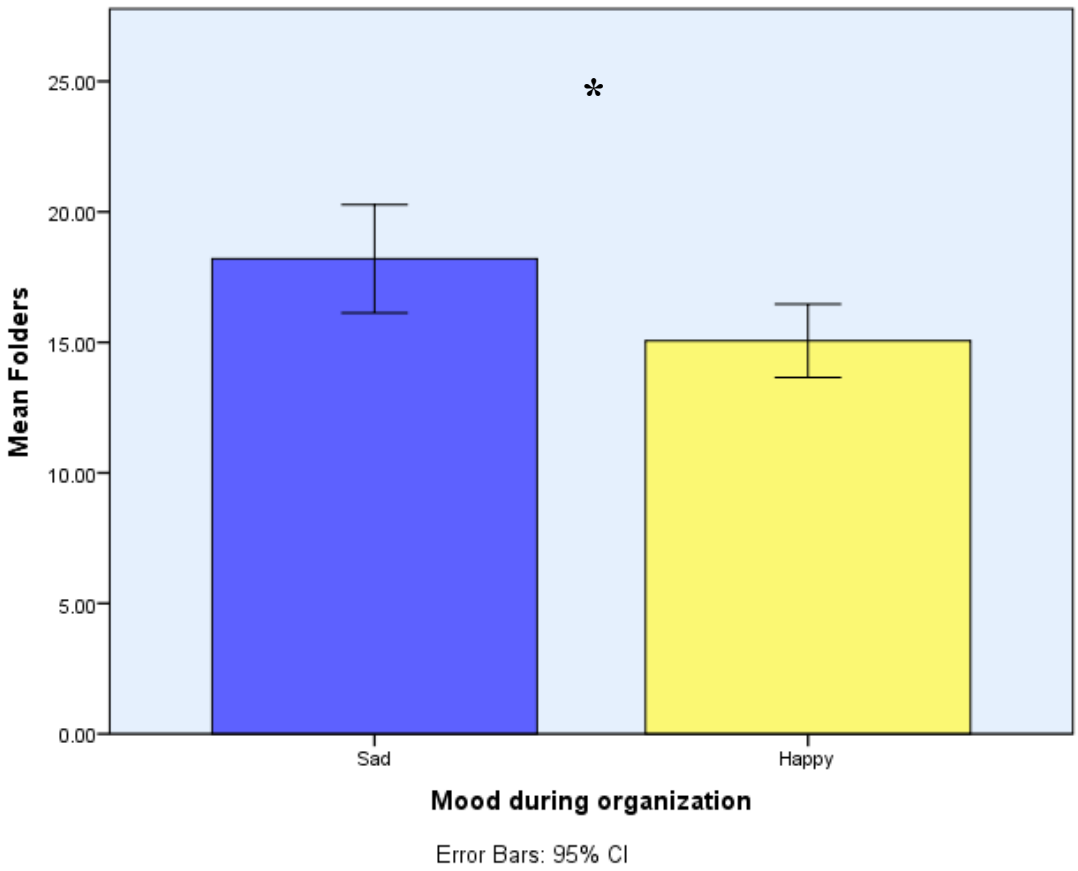

Figure 4. Average number of folders for happy and sad participants, showing a significant increase in number of folders generated by sad participants.

For comparison, all three independent samples t-tests were re-run with outlier participants included, and we saw similar results. Sad participants still made significantly more folders (M = 19.51, SD = 10.42) than happy participants (M = 15.73, SD = 6.87), M = 3.78, 95% CI [0.68, 6.87], $t(122) = 2.415$, $p = 0.017$, $d = 0.44$. Sad participants were still only trending towards making deeper folder hierarchies (M

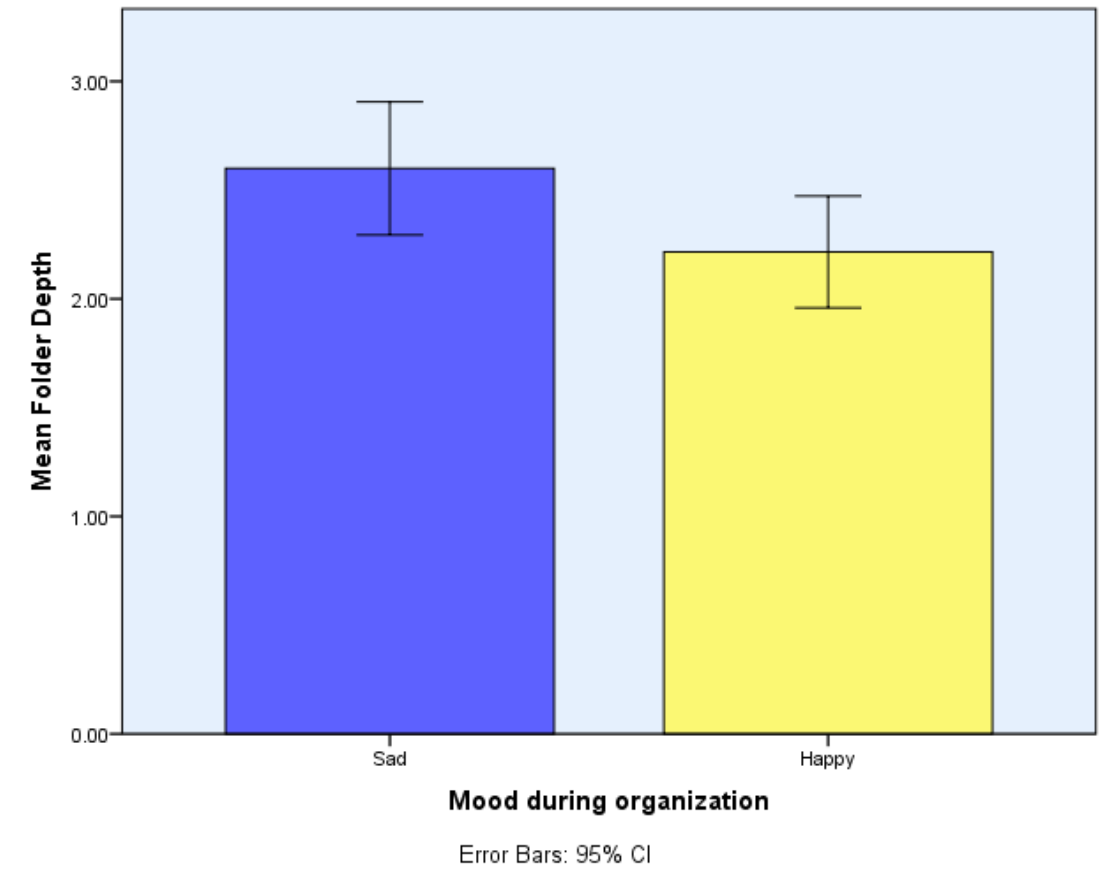

Figure 5. Average hierarchy folder depth for happy and sad participants, showing a trending increase in average folder depth generated by sad participants ($p < .1$).

= 2.67, *SD* = 1.17) than happy participants (*M* = 2.31, *SD* = 1.17), *M* = 0.35, CI [-0.06, 0.77], *t*(122) = 1.675, *p* = 0.096, *d* = 0.30. And finally, task time continued to show no statistically significant difference between sad (*M* = 40.23, *SD* = 12.42) and happy participants (*M* = 39.54, *SD* = 13.84), *M* = 0.69, CI [-4.02, 5.40], *t*(118) = 0.266, *p* = 0.791.

An additional source of variance that may have been unaccounted for in our initial analyses could be from participant's operating system (OS) preference (e.g.,

Mac vs. PC). Our previous work indicated differences in the way that personality presented across operating system (Massey et al., 2014). In light of this we provide one more set of analyses that uses operating system as a covariate to determine the effect of mood on number of folders, maximum hierarchy depth, and total task time. The results were unaffected by the addition of the covariate OS preference. Sad participants still created more folders than happy, $F(1, 116) = 6.51$, $p = .012$, partial $\eta 2 = .053$. Depth across mood conditions was still only trending towards a significant difference, $F(1, 116) = 3.65$, $p = .058$, partial $\eta 2 = .030$. And there was no evidence to support a difference between task time across mood conditions, $F(1, 116) = 0.08$, $p = .776$, partial $\eta 2 = .001$.

Part 2: Retrieval Task

Participants. Of the 124 participants that met the inclusion criteria for the organization task, 107 participants met the inclusion criteria for part 2 of the study (the retrieval task). However technical issues with screen recording software meant that we lost retrieval data for 11 of these participants. We were reliant on these recordings to assess retrieval performance so these participants had to be excluded from these results. This left 96 participants (N=96, Male=31, Female=65, Conditions: Mood Congruent Happy=26, Mood Congruent Sad=28, Happy First Mood Incongruent=21, Sad First Mood Incongruent=21). Participants' demographics were similar to the organization task.

Retrieval Task Hypothesis Testing. To recap our hypotheses for the retrieval task were:

Hypothesis 4: Negative mood during organization will induce analytical processing leading to reduced retrieval times

Hypothesis 5: Negative mood during organization will induce analytical processing leading to reduced retrieval errors

Hypothesis 6: Mood incongruence between organization and retrieval will increase retrieval times

Hypothesis 7: Mood incongruence between organization and retrieval will increase retrieval errors

We again conducted a set of independent samples t-tests comparing participants who organized happy vs sad on their total retrieval time and their total retrieval errors (measured by opening the wrong file). We also conducted a set of independent samples t-tests comparing participants in mood congruent vs. mood incongruent conditions for their retrieval times and errors. Each variable was inspected to determine any outliers or violations of normality. Both retrieval time and retrieval errors were extremely positively skewed with 3 extreme outliers, and 5 general outliers. Removal of outliers was not sufficient for normalizing these distributions, so instead we included all data points and logarithmically transformed these two variables in order to run our analyses. Log transformations were very successful in normalizing these distributions as determined by inspection of q-q plots. For comparison we re-ran our analyses with untransformed variables and the results were unaffected by the transformation.

Hypotheses 4 and 5 predicted that participants who organized while in a sad mood would have better performance on the retrieval task, measured by retrieval time and retrieval errors. Neither hypothesis was confirmed (see Table 4). Participants who were in the sad condition during organization were not faster to retrieve their files (M =2.54, SD = 0.24) compared to those in the happy condition (M =2.49, SD = 0.21), M = 0.06, CI [-0.03, 0.15], $t(94) = 1.23$, $p = 0.224$. Similarly, participants who organized while sad (M = 1.05, SD = 0.42) did not make fewer errors during the retrieval task than participants who organized while happy (M = 1.11, SD = 0.41), M = 0.06, CI [-0.11, 0.23], $t(94) = 0.71$, $p = 0.481$.

Table 4

Results of t-test and Descriptive Statistics for Retrieval Time and Retrieval Errors by Mood at Organization

	Mood at Organization						95% CI for Mean Difference		
	Organized Happy			Organized Sad					
	M	SD	n	M	SD	n		t	df
RT (Seconds)	348.95	201.07	47	411.75	271.55	49	-0.03, 0.15	1.23	94
Errors	15.40	14.48	47	18.67	19.12	49	-0.11, 0.23	0.71	94

Note. Response Time and Errors have undergone log transformations for 95% CI and t-test. Descriptive statistics are in original untransformed format for clarity.

Hypotheses 6 and 7 predicted that mood congruent conditions should improve retrieval performance. Once again neither hypothesis was confirmed (see Table 5). Participants in the mood congruent conditions were no faster (M = 2.50, SD = 0.21) to retrieve files than those in mood incongruent conditions (M = 2.54, SD = 0.25), M =

0.03, CI[-0.06, 0.12], $t(94) = 0.69$, $p = 0.490$. Similarly participants in mood congruent conditions showed no statistically significant mean differences in their retrieval errors ($M = 1.10$, $SD = 0.38$) compared to those in mood incongruent conditions ($M = 1.07$, $SD = 0.46$) during the retrieval task, $M = -0.03$, CI[-0.20, 0.14], $t(94) = -0.35$, $p = 0.729$.

Table 5

Results of t-test and Descriptive Statistics for Retrieval Time and Retrieval Errors by Mood Congruence

	Mood Congruence						95% CI for Mean Difference		
	Mood Congruent			Mood Incongruent					
	M	SD	n	M	SD	n		t	df
RT (seconds)	360.96	216.66	54	406.77	268.53	42	-0.06, 0.12	0.69	94
Errors	16.26	14.30	54	18.12	20.07	42	-0.20, 0.14	-0.35	94

Note. Response Time and Errors have undergone log transformations for 95% CI and t-test. Descriptive statistics are in original untransformed format for clarity..

One explanation for these null results could be that there was too much variance in the sample (as is typical when measuring PIM behaviors) in order to detect what we anticipated to be a small effect. Some support for this explanation can be seen in examining bar charts for retrieval times and retrieval errors (see Figure 6) where we see massive overlap in our 95% confidence interval error bars. To attempt to address this, we once again provide a set of analyses that introduce covariates as was seen in the Organization Task analyses. In our prior analyses we conducted a set of ANCOVA analyses that introduced OS preference as a covariate. For these follow

up analyses we added in a second covariate – the number of seconds spent reading the task files. By adding in reading time we address what if any differences are seen in retrieval times and errors over and above what would be expected by increasing the time spent reading the information.

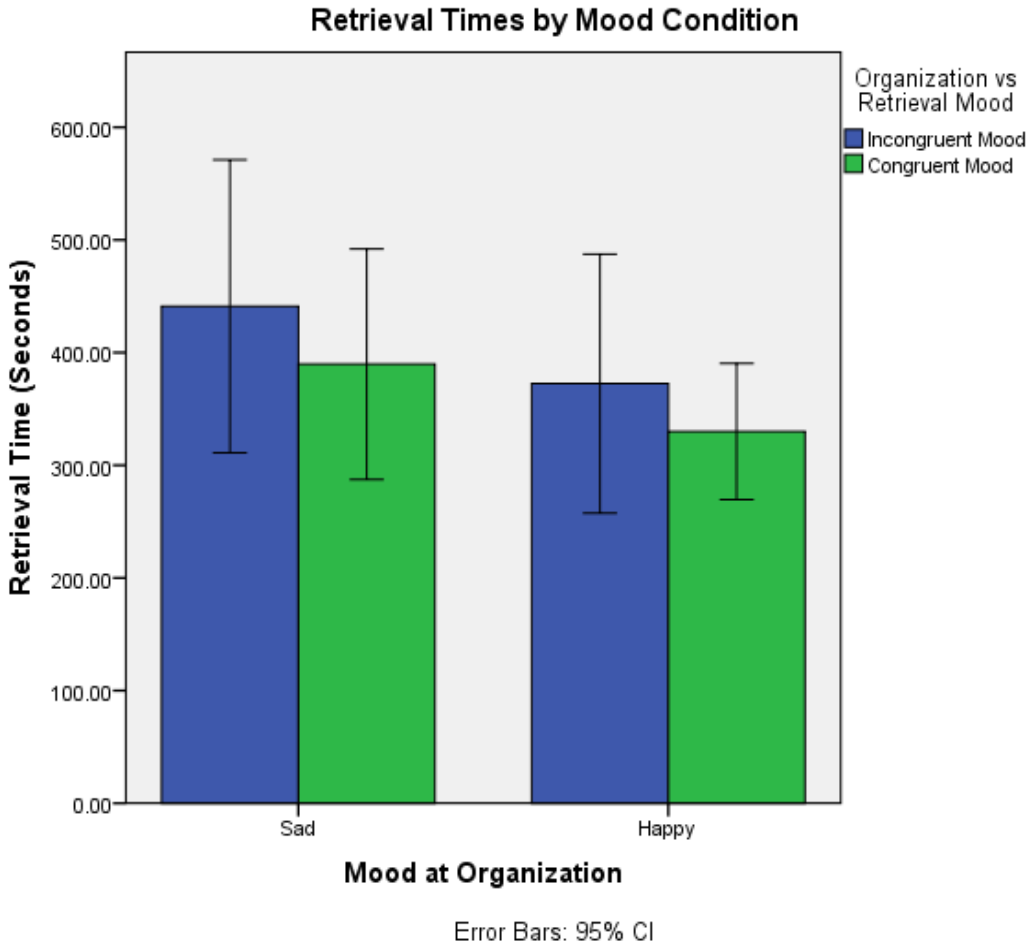

Figure 6. Average retrieval time (seconds) for participants in sad and happy conditions at organization, and congruent and incongruent moods at retrieval. Large error bars indicate highly variable data. No significant main effects or interaction.

The results were unaffected by the addition of the covariates OS preference and total reading time. After accounting for these potential confounding variables, participants in mood congruent conditions continued to show no statistically significant differences in retrieval time than those in mood incongruent conditions, $F(1, 88) = 0.755$, $p = 0.387$, partial $\eta 2 = 0.009$. There continued to be no detectable difference in number of errors across mood congruent and incongruent conditions, $F(1, 88) = 0.050$, $p = 0.824$, partial $\eta 2 = 0.001$. Additionally, initial mood (at organization) continued to have no effect on retrieval time, $F(1, 88) = 1.029$, $p = 0.313$, partial $\eta 2 = 0.012$, and no effect on retrieval errors, $F(1, 88) = 0.473$, $p = 0.493$, partial $\eta 2 = .005$.

Finally, to ensure that our independent variables (mood at organization and mood congruency) did not interact with each other, we conducted two one-way ANOVAs that incorporated both. As seen before, there was no main effect of mood at organization on retrieval times, $F(3, 92) = 1.582$, $p = 0.212$, partial $\eta 2 = 0.017$, and no main effect of mood congruency on retrieval times, $F(3, 92) = 0.502$, $p = 0.480$, partial $\eta 2 = 0.005$. In addition the interaction effect between mood at organization and mood congruency was not significant, $F(3, 92) = 0.095$, $p = 0.758$, partial $\eta 2 = 0.001$. In our second ANOVA looking at our two mood variables and their effect on retrieval errors we saw similar results. There was no main effect of mood at organization, $F(3, 92) = 0.670$, $p = 0.415$, partial $\eta 2 = 0.007$, and no main effect of mood congruency on retrieval errors, $F(3, 92) = 0.123$, $p = 0.727$, partial $\eta 2 = 0.001$.

And once again the interaction between mood at organization and mood congruency was not significant, $F(3, 92) = 1.036$, $p = 0.311$, partial $\eta 2 = 0.011$.

Debrief Survey

At the end of the study all participants completed a debrief survey. This survey asked participants demographic questions, questions about their perceptions of their task performance, and finally asked them what they thought the point of the study was. There was no indication that any of the participants were aware of any of our hypotheses. The closest responses to the question asking what they thought was the point of the study included answers like: "*how a person's mood can be affected while doing their work*", "*see if your mood affected your ability to organize and pay attention to where you put files*", and "*see the effect of mood on file organization.*" We determined that answers like these were not problematic as they gave no indication that they were aware of how we predicted mood would affect their PIM strategies. In total, 50.5% of participant responses made no mention of mood, 21.8% thought we were testing the relationship between mood and something other than PIM, and 27.7% believed that the study was testing the relationship between mood and PIM.

Responses to questions about perceptions of task performance were inspected. All questions were rated using a 1-5 scale (see Appendix 1 for full list of questions). Overall participants reported an average effort level of 3.73, an average enjoyment of 3.46, an average difficulty score of 1.72, and their average response was 4.6 when asked if organization was helpful. Responses on these questions contained no

significant differences between conditions. Each of these questions were statistically unrelated to any of the major study outcomes (number of files, folder depth, retrieval times, or retrieval errors), with the exception of perceived difficulty. Perhaps unsurprisingly, there was a small positive correlation between level of perceived difficulty and retrieval times, $r(96) = .262$, $p = .011$, and between level of perceived difficulty and retrieval errors, $r(96) = 263$, $p = .011$.

Discussion

The data in Study 1 support only our first hypothesis that participants in a sad mood generate more folders than participants in a happy mood. Hypothesis 2 predicted that sad participants would also generate deeper folder hierarchies and our data indicated only a trending effect of mood on folder depth. We found no evidence that participants took longer on the organization task based on their mood. And finally our data were not sufficient to confirm any of our retrieval task hypotheses. As it stands we have no evidence to support the prediction that negative mood at organization leads to better retrieval performance, and that mood congruence between organization and the retrieval task leads to better performance. These results are discussed in depth in the general discussion.

Study Two: Emotional Tendencies and their Relationship to PIM

While a lab procedure has its benefits, it limits our ability to determine how our results generalize to PIM behaviors in the real world. More specifically, by using a simulated PIM task, we ultimately asked participants to organize digital items that weren't actually theirs. While it’s often the case that one acquires digital items from

outside sources that are then saved into a personal archive, much of PIM behavior involves the organization of materials that are highly personally relevant (Bergman & Whittaker, 2016). To address this we conducted a follow-up study using a naturalistic approach that examines real-world PIM organizational behaviors and explores how they relate to participants' trait based emotional habits. We examined how the structures that people had personally created to organize their own personal information related to their emotional dispositions as assessed by standardized surveys.

In this study participant's general emotional tendencies were characterized using a set of well validated scales in order to see what relationship emotional traits had with their real-world PIM strategies. The four emotional scales used were the Subjective Happiness Scale (Lyubomirsky & Lepper, 1999), Satisfaction with Life Scale (Diener, Emmons, Larsen, & Griffin, 1985), the Scale of Positive and Negative Experience (Lyubomirsky & Lepper, 1999), and the Ruminative Response Scale (Treynor, Gonzalez, & Nolen-Hoeksema, 2003). The first two scales assess the individual's general trait levels of happiness. The Scale of Positive and Negative Experience provides us with the participant's estimation of the amount of positively or negatively valenced feelings they've had in the last month. And the last scale approximates participant's tendency towards negative thinking and trait levels of negative emotionality. Using these scales to characterize our participant's emotional tendencies, we could then assess how that related to how they organize their personal digital hierarchies.

The choice to use trait levels of emotionality instead of state, like we use in Study 1, is an attempt to address the fact that we cannot rely on participants' accuracy about their previous emotional states. In order to relate state levels of emotion to these real world PIM behaviors we would need to ask participants what mood they were in when they interacted with whatever parts of their hierarchy we are analyzing. However we know from previous research that memory is very likely to be biased (Loftus & Palmer, 1996; Mitchell et al., 1997; Walker et al., 2003). Asking participants to recall their previous emotional states would have likely led them to try to reconstruct their emotional past using inductive reasoning (e.g., assuming one was unhappy when interacting with a file that is associated with a high stress project).

The scales we used for emotional tendencies measure hedonic aspects of well-being. The literature on well-being typically differentiates between two general perspectives of well-being (Ryan & Deci, 2001). Hedonic refers to happiness and well-being from the perspective of pleasure seeking and pleasurable experiences, whereas eudaimonic refers to well-being not from experiences of happiness, but instead from leading a life that is congruent with one's larger set of values and leads to achievement of one's full potential (Ryan & Deci, 2001). For the purposes of our study we focused on the hedonic scales because they are most closely related to state by state emotional tendencies.

Participant's personal digital hierarchies were characterized using the same "Directory Crawler" described in Study 1. The program was run on participant's Desktop and Documents locations, as well as any other location the participant

acknowledged using regularly. This approach was adapted from our previous work exploring the relationship between PIM behaviors and personality traits (Massey et al., 2014). We did not analyze participant's hierarchies in the default location for Pictures and Music. These hierarchies were excluded because of the higher likelihood that they would have been automatically organized by programs like iPhoto and iTunes. Using the Directory Crawler program we were able to characterize the level of structure that participants use (i.e., average number of files per folder, average folder depth, etc.). The goal of this study was to determine the extent to which our findings from Study 1 generalized to real world behaviors. Of course, because of its design, this study can at best provide a correlational account of the relationship between emotional tendencies and PIM behaviors. This and further limitations are discussed later.

Hypotheses for this study were derived from the findings for Study 1 and are as follows:

Hypothesis 1: Participants with negative emotional biases will be more analytic and so organize materials more systematically drawing finer distinctions between files leading them to have fewer files per folder

Hypothesis 2: Participants with negative emotional biases will be more analytic and so organize materials more systematically drawing finer distinctions between files leading them to have deeper hierarchies

Method

The study consisted of three parts: the pre-survey screener questions, a battery of demographic and emotional tendency surveys, and a structural analysis of the file organization on the participant's personal computer.

Participants

109 undergraduate students (Male=32, Female=77) recruited from psychology courses participated in the experiment. Ages ranged from 18-23 years old (mean age=19.62, SD=1.23). Based on the completed responses (n=109), to optional demographics questions, our sample demographics are roughly: 0.9% American Indian/Native Alaskan, 25.7% Asian, 22.9% White/Caucasian, 34.9% Hispanic/Latino, 10.1% Mixed race, 1.8% Black/African-American, and 3.7% Other. Ages ranged from 18-23 years old (mean age=19.62, SD=1.23). All participants completed 1 short demographic survey, 4 surveys assessing their emotional tendencies. Three participants failed to complete the 4 emotional tendency surveys.

Participants were required to bring in a personal laptop computer (Mac=70, PC=38, Chromebook=1). We then asked them to allow us to conduct a structural analysis of the files they had saved on their personal computer using our Dircrawl analysis program. Ten of the participants' computers were incompatible with our analysis software. Other participants' computers contained insufficient data. Our procedure required them to have owned their computer for at least one year to ensure that they would have a sufficient number of files. Despite this, 36 of the Document hierarchies we analyzed contained fewer than 20 files and were excluded from

analyses that included the Documents folder. And 35 of their Desktop hierarchies contained fewer than 20 files and were excluded from analyses that included the Desktop folder. This left our final count at 60 Documents hierarchies and 61 Desktop hierarchies to include in our analyses.

Procedure

Upon arrival the experimenter asked the participant two screener questions:

1. Did you bring in your personal computer today?
2. Have you owned this computer for at least one year?

As long as the answer was "Yes," to both of these questions the experimenter then prompted the participant to read over and sign a consent form that included some general orienting information about the study. The participant was then asked to turn on their personal computer and navigate to an online survey. The survey contained some demographic questions, some background questions about their computing habits, and was the method by which we administered all four of the validated emotional tendencies scales. The survey typically took between 8-15 minutes.

Once the survey was completed, the researcher explained the process by which we would be analyzing their personal computer using a similar version of the Directory Crawler described in Study 1. This version of Directory Crawler also anonymized all the file and folder names because of the potential for capturing personally identifiable information. In addition it removes from our analysis all file types that are likely to be system generated files, as these were not organized by participants themselves. For a full list of the file types included in our cleaned up

Directory Crawler data see Appendix 2. This approach and version of the Directory Crawler program is similar that used in our previous work (Massey et al., 2014). To obtain informed consent from our participants, we first demonstrated the directory crawler analysis program showing how it generates anonymized structural data. Participants were encouraged to ask questions and allowed to withdraw if they did not want to participate. None withdrew. Similar to our previous approach (Massey et al., 2014), we did not run the analysis on the default locations for Music or Pictures because files in My Music and My Photos folders are an ambiguous case; they are personal files, but are often automatically organized by the system, such as iTunes or iPhoto. Instead, for every participant whose computer was compatible, we conducted our analysis on their "My Documents" or "Documents" folder and their "Desktop" folder as these were the most likely to be organized by the participants themselves. Participants were shown the results of this analysis to ensure they were comfortable that no identifiable personal data was being captured. No participants asked to have their data removed from the study.

Materials

Participants' trait levels of emotionality were assessed using four well validated scales. These included the Satisfaction With Life Scale, the Subjective Happiness Scale, the Scale of Positive and Negative Emotions, and the Ruminative Response Scale (see Appendix 3 for all items in the four scales).

Results

Trait levels of mood

Each of the 4 scales of trait levels of emotionality were scored. All scales followed normal distributions as assessed by q-q plots and inspection of boxplots indicated no presence of outliers.

Scores calculated for the Satisfaction With Life Scale (Diener et al., 1985) fall between 5-35. Scores below 20 indicate increasing levels of dissatisfaction, whereas scores above 24 indicate increasing levels of satisfaction. The average score in our sample was a 23.99 (SD = 5.586) which is considered a relatively neutral score.

The Scale of Positive and Negative Emotions (Diener et al., 1985) results in 3 different scores – Positive feelings (range 6-30), Negative Feelings (range 6-30), and Affect Balance (range from -24 to +24). The Affect Balance combines the scores from Positive Feelings and Negative Feelings by subtracting negative from positive. Because Affect Balance takes into account both types of feelings this is the score we used in our analyses. The average score in our sample on Affect Balance was a 6.49 (SD = 6.75), which is considered a slightly positive score.

Scores on the Subjective Happiness Scale (Lyubomirsky & Lepper, 1999) range from 1 to 7, where lower scores reflect lower happiness. The average score in our sample was 4.71 (SD = 1.18).

Finally, scores on the Ruminative Response Scale (Treynor et al., 2003) range from 22 to 88, with a general average across men and women of roughly 41 (Nolen-Hoeksema, Larson, Grayson, 1999). Higher RRS scores indicating a larger amount of rumination which has been correlated with depressive symptoms (Treynor et al.,

2003). The average score in our sample was 47.07 (SD = 14.06) indicating a slightly higher score than what may be expected.

Hypothesis Testing

Hypothesis 1: Participants with tendencies towards negative feelings will have fewer files per folder because they tend to be more systematic with the structure they apply

Hypothesis 2: Participants with tendencies towards negative feelings will have deeper hierarchies because they tend to be more systematic with the structure they apply

To test our hypotheses, we ran separate analyses on each of the 4 emotional tendency scales outlined in our method. For each scale we ran 2 separate one-way multivariate analyses of variance (MANOVA) to see if features of the Documents hierarchy or features of Desktop hierarchy were significantly different based on low and high levels of emotionality. Participants were divided into high versus low levels of emotionality for each survey based on median splits. We conducted separate analyses for each hierarchy (Documents, Desktop) because previous work has indicated that these hierarchies are used in different ways (Barreau & Nardi, 1995; Massey et al., 2014). In order to compensate for overall hierarchy size for examining depth (which is likely to be deeper if there are more files) we scaled this variable to be files per depth. This can be thought of similarly to files per folder, which indicates the typical size of the categories made. But instead files per depth indicates the average number of files at any given depth indicating a relative threshold at which the participant would be likely to add to the depth to compensate for more files. There

was not enough evidence to support any of the hypotheses for either the Desktop or Documents hierarchies. The results of these analyses are described below by scale.

Prior to each MANOVA we conducted preliminary assumption checking. Each of the dependent variables (files per folder, and files per depth) were extremely positively skewed as assessed by Shapiro-Wilk test for both Documents ($p < .001$ & $p < .001$ respectively) and Desktop hierarchies ($p < .001$, $p < .001$, & $p < .01$, respectively). They each also contained multiple univariate outliers as assessed by boxplot. Simple outlier removal was not enough to address these issues with normality so outliers were left in and we instead log transformed each variable to reduce the impact of these outliers and improve normality. The normality was improved, but still somewhat skewed for both Documents ($p = .454$ & $p < .020$ respectively) and the Desktop hierarchies ($p = .559$ & $p < .057$ respectively), however the MANOVA fairly robust to these violations so analyses were carried out with the log transformed variables.

Scale of Positive and Negative Emotions (SPANE). We ran a MANOVA to see if participants who reported High vs. Low SPANE scores behaved differently in their Desktop hierarchy. A median split was conducted to categorize participants into High or Low SPANE scores. Number of Desktop files per folder and files per depth were compared across groups. The differences between High and Low SPANE groups on these combined Desktop variables was not statistically different, $F(2, 58) = 0.938$, $p = .397$; Wilks' $\Lambda = .969$; partial $\eta 2 = .031$.

Additionally we tested the Documents hierarchy to see if low and high SPANE scores differed on these same organizational features. The differences on these combined Documents variables was not statistically significant between high and low SPANE groups: $F(2, 57) = 1.073$, $p = .349$; Wilks' $\Lambda = .964$ partial $\eta 2 = .036$.

Subjective Happiness Scale (SHS). SHS scores were categorized into High and Low scores using a median split and were compared to see if they differ on number of files per folder and files per depth on the Desktop. High and Low SHS groups showed no statistically different differences on the combined Desktop variables, $F(2, 58) = 0.828$, $p = .442$; Wilks' $\Lambda = .972$; partial $\eta 2 = .028$.

Similarly, High and Low SHS groups were compared on these same variables in the Documents hierarchy and no statistically significant differences were detected, $F(2, 57) = .2.284$, $p = .111$; Wilks' $\Lambda = .927$; partial $\eta 2 = .073$.

Satisfaction With Life Scale (SWLS). Scores from the SWLS were divided into “High” or “Low” using a median split. High and low groups were compared to see if they differed in number of files per folder and files per depth on the Desktop. The differences between High and Low SWLS groups on the combined Desktop variables was not statistically significant, $F(2, 58) = 0.368$, $p = .694$; Wilks' $\Lambda = .987$; partial $\eta 2 = .013$.

Additionally we tested whether High and Low SWLS groups would differ in the same variables in the Document hierarchy. There was no statistically significant

difference on the combined documents variables across SWLS groups, $F(2, 57) = .979$, $p = .382$; Wilks' $\Lambda = .967$; partial $\eta 2 = .033$.

Ruminative Response Scale (RRS). Lastly we tested similar results using responses on the RRS. Once again responses were categorized into High and Low RRS groups and a MANOVA was run to determine if there were group differences on the combined variables of files per folder and files per depth. These combined variables on the Desktop showed no statistically significant group differences between High and Low RRS groups, $F(2, 58) = 0.689$, $p = .506$; Wilks' $\Lambda = .977$; partial $\eta 2 = .023$. Additionally these same variables from the Documents hierarchy indicated no group differences for High and Low RRS responses, $F(2, 57) = 1.204$, $p = .279$; Wilks' $\Lambda = .957$; partial $\eta 2 = .043$.

General Discussion

Personal information management can be a challenging task, but in an increasingly technological world, effective organization has become crucial for both one's work and personal life. Furthermore, as personal digital archives continue to grow, it promises to become even more critical. Ensuring that one can quickly access personal digital information clearly impacts productivity, but as personal archives grow to include personal photos and music it is also becoming more broadly important.

Researchers are still working to understand how people undertake this often poorly defined problem and have regularly noted the large range of behaviors and preferences (Bergman & Whittaker, 2016; Bergman, et al., 2008; Boardman & Sasse,

2004; Gwizdka, 2004; Jones & Teevan, 2007; Malone, 1983). For example, individual differences have been repeatedly documented in organizing files (Bergman & Whittaker, 2016; Massey et al., 2014), email (Fisher et al., 2006; Gwizdka, 2004; Whittaker et al., 2011; Whittaker & Sidner, 1996), bookmarks (Aula, Jhaveri, & Käki, 2005), and photos (Whittaker, Bergman, & Clough, 2010). The goal of the studies in the current thesis was to determine how much of such individual organizational variability might be explained by mood and how those individual differences impact file access. Prior research has shown that mood can affect a variety of behaviors like memory (Bower, 1981), categorization (Isen et al., 1978), and more generally, processing style (Forgas 1987). One explanation for these changes is that mood is an adaptive cue about our current behaviors, serving as an indication about how our current behavioral strategies are working with regards to larger goals (Erber & Erber, 2001; Isen, 1984). This adaptive theory therefore argues that negative mood signals that something is awry and an adjustment is needed. This negative signal promotes a change in cognitive processing style, leading behavior to become more analytical and systematic to identify and remedy the perceived problem. In contrast, positive moods signal progress, indicating that current strategies are working effectively and going forward we should integrate new information and goals using these strategies. However, no prior work has explored the implications of this relationship between mood and cognitive processing style in the context of PIM.

To test this we conducted an in-lab and follow-up naturalistic study to determine if changes in mood could similarly change behaviors in PIM. Specifically

we wanted to know whether file organizational style might be affected by mood differences. In Study 1 we experimentally manipulated whether participants were in a happy or sad mood and then asked them to do an in-lab filing simulation. Results from this filing simulation showed, as anticipated, that sad participants made significantly more folders than happy participants. This finding is complementary to previous work (Isen & Daubman, 1984) demonstrating that individuals put into happy moods generate more inclusive categories, however it extends this finding to a new digital domain. The increase in folder generation for sad participants also lends support to the more broad claim that negative moods increase analytic and systematic processing as is suggested in models like the Affect Infusion Model or AIM (Forgas 1987). One explanation for the generation of larger numbers of folders could be that sad participants are focusing on more fine grained distinctions leading them to generate more exclusive categories. This strategy is consistent with observations from the domain of visual processing where sad moods lead to a focus on local rather than global details (Fredrickson & Branigan, 2005).

A second aspect of PIM we predicted would be affected by mood was the total folder depth. We predicted folders would be deeper for sad participants as they were more likely to be engaging in more systematic processing strategies. We did not find support for this prediction. While the effect was trending in the correct direction there was too much variability to make confident claims that the observed difference would hold stable. There is also previous research that shows that individuals in happy moods tend to make decisions more quickly and efficiently (Isen, 2001; Isen &

Means, 1984) leading us to predict that task times should differ by condition as well. However, we found no evidence that happy participants took significantly less time on our task. The amount of time spent on the task was nearly identical across conditions even when we inspected more nuanced aspects like the time spent reading files, versus the time spent organizing.

In addition to organizing a set of files in Study 1, participants were also required to retrieve those files. This retrieval task came after a second mood manipulation that was either congruent or incongruent with the mood induced at organization. Participants had to use their self-generated organizational structure to re-find the file in response to question prompts. We predicted that mood during the organization task would affect retrieval performance, and specifically that sad mood would lead to better performance (measured by retrieval time and number of errors). This prediction was based on prior work showing that memory is more accurate and less susceptible to distortion when the original memory is formed during a negative mood (Kensinger, 2007; Kensinger et al., 2007; Levine & Bluck, 2004). These findings are often used as additional support for the claim that negative mood leads to systematic and analytic thinking styles.

We did not find any evidence to support this hypothesis. Happy and sad participants were no different in either their retrieval time or errors. Further, had the mean differences between conditions been significant they would have been in the opposite direction predicted. While this suggestion alone does not disprove the theory that negative mood makes people more systematic, it does lend support to an

important critique (Isen, 2002) of theories like the AIM. Isen (2002) argues that framing of negative mood as systematic and analytical has led to the erroneous conclusion that positive mood leads to lazy, imprecise, and stereotype driven behaviors. Our data, while inconclusive, supports this view; that it is likely not as simple as negative mood is better than positive mood with regard to getting work done.

We also explored mood congruence between the organization task and the retrieval task predicting worse performance if organization and retrieval moods were not matched. Previous work has found that mood congruency can have a significant impact on recall (Bower, Monteiro, & Gilligan, 1978; Leight & Ellis, 1981; Schare, Lisman, & Spear, 1984), an effect that is referred to as mood dependent memory. We found no evidence to support this hypothesis. Participants in our mood congruent and incongruent conditions did not perform differently. Mood dependent memory has been noted as difficult to replicate even by some of the original researchers who found the effect (Bower & Mayer, 1985; Brown & Taylor, 1986), so it is perhaps unsurprising that we showed little difference between our mood congruent and mood incongruent conditions.

In Study 2 we looked at real world PIM behaviors by running an anonymized analysis of people's digital file hierarchies on their personal computers. To explore the relationship between mood and PIM we gave participants validated scales to measure their *emotional tendencies* towards positive and negative emotions.

The hypotheses for this thesis are based on mood states, which are what we tested in Study 1, however mood states are difficult to determine retroactively. It is unreliable to ask a participant to self-report what mood they were in when organizing a specific part of their digital file hierarchy, as this behavior could have occurred long in the past. Because of this limitation, rather than mood in Study 2 we explored *emotional tendencies* (trait as opposed to state levels of emotions). This allowed us to develop a set of predictions that are consistent with our overall hypotheses. People with strong negative emotional tendencies are more likely to file when in negative moods, and those with strong positive tendencies to file when positive. Similar to Study 1's findings, we therefore predicted that participants with negative emotional tendencies would have fewer files per folder (i.e. more folders). The opposite should be true for those positive emotional tendencies. We also predicted a similar relationship to the trending result we saw in Study 1, that sad participants would have deeper folder hierarchies. But despite promising results in Study 1, we found no evidence in Study 2 that emotional tendencies were related to the number of folders and the relative depth of participants digital file hierarchies.

Implications

Although sad participants generated more folders than happy participants undergoing the same procedure, Study 1 failed to show any significant differences in retrieval outcomes. The fact that retrieval performance appeared not to be affected by these changes to strategies raises questions about the practical consequences of these results. However one response might be that PIM is a very complex behavior, and

while mood may affect some aspects of that behavior (like the number of folders one generates), it just does not have enough of an impact on these behaviors to result in any measurable differences in our ability to re-find information. If this is the case, then these results are interesting from a psychological perspective in terms of understanding the impacts of mood on behavior, but from a PIM perspective there are less strong design recommendations.

However, another possibility could be that there are effects on retrieval performance but only when dealing with a larger realistic set of files. It may be that this is a simple lack of statistical power because the base PIM behaviors themselves are already so variable, and it isn't until an individual is dealing with a hierarchy much larger than 60 files that we see a change in their performance resulting from mood based behavioral changes. For example previous work (Bergman et al., 2010) has indicated having overly complex PIM structures can negatively affect retrieval. Bergman et al. (2010) showed that each level of folder depth adds about 2.236 seconds to retrieval and each non-target file in a folder adds about 0.106 seconds, Given that our average across conditions for folder depth (2.48 levels) and number of files per folder (3.43 files per folder) was so small, it's reasonable to expect that mood impacts may not appear until we are dealing with a larger archive.

In general participants were relatively successful at the retrieval task with only 8% of trials containing more than 4 errors. In addition, during the debrief participants typically reported that they found the organization helpful a response which not differ based on differences in mood or in the folder structure generated. This observation in

combination with the fact that retrieval performance was unaffected by mood or the differing filing approaches is actually consistent with the user subjective approach (Bergman, Beyth-Marom, & Nachmias, 2003) that argues that what matters most for PIM success is that the structure makes subjective sense to the individual user that uses it. Based on the user subjective approach you could argue that it matters less what specific strategy our participants used (e.g. making many versus fewer folders), instead files had to be structured in a way that made sense to them.

In addition the study design itself could have reduced the effects of mood on retrieval. Our procedure involved a single session, because we wanted to avoid inevitable participant dropout arising from asking participants to return a second time. But by completing all the tasks in one day we ended up with a relatively long experimental session (1.5-2 hours). This might have induced fatigue by the time participants were doing the retrieval task. This fatigue may have differentially affected our experimental manipulations because sad moods are supposed to lead to systematic, analytic processing. This means that sad participants were required to do a more cognitively demanding task over an extended interval than those who were only experiencing happy moods.

Regardless of the difficulties in explaining the lack of mood based retrieval effects, there are still implications for the PIM literature specifically in explaining the wide range of individual preferences and behaviors. In particular, the fact that we can change a key PIM organizational behavior by manipulating mood demonstrates a source of individual difference not previously discussed – organizational

inconsistency. Research on individual differences in PIM suggests that such differences arise from factors such as cognitive style (Gwizdka, 2004), personality (Massey et al, 2014), or job demands (Whittaker and Hirschberg, 2001; Whittaker and Sidner, 1996). But these discussions of differences include a subtle, perhaps unintended, assumption about individual consistency. In other words, they assume that people are idiosyncratic only when compared with each other, but each individual has unique preferences and their own consistent method for dealing with PIM. Our results call into question this assumption and demonstrate a situation where individuals may be internally inconsistent. It is therefore perhaps unsurprising that we found little difference when looking at average filing behaviors across personal hierarchies in Study 2, because it may be that we need to be looking beyond averages to markers of inconsistency, and such markers are difficult to assess with an anonymizing analysis tool like Directory Crawler.

Limitations

There are limitations with both studies. Although conducting a lab-based study of PIM allowed us to control experimental materials, Study 1 is limited because it examines an organizational behavior that occurs in wide range of contexts with material that one usually feels a sense of ownership over (Bergman & Whittaker, 2016). By asking participants to organize artificial files, we run the risk that they will treat these files differently from their own personal archives, which they have often taken care to generate and are motivated to organize. There may be a concern that lab participants are not motivated to make the kinds of file structures they would for re-

finding personal files from their own archives. We aimed to motivate lab participants to actively organize files by requiring participants to retrieve those files later, but the organizational strategies they used could have been slightly different knowing that they would only need to retrieve files once.

And while the retrieval task was crucial for both ensuring that participants took the organization task seriously and assessing whether there were measurable outcomes to different organizational strategies, it did make Study 1 long and demanding for participants. We have already discussed how fatigue might have interacted with experimental condition, but there is also the possibility that fatigue could have had a bigger impact on the retrieval times than the mood that participants were induced into. In addition, we had to keep the task feasible to complete within a maximum of 2 hours so we had to limit the number of files participants were required to organize. Overall people have thousands of files in their personal archives (Bergman & Whittaker, 2016; Whittaker, 2011). As mentioned previously, by only asking participants to organize 60 files we may have limited the effects resulting from the mood induced organizational strategies.

Finally, Study 1 was also limited by the mood induction procedure. Mood induced in the lab could be different from how we experience it in the real world. And while there are many studies that use lab induced moods, there is no real standard procedure for mood induction (Westermann et al., 1996) which forced us to modify and adapt existing approaches. Without a standardized approach it's difficult to say whether the moods we induced in lab are comparable with other studies.

Some important limitations in Study 2 include the directory analysis tool used (Directory Crawler) which collects large-scale metrics for what may be a very nuanced aspect of behavior. In addition, Study 2 had to rely on emotional tendencies as opposed to state based emotions (as was manipulated in Study 1), which makes it a weaker manipulation making it difficult to interpret our null findings compared with Study 1. One possibility is that if we wish to explore emotional tendencies, it may be that traits like emotional stability (e.g., neuroticism) represent a more promising approach because this trait gets more directly at the extent to which an individual's emotions are consistent or stable. This was explored by Massey et al (2014) and this point is explored more in our future work section.

And finally, our samples in both studies consisted entirely of undergraduate college students at University of Santa Cruz, California. Because this sample is limited we have to be careful about generalizing to other populations. In particular, undergraduates may have less experience with needing to manage a large digital archive for work, so their strategies may look different from other populations. In addition they may simply have less information than populations studied in other contexts (Bergman and Whittaker, 2016, Whittaker, 2011).

Future work

There are many open questions arising from this thesis. In particular future studies should focus on exploring what practical outcomes and real world effects result from mood based behavioral changes to PIM. For example, the use of more nuanced ways of exploring individuals' personal computers like the PIM tour

(Barreau, 1995; Boardman & Sasse, 2004) might be more sensitive methods for determining whether these changes to behavior are found in the real world. Using the PIM tour, researchers could leverage participants' knowledge of their personal hierarchy to discover ways that they may be organizing in consistent or inconsistent ways. Additionally, researchers could explore with participants and get explanations for why different areas of their file systems may be organized differently. In contrast to our anonymizing structural analysis tool (Directory Crawler), the PIM tour could allow researchers to go beyond simple totals and averages to some more interesting features of these structures like organizational consistency.

In addition, the use of emotional tendencies is a similarly imprecise proxy for mood. Given that changes to mood state induced behavioral changes, perhaps the addition of scales that identify general tendencies towards emotional fluctuation could be useful in developing metrics for predicting the types of PIM structural changes researchers should expect within an individual's personal computer. For example, researchers could look at whether an individual scores high on the Big Five trait Neuroticism (John & Srivastava, 1999; McCrae & Costa, 1999) which can serve as an indication that they tend to be very emotionally reactive. Lower scores on Neuroticism would indicate a more stable emotional tendency. When used in combination with the type of emotional tendency scales we used in Study 2, we could get a clearer picture of not just whether an individual tends to be more positive or negative but also whether these tendencies are generally stable or tend towards inconsistency. From this researchers may predict that individuals who tend towards

negative emotions and tend towards being emotionally reactive would use PIM strategies that lead to inconsistent organization (e.g., inconsistent usage of highly complex folder structures). And providing further support to this approach, we have shown in prior work that Neuroticism may be linked to differing strategies on the Desktop when workload is high (Massey et al., 2014)

Additionally future studies could look into what consequences these changes to PIM behavior have on retrieval. While our results were inconclusive, future work could test file retrievals that involve the organization of more files. Having more files should increase the likelihood of retrieval effects should organizational strategies differ. Another interesting direction could be to have participant's retrieve and organize their own files. And even a method similar to the one presented in our study could benefit by changing the retrieval to include a longer delay (e.g., 24 hours) between organization and re-finding which may improve results by simply reducing fatigue.

If we can establish benefits to strategies used by happy or sad individuals then it might be possible to design desktop tools to manipulate mood to generate desirable effects. If, for example, making fewer folders is a good thing then designs might manipulate mood to encourage people to be in happy moods when making decisions about how to structure their computer. For example various recent systems have been developed to improve mood and well-being (Hollis, Konrad, Springer, M. Antoun, C. Antoun, Martin, & Whittaker 2017; Isaacs, Konrad, Walendowski, Lennig, Hollis, & Whittaker, 2013; Konrad, Isaacs, & Whittaker, 2016). And even the file system itself

could serve as an emotional regulator by encouraging people to organize so that they are more likely to encounter positive information than negative information. And this behavior may be happening to some extent already. This strategy of using one's environment to regulate emotions has been established in physical spaces like dorm rooms and offices (Gosling, Ko, Mannarelli, & Morris, 2002) and even in online profiles (Sas & Whittaker, 2013). Screensavers may be another example where people structure their online environment so that they will actively encounter emotionally positive information.

Conclusion

The relationship between mood and personal information management has never been discussed or explored empirically. Using a simulated digital filing task we demonstrated that by manipulating mood we can change filing behaviors. In the lab, participants we had induced to be sad made more folders than those we had induced to be happy. This extends previous psychology research demonstrating the effects of mood on general categorization. Furthermore this thesis demonstrates a new kind of individual difference not previously discussed in PIM literature – organizational inconsistency, namely that different aspects of people's file systems will be ordered differently depending on their mood at organization. From the current research we still cannot conclude what impacts such filing inconsistency may have on retrieval success and we were unable to determine how mood changes real world filing behaviors. Further work is needed to further explore this relationship in more naturalistic settings using larger scale hierarchies.

Appendix

Appendix 1. List of debrief survey questions on task performance (Study 1)

1. Rate how enjoyable you found this task:

   -1- -2- -3- -4- -5-

   Not at all enjoyable Extremely enjoyable

2. Rate how difficult you found this task

   -1- -2- -3- -4- -5-

   Not at all difficult Extremely Difficult

3. Rate the level of effort you put into this task

   -1- -2- -3- -4- -5-

   No effort/Did not try Extreme Effort

4. Rate how helpful you found organizing the files was for retrieval

   -1- -2- -3- -4- -5-

   Not at all helpful Extremely helpful

Appendix 2. List of all files Directory Crawler kept from participants personal archives.

aup	m4a	ott	wma
avi	mid	pages	wmv
band	mov	pdf	wpd
bmp	mp2	png	wpd
csv	mp3	ppt	wps
doc	mp4	pptx	xls
docx	mpeg-4	ram	xlsx
dot	mpg	realaudio	xlw
dotx	msg	rpj	xm
flv	numbers	rtf	zip
gif	odm	tex	
jpeg	odt	tiff	
jpg	oth	wav	

Appendix 3. List of questions from four emotional tendency scales (Study 2)

1. **Satisfaction with Life Scale (SWLS)**

Below are five statements that you may agree or disagree with. Using the 1 - 7 scale below, indicate your agreement with each item by placing the appropriate number on the line preceding that item. Please be open and honest in your responding.

In most ways my life is close to my ideal.
7 (Strongly agree) – 1 (Strongly disagree)

The conditions of my life are excellent.
7 (Strongly agree) – 1 (Strongly disagree)

I am satisfied with my life.
7 (Strongly agree) – 1 (Strongly disagree)

So far I have gotten the important things I want in life.
7 (Strongly agree) – 1 (Strongly disagree)

If I could live my life over, I would change almost nothing.
7 (Strongly agree) – 1 (Strongly disagree)

2. Subjective Happiness Scale (SHS)

For each of the following statements and/or questions, please circle the point on the scale that you feel is most appropriate in describing you.

1. In general, I consider myself:
not a very a very
happy person 1 2 3 4 5 6 7 happy person

2. Compared with most of my peers, I consider myself:
less happy 1 2 3 4 5 6 7 more happy

3. Some people are generally very happy. They enjoy life regardless of what is going on, getting the most out of everything. To what extent does this characterization describe you?
not at all 1 2 3 4 5 6 7 a great deal

4. Some people are generally not very happy. Although they are not depressed, they never seem as happy as they might be. To what extent does this characterization describe you?
not at all 1 2 3 4 5 6 7 a great deal

3. Scale of Positive and Negative Emotions (SPANE)

Please think about what you have been doing and experiencing during the past four weeks. Then report how much you experienced each of the following feelings, using the scale below. For each item, select a number from 1 to 5, and indicate that number on your response sheet.

1. Very Rarely or Never 2. Rarely 3. Sometimes 4. Often 5. Very Often or Always

- Positive
- Negative
- Good
- Bad
- Pleasant
- Unpleasant
- Happy
- Sad
- Afraid
- Joyful
- Angry
- Contented

4. Ruminative Response Scale (RRS)

People think and do many different things when they feel depressed. Please read each of the items below and indicate whether you almost never, sometimes, often, or almost always think or do each one when you feel down, sad, or depressed. Please indicate what you generally do, not what you think you should do.

1 almost never - 2 sometimes - 3 often - 4 almost always

1. think about how alone you feel
2. think "I won't be able to do my job if I don't snap out of this"
3. think about your feelings of fatigue and achiness
4. think about how hard it is to concentrate
5. think "What am I doing to deserve this?"
6. think about how passive and unmotivated you feel.
7. analyze recent events to try to understand why you are depressed
8. think about how you don't seem to feel anything anymore
9. think "Why can't I get going?"
10. think "Why do I always react this way?"
11. go away by yourself and think about why you feel this way
12. write down what you are thinking about and analyze it
13. think about a recent situation, wishing it had gone better
14. think "I won't be able to concentrate if I keep feeling this way."
15. think "Why do I have problems other people don't have?"
16. think "Why can't I handle things better?"
17. think about how sad you feel.
18. think about all your shortcomings, failings, faults, mistakes
19. think about how you don't feel up to doing anything
20. analyze your personality to try to understand why you are depressed
21. go someplace alone to think about your feelings
22. think about how angry you are with yourself

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