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Chapter 13

Repression: A Cognitive Neuroscience Approach

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Over a century ago, Freud proposed that memories can be forgotten by pushing them into the unconscious, a process called repression. The existence of repression has remained controversial for more than a century, in part because of its strong coupling with trauma and the ethical and practical difficulties of studying this process in controlled laboratory experiments. In the popular media, skeptics of repressed memories have cast repression as a "myth," a bit of clinical folklore with no bearing on reality, and a process for which no scientifically valid psychological mechanism exists. In contrast to this, repression, or at least behavior resembling it, is often reported by psychoanalysts and other mental health professionals who interact regularly with psychological patients. The distance between these perspectives on repression is striking, reflecting an enduring disconnection between those who claim to witness the phenomenon or its effects, and those who insist on rigorous specification and evaluation of this construct. Psychology, as a field, has two ways in which it might respond to this persisting conflict: to continue with dissociated traditions and viewpoints, leaving matters unresolved, or to reconcile these perspectives by specifying the mechanisms of repression, relating it to the growing body of research on the cognitive and neural mechanisms of memory, and by making it empirically testable. But is a science of repression even possible?

In this chapter, I review a program of research that I have been pursuing now for over a decade that may reconcile these dissociated views. A central strategy I have pursued has been to consider how repression might be understood in terms of mechanisms that are widely studied in cognitive psychology and cognitive neuroscience. To this end, I have focused on

a well-specified question: what are the mechanisms by which human beings willfully control awareness of unwanted memories, when confronted with reminders to them? Although my colleagues and I view this question through the lens of cognitive psychology, the situation bears a strong resemblance to repression. Thus, a better understanding of memory control may provide both the theoretical and empirical grounding necessary to make repression a scientifically tractable problem. The resulting theory may not be identical to Freudian repression, but it clearly speaks to the situations characterized by Freud. First, I describe our general theoretical perspective, and the behavioral and neurobiological evidence that supports it. I then discuss how these constructs relate to Freudian repression.

Executive Control and the Mechanisms of Retrieval

The current perspective about memory control begins with the indisputable observation that actions, once started, can usually be stopped. This fact was impressed upon me one evening while opening the kitchen window. As the window slid along its track, it pushed a cactus off the sill. My hand darted to catch the cactus. Mere centimeters from it, I stopped my hand from clutching the cactus's needle-dense body. This timely save was made possible by my ability to stop physical action–an ability so pervasive that it goes unnoticed in daily life.

The preceding case is a classic example of a situation in which we need to stop a strong habitual response, a situation widely regarded as requiring executive control. This is sometimes referred to as response override, and is illustrated in Fig. 1. In response override, one must stop a prepotent response to a stimulus, either because the response needs to be withheld, or because a less common response is more appropriate. The capacity to stop or redirect action in this way is crucial. Without it, we would lose the flexibility to adapt behavior according to changes in goals, or to changes in the environment. We would be slaves to habit or reflex.

But how do we keep from being automatically controlled by the habitual action? One widely discussed answer is that inhibition is used to suppress the habitual response. On this view, the appearance of a stimulus activates a representation of that stimulus in memory. Activation then spreads to associated responses in proportion to how strongly associated

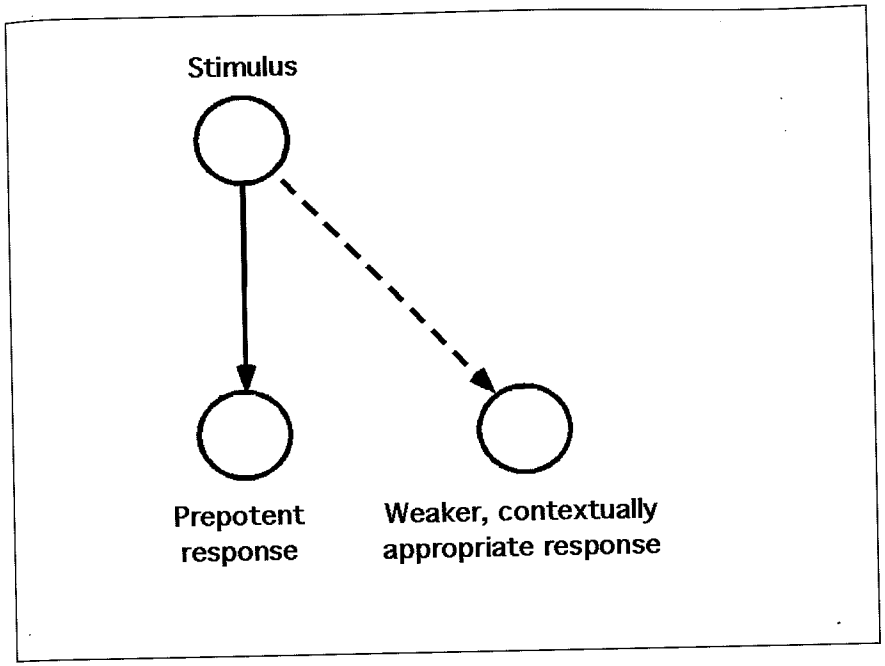

Fig. 1. A typical response override situation. *Circles* correspond to representations in memory, with *lines* representing associations between these representations. The stimulus is linked to two responses, one of which is stronger (prepotent), and the other of which is weaker (*dotted line*). Response override must occur when the organism needs to either (a) emit the weaker, but more contextually appropriate response, despite the stronger association with the prepotent response, or (b) stop any response from occurring. Inhibitory control is thought to suppress activation of the prepotent response to permit response override. The response override situation characterizes many paradigms in work on executive function, including the stroop and go/no-go tasks

they are to the stimulus. When a response becomes sufficiently activated, it will be emitted. If there are multiple responses, the one that achieves threshold most quickly will generally be emitted. However, if a weaker response is more appropriate, inhibition can be recruited to suppress the stronger ones. Inhibition is thought to reduce the activation level for a given response, preventing it from achieving threshold. By doing so, weaker but more appropriate responses can be expressed, enabling flexible, context-sensitive behavior. This is known as inhibitory control.

Given the importance of inhibitory control in managing overt behavior, one might ask whether internal actions might also be influenced by such mechanisms. Parallels exist between the control of action and the control of memory. Just as a stimulus may spread activation to a prepotent motor response, a retrieval cue may activate a strongly associated item in

memory, leading it to be retrieved. The retrieval of associated memories is not always desirable; sometimes we may wish to retrieve a memory associated with the cue; at other times we may wish to avoid retrieval altogether, either because the memory is unpleasant or because we wish to maintain focus on the cue concept. Although we often retrieve things that we do not intend, we can control this tendency; we can recollect the event we are seeking despite interference from stronger competitors, and we can stop ourselves from thinking about unwanted memories. Given these parallels between motor behavior and retrieval, response override mechanisms may be recruited to control unwanted memories. If so, we should find evidence for inhibitory control in memory situations likely to involve response override.

In my view, strong evidence for these parallels exists. In support of this, I briefly review evidence for inhibition in memory selection and in memory stopping. Memory selection is required when our goal is to recall an event or fact from memory in the face of interference from related traces that become activated by cues guiding retrieval. The need to stop retrieval arises when we confront a cue and wish to prevent an associated memory from entering awareness. In both cases, attempts to limit the influence of distracting memories have been found to impair later retention, highlighting an important link between forgetting and the control of retrieval.

Selective Retrieval and Retrieval-Induced Forgetting

The need to select a weaker response to a stimulus in the face of interference from a prepotent competitor has a parallel in memory in the situation of selective retrieval. Here, the aim is to recall a target memory when given one or more cues. Typically, a cue will be associated with other memories as well–and some may be more associated to the cue than the target item. It is well known that when multiple traces are associated with the same cue, they compete for access to consciousness [1, 2]. This form of competition presents a problem of control because the cue cannot be relied upon to access the target–in fact, the presence of a strong competitor could perpetually divert us from that target. If inhibitory control is recruited to override prepotent responses, they might also be used to override prepotent memories. To the extent that inhibition persists, situations demanding

the selective retrieval of a target should induce lasting memory impairment on competitors. Thus, the act of remembering should cause the forgetting of related memories.

Over the last decade, I have explored this prediction with a procedure we refer to as the retrieval practice paradigm [3]. In the typical study, subjects encode lists of category–exemplar pairs (e.g., *fruit–orange*; *drinks–scotch*; *fruit–banana*). They then perform retrieval practice on half of the exemplars from half of the categories by completing cued stem recall tests (e.g., *fruit–orange*). Each practiced item is tested several times to increase the effect of retrieval practice on related items. After a delay, subjects are tested on all studied exemplars. Performance on this category cued recall test can be measured for three item types: practiced items (e.g., *orange*), unpracticed items from the practiced categories (e.g., *banana*), and unpracticed baseline items from unpracticed categories (e.g., *scotch*). Figure 2 illustrates typical findings. As can be seen, recall of the practiced exemplars was improved relative to performance on baseline items. More importantly, recall of the unpracticed exemplars from the

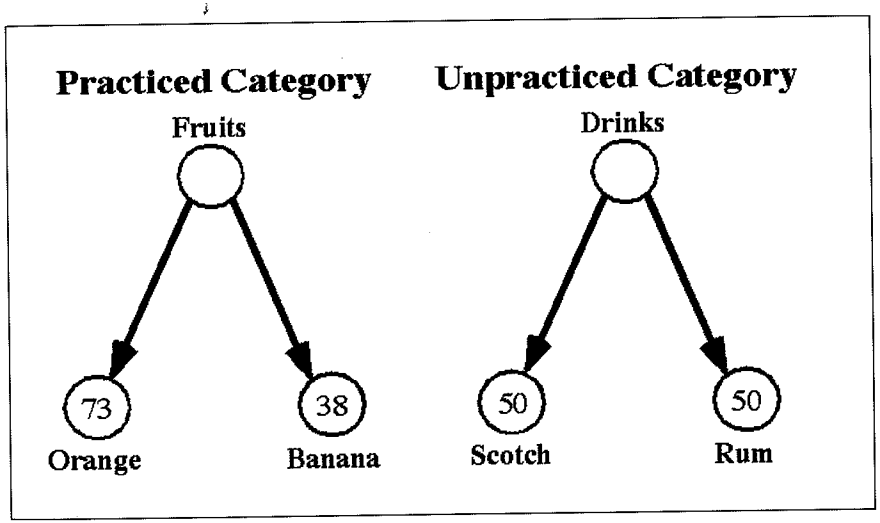

Fig. 2. A typical within-category retrieval-induced forgetting study, as done by Anderson et al. [3]. The example illustrates two items from each of two categories that subjects have studied (six items are usually studied in eight categories), for illustration. In this example, subjects have performed retrieval practice on *fruits–orange*, but not on *fruits–banana* (unpracticed competitor) or any members from the *drinks* category (an unpracticed baseline category). As shown here, practice typically facilitates recall of the practiced item, and impairs recall of the unpracticed competitor, relative to performance in baseline categories

practiced categories (e.g., *banana*) was worse than for the items from baseline categories (e.g., *drinks*). Thus, remembering some items during retrieval practice led subjects to forget related items on a delayed test. We refer to this finding as *retrieval-induced forgetting* [3] to highlight the central role that retrieval plays in generating the effect. Retrieval-induced forgetting is consistent with the view that inhibitory control is recruited to combat interference during retrieval, with inhibition manifesting as recall impairment for competitors on the final test.

Although the basic finding of retrieval-induced forgetting is compatible with inhibition, other mechanisms can explain this effect as well, including McGeoch's classical response competition theory of interference [4]. According to this theory, the likelihood of recalling a target should decrease either when a new response becomes associated with the cue used to retrieve it or when an existing alternative response is strengthened. In either case, the target will suffer increased competition from the alternative response. These competitive dynamics have become formalized in several memory theories that posit relative strength rules of retrieval (e.g., [5, 6]).In these models, the probability of recalling a target is determined by that item's association with a cue, relative to the strengths of association of all items related to that cue. When an alternative response is strengthened, say by retrieval practice, the relative strength of all nonpracticed items declines. Later, when the subject tries to recall the target, the strengthened competitor will have a retrieval advantage, leading it to intrude so persistently that subjects abandon efforts to recall the unpracticed exemplars (see also [7]). This approach does not require inhibition; rather, practiced items become so strongly linked to the practice cue that they block other exemplars. This account is plausible, given the strengthening that practiced items enjoy (however, see section below on "Properties of Retrieval-Induced Forgetting"). Other mechanisms may also contribute to retrieval-induced forgetting. For example, retrieval practice may damage the association linking the category to the affected exemplar, or it may alter the meaning of the practiced category cue (e.g., by biasing *fruit* towards *citrus fruits*) so that the category label is no longer a functional cue for retrieving the unpracticed competitor. All of these mechanisms have been proposed as theories of interference (for a review of noninhibitory sources of impairment, see [8]). Although it might seem difficult to distinguish these alternatives, focused empirical research has yielded evidence for properties of retrieval-induced forgetting that favor the inhibition view. We briefly review these next.

Properties of Retrieval-Induced Forgetting

Work on retrieval-induced forgetting has revealed properties that uniquely support the inhibitory control hypothesis and that suggest that alternative strength-based models may not be correct (see [9] for a review). First, several findings demonstrate that strengthening practiced items does little to impair the recall of related competitors provided that all sources of retrieval-induced forgetting are eliminated from the strengthening process and from the measurement of impairment. For instance, retrieval-induced forgetting appears to be *recall-specific:* retrieval practice impairs the delayed recall of competing items, but the same number of repeated study exposures does not (provided that output interference is controlled on the final test), even though the two practice procedures strengthen practiced items to the same degree. The fact that strengthening can occur with little associated impairment suggests that retrieval practice, not strengthening, is responsible for the effect. Consistent with this, when retrieval practice is performed, the amount of impairment often has no relationship to the amount of strengthening observed on practiced items–that is, retrieval-induced forgetting appears to be *strength-independent.* Impairment does appear to be *interference-dependent*, however: whether retrieval practice impairs a related item depends on whether the item causes interference during retrieval practice. So, for instance, high-frequency exemplars of categories suffer retrieval-induced forgetting whereas low-frequency exemplars do not; similarly, the dominant meanings of homographs suffer significant retrieval-induced forgetting, whereas the subordinate meanings do not. Interference-dependent impairment is exactly what one would expect if inhibitory control is recruited to override retrieval of distracting competitors. Finally, retrieval-induced forgetting exhibits a crucial theoretical property that is difficult for traditional associative interference accounts to explain: *cue independence.* Cue independence refers to the tendency for retrieval-induced forgetting to generalize to novel cues other than those used to perform retrieval practice. Not only does retrieval practice on *fruit–orange* impair the later recall of *banana* when it is tested with the cue *fruit*, but also when it is tested with a novel, independent cue such as *monkey–banana.* These findings argue against interpretations of retrieval-induced forgetting such as associative blocking or cue change, which posit mechanisms that are specific to the cues guiding retrieval practice. They are consistent, however, with the idea that competing memories themselves are suppressed by an inhibitory process in order to retrieve the retrieval practice target.

Taken together, the foregoing properties indicate that the impairment underlying retrieval-induced forgetting is unlikely to be produced by traditional associative interference mechanisms. Rather, it is likely to reflect the action of an inhibitory control process acting to override unwanted retrievals of competitors in memory, helping to achieve selective memory retrieval. This supports the view that selective memory retrieval may be regarded as a special case of response override arising in long-term memory retrieval.

Stopping Memory Retrieval

Response override is also involved when we need to stop a response. In retrieval, the ability to stop could prove useful in preventing a memory from entering consciousness. We sometimes confront reminders of things that we would prefer not to think about: the sight of a car may remind us of an accident we had, or of a former significant other who drove that type of car; or the sight of the World Trade Center in a movie may lead us to stop the natural progression from cues to memories. Other times, we may wish to focus on a thought without letting our mind wander. Can inhibitory mechanisms be engaged to serve these goals? Anderson and Green [10] looked at this issue by examining how stopping retrieval affected the memories that were to be retrieved. To study this, they developed a procedure modeled after the widely used go/no-go task, which has been used to measure the ability to stop a prepotent motor response and to study its neural basis in humans [11-13]. In one version of this task, letters are presented one at a time and subjects press a button as quickly as possible whenever they see a letter, *except* when the letter is an X. When they see an X, they are supposed to avoid pressing the button. The majority of trials require a button press, so that when an X occurs, subjects have difficulty withholding their response. The ability to withhold the response is taken as a measure of inhibitory control.

To explore whether people can stop retrieval, Anderson and Green [10] adapted the go/no-go task to create the *think/no-think paradigm*. In this procedure, subjects studied pairs of weakly related words (e.g., *flag–sword*, *ordeal–roach*) and were then trained to provide the second word (e.g., *roach*; hereinafter referred to as the response word) whenever they were given the first word as a cue (e.g., *ordeal*). Subjects then entered the think/no-think phase, which required them to exert control over

retrieval. For most of the trials, the task was the same as it had been during training–to recall and say aloud the associated word as quickly as possible at the sight of its cue. For certain cues, however, subjects were admonished to avoid thinking of the response. It was emphasized that it was not enough to avoid *saying* the response word–it was crucial to prevent the memory from entering *conscious awareness* at all. Thus, subjects had to override not only a vocal response, but also the cognitive act of retrieval. Could subjects recruit inhibitory control mechanisms to stop the memory from entering consciousness?

Of course, Anderson and Green could not directly measure whether subjects controlled consciousness. However, if inhibitory control was recruited, later recall of the excluded memory should be impaired. To examine this, immediately after the think/no-think phase, subjects were given the cues for all of the pairs, and asked to recall the response for each. As predicted, forgetting occurred: response words that subjects excluded from awareness were impaired compared to baseline pairs they had studied initially but had not seen during the think/no-think phase. The more often subjects tried to stop retrieval, the worse recall became (see Fig. 3a). Interestingly, avoided words were harder to recall even though subjects had seen as many as *16 reminders* (i.e., cues) during the think/no-think phase. Normally, reminders facilitate memory, much as it did for the items to which subjects continued to respond (Fig. 3a). Anderson and Green [10]

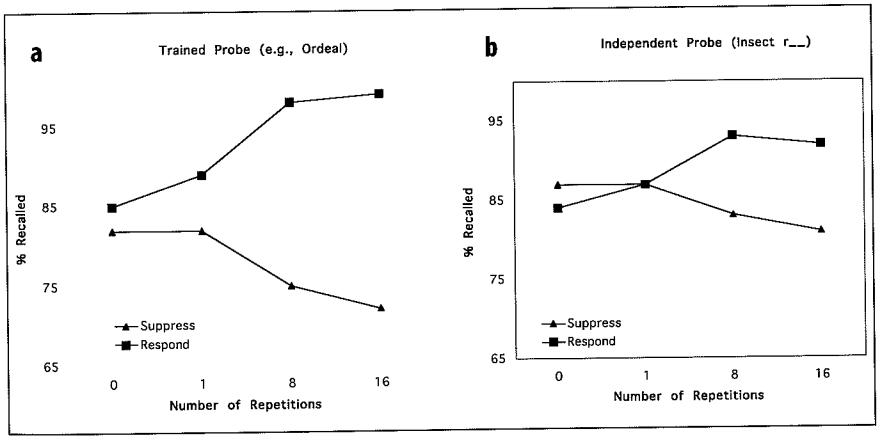

Fig. 3. Final recall performance in experiment 1 of Anderson & Green (2001) using the think/no-think procedure. The plot represents the percentage of items that subjects recalled on the final recall test as a function of the number of times that suppressed the item (*Suppress*) or tried to recall it (*Respond*). The *lefthand panel* represents final recall performance when tested with the originally trained retrieval cue (i.e., the "trained probe"), whereas the *righthand panel* represents final recall performance when tested with a novel, independent, extra-list category cue

further established that this impairment was cue-independent, echoing the results of Anderson and Spellman [14] forgetting occurred regardless of whether subjects were tested with the studied cue word (e.g., *ordeal*) or with a novel cue never studied in the experiment (e.g., *insect r____* for *roach*; Fig. 3b). This argues that the forgetting is not caused solely by associative interference; rather, impairment reflects suppression of the excluded memory itself. In a control experiment, subjects were merely asked to avoid saying the response out loud and all mention of preventing it from entering awareness was eliminated. No inhibition was observed, indicating that the recall deficits were not merely due to suppression of the vocal response for avoided words. These results isolate forgetting in the think/no-think paradigm to processes directed at keeping the unwanted memory out of awareness and demonstrate that this cognitive act has persisting consequences for the avoided memories.

The impaired memory observed by Anderson and Green [10] suggests that inhibitory control mechanisms may be recruited to regulate awareness of intrusive memories. In particular, whenever the environment is such that it presents unavoidable reminders of something that we would prefer not to think about, people may resort to controlling their memories instead to resolve this conflict. The end result may be impaired memory for the things that people avoid thinking about. This suggests that the think/no-think paradigm of Anderson and Green [10] may provide a useful laboratory model of the repression proposed by Freud [15]. If so, results from this paradigm and other related paradigms such as the directed forgetting procedure may have implications for understanding clinical phenomena relating to motivated forgetting [10, 16-20] (see [21] for a review of directed forgetting).

Neural Systems Underlying Voluntary Memory Suppression

The above work on selective retrieval and retrieval stopping indicates functional parallels between controlling retrieval and overriding prepotent responses. This suggests the intriguing possibility that the ability to control unwanted memories may in part rest on neural systems essential for controlling overt behavior. More direct evidence for this relationship might be gained if more were known about the anatomical systems that support memory control. Recently, I have used neuroimaging to identify

the neural systems underlying this ability. If memory control and response override are related, one might expect stopping memory retrieval to recruit neural systems known to be involved in overriding prepotent responses to control structures involved in memory.

Research on the neural basis of executive control and declarative memory indicates that at least two brain regions may play important roles in the neurobiological basis of memory control: the hippocampus and the lateral prefrontal cortex. The hippocampus is essential for declarative memory formation [22], and increased hippocampal activation is associated with the subjective experience of consciously recollecting a recent event [23]. Memory suppression requires people to stop retrieval to prevent conscious recollection. The lateral prefrontal cortex is involved in overriding prepotent motor responses [24-26], switching task set, and combating interference in a range of cognitive tasks [27-29]. We hypothesized, therefore, that people suppress consciousness of unwanted memories by recruiting lateral prefrontal cortex to disengage the hippocampal processing that supports recollection.

Anderson et al. [30] recently examined this frontohippocampal hypothesis using the think/no-think procedure. Subjects first learned pairs of words. They then underwent trials in which they were given the first member of the word pair and asked (if the word appeared in green) to think of its corresponding response (respond condition) or (if the word appeared in red) to suppress awareness of the response (suppression condition). Subjects performed this task while being scanned in an event-related functional magnetic imaging design. After this phase was over, scanning ended, and memory was tested for all of the word pairs the subjects had studied. Replicating prior work, the subjects recalled significantly fewer suppression words (i.e., responses to red hint words) than baseline items (i.e., responses to pairs that were learned in the initial study phase, but which did not appear during the think/no-think phase), showing that suppression has occurred.

To examine the neural systems underlying suppression, we contrasted activation during suppression and respond trials of the think/no-think phase. In both trial types, subjects had been presented for 4 seconds with a cue word that had previously been associated with a response word; the only difference was that the cues presented in red had directed subjects to suppress consciousness of the unwanted memory, whereas words presented in green had directed subjects to recall and maintain the corresponding response. Several remarkable findings were obtained. First, a network of regions was more active during suppression than during active

retrieval, including bilateral dorsolateral and ventrolateral prefrontal cortex and anterior cingulate cortex. This network overlaps strongly with networks involved in motor response suppression tasks (such as go/no-go), even though no motor responses were required. These findings support the possibility that neural systems involved in overriding prepotent responses are recruited to control retrieval. More generally, they indicate that regulating consciousness of unwanted memories is an active process, and is not accomplished by simply failing to engage retrieval mechanisms.

Interestingly, Anderson et al. [30] also found that suppressing awareness of a memory significantly reduced activation in the hippocampus bilaterally, relative to retrieval. Because activation in the hippocampus has been linked to conscious recollection, this finding suggests that subjects can control awareness of past experiences by strategically disengaging activation in the hippocampal memory system that might otherwise support conscious recollection.

One might wonder to what extent the suppression regions observed in the overall analysis are functionally involved in suppressing unwanted memories. More compelling support for this role could be obtained if it could be shown that these regions predicted later memory suppression effects. We evaluated this by using regression to examine which brain regions predicted individual differences in memory inhibition. Crucially, activation in dorsolateral prefrontal cortex and lateral premotor cortex–regions often observed in go/no-go task performance–predicted subsequent memory impairment for suppression items (Fig. 4a). The more the activation in these regions, the more suppression subjects showed (Fig. 4b). Anderson et al. further showed that activation in the hippocampus predicted later memory failures for suppressed items, and that these variations were correlated with activation in the dorsolateral prefrontal cortex. These findings suggest that dorsolateral prefrontal cortex interacted with mediotemporal lobe structures to attenuate activity, reducing recollection and disrupting retention.

This work provides a strong indication that some of the neural systems involved in overriding prepotent responses may also be recruited to terminate internal actions such as retrieval. Such systems appear to be targeted at mediotemporal regions that support declarative memory rather than motor representations. Because ideas and memories are brought into consciousness by retrieval, the capacity to stop retrieval provides a specific cognitive and neurobiological foundation for how human beings regulate consciousness of unwanted memories. This work, and related work with retrieval-induced forgetting and directed forgetting [16, 17] further

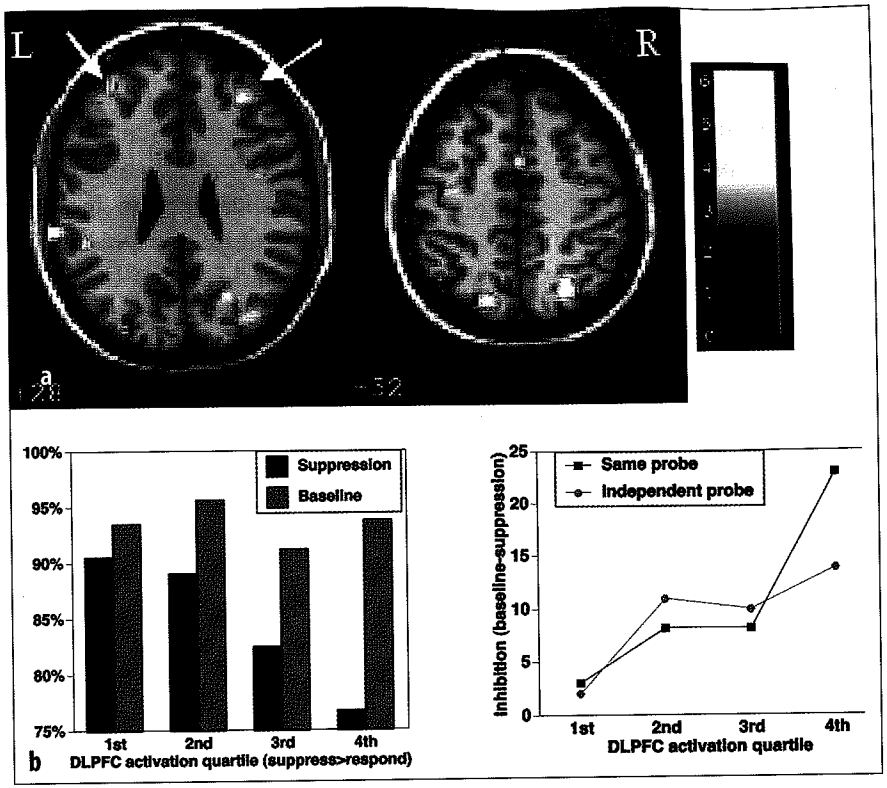

Fig. 4. Relationship of suppression-related activations to memory inhibition. **a** Regions for which activation during suppression trials predicted differences in below-baseline inhibition (n = 24). *White arrows* highlight dorsolateral prefrontal cortex (DLPFC) regions from our regression analysis that also predict hippocampal activity for suppression items. **b** Memory inhibition effects for four subject groups matched for counterbalancing manipulations, differing in degree of activation in right DLPFC. Note that increasing activation in DLPFC predicts reduced suppression performance, but leaves baseline performance unaffected. **c** Memory inhibition effects (baseline–suppression) in four DLPFC groups, separated out by test type

supplies a model for how motivated forgetting occurs that may be applicable to understanding the adaptation of memory in the face of traumatic experiences.

Relations to Freudian Repression

The framework and paradigm developed in the foregoing experiments may provide a viable laboratory model of repression. The correspon-

dences between the situation studied in these experiments and the characterization of repression by Freud are striking. Consider, for example, the following brief definition of repression, offered by Freud: "The essence of repression lies simply in the function of rejecting and keeping something out of consciousness" (p. 147 in [31]). Clearly, if this is what constitutes the essence of repression, as Freud indicates, then research done with the think/no-think procedure directly addresses what Freud had in mind. In our procedure, subjects confront reminders to an experience that they are instructed to reject from consciousness for the duration of each suppression trial. From the many experiments that we have done with this procedure, this cognitive act clearly reduces the accessibility of the excluded memory. Thus, within the confines of a carefully designed laboratory procedure, this work establishes a close connection between efforts to regulate consciousness of unwanted memories and their later accessibility. It is now no longer possible to say that there is no mechanism that could possibly support repression.

One might raise several objections to the think/no-think procedure as a model of Freudian repression, however. In the final section, I raise several key objections one might have. The first concerns the distinction between suppression and repression, and whether this work is better characterized as suppression. The second concerns whether the impairment produced by the think/no-think procedure is missing some core feature, proposed by Freud, that renders this irrelevant as a model of repression.

On the Distinction Between Suppression and Repression

One might object to characterizing work on memory inhibition as evidence for repression on the grounds that this work better fits Freud's idea of suppression than repression. According to this argument, Freud intended a strong distinction between suppression, which was a conscious, intentional process, and repression, which was an unconscious, unintentional process. In this view, the fact that we instructed our subjects to intentionally exclude unwanted memories from awareness renders the think/no-think paradigm a way of studying intentional suppression, but has no bearing on the unconscious repression process. The unconscious repression process, it is asserted, is capable of excluding unwanted mental contents quickly and without any conscious intention or awareness on

the part of the subject that the excluded thought ever occurred, or even that the act of repression ever occurred. If one accepts that Freud intended this strong distinction, work with the think/no-think procedure would not be considered repression. Indeed, it is conventional wisdom amongst psychoanalysts that Freud intended this distinction, a wisdom reflected in textbook treatments of repression, which usually characterize it as an unconscious psychological defense process.

Not all scholars believe, however, that Freud intended repression to be an exclusively or even primarily unconscious process. Erdelyi, for example, reports a scholarly analysis of Freud's writings that dismantles this view–a view that he contends is a historical distortion of Freud's theory [32-34]. Although many in the psychoanalytic field (and certainly all those seeking to criticize it) presume that Freud intended repression to be unconscious, Erdelyi argues that it was Freud's daughter Anna who imposed this requirement. By contrast, Erdelyi persuasively shows that Sigmund Freud wrote about repression in terms that allowed for it to be an active, intentional process of exactly the sort characterized in the work reviewed here. Consider this quotation, which is one of several offered by Erdelyi [34] in support of this argument: "It was a question of things which the patient wished to forget, and therefore intentionally repressed from his conscious thought and inhibited and suppressed" (p. 10 in [35]). Clearly, Freud uses the term repression here in a manner consistent with the intentional suppression studied in the current work. One might worry that this is merely an isolated quote, a lapse in speech not in agreement with an otherwise consistent distinction between repression and suppression, but Erdelyi argues that this is not the case [35]:

"Although Freud's half century of psychological writing on repression is not without some ambiguities and even contradictions, the overwhelming textual evidence is that Freud used repression and suppression interchangeably, from his earliest writings (e.g., 1893, as we have seen), to his last (e.g., *An Outline of Psychoanalysis*, 1940)" [36, 37].

Erdelyi argues that it was Anna Freud [38]who, in an effort to tidy up her father's "messy work," introduced the claim that repression was unconscious and suppression was its conscious counterpart. Erdelyi argues that this forced distinction is actually deeply inconsistent with Freud's general insistence on the "continuity of mental life." According to Erdelyi's reading of Freud, complex mental processes could be conscious or unconscious, and did not become something else by virtue of crossing a hypothetical threshold of consciousness. He offers a quotation from Freud to make his point: "It would be unjustifiable and inexpedient to

make a break in the unity of mental life for the sake of propping up a definition" (p. 286 in [39]).

Thus, according to Erdelyi, the modern day truism that repression is fundamentally unconscious reflects a serious distortion of Freud's thinking about this concept. This distortion has been perpetuated on the one hand, by psychoanalysts trained according to Anna Freud's interpretation of psychoanalytic theory, and on the other hand, by skeptics of repression who wish to marginalize the concept by insisting on its most extreme, least intuitive (to the lay public) form as the only legitimate definition of repression.

If Erdelyi's scholarship and historical analysis are correct, this suggests that the psychoanalytic field may need to reconsider the distinction between repression and suppression, at least to the extent that it is intended to reflect Freud's views. Moreover, Erdelyi's analysis suggests that work with the think/no-think procedure fits Freud's ideas of repression well. This certainly seems true from Freud's own statements. If so, then work with the think/no-think procedure provides a tractable way to scientifically evaluate the existence and properties of repression, laying the groundwork for a theoretical synthesis of this idea with well-established constructs within the field of cognitive psychology and cognitive neuroscience.

The Object of This Work Lacks a Key Feature of "Repression"

One might object to calling the object of the current work "repression" because it is lacking some additional quality viewed as essential to match Freud's concept. For instance, the current experiments used neutral, nonemotional stimuli, and the materials were simple word pairs. One might argue that repression is entirely about psychological defense and is, by definition, tied to personal trauma or to psychological discomfort; thus, any research that does not include these critical ingredients, though it may be interesting, has little to do with Freudian repression. This view endorses the idea that repression is a special-purpose mechanism dedicated to helping the individual cope with psychological conflict, anxiety, or pain. Alternatively, one might insist that repressed contents continue to influence behavior after they are banished into the unconscious, or that the repressed contents should be recoverable over time. I consider these objections in turn.

Repression as a Specialized Defense Mechanism

Freud clearly emphasized the role of repression in reducing psychological conflict and anxiety, and thus also emphasized the emotional content of the memories being repressed. Based on this, one might argue that because our experiments do not present psychologically threatening material, the effects cannot reflect true repression. It is important, however, to distinguish the mechanism underlying repression from the use to which that mechanism is put: psychological defense. I have argued [10] that the mechanism underlying repression, by virtue of acting on memorial representations in the human brain, must be considered a cognitive process, and, as such, might reflect general mechanisms used in a range of circumstances. In particular, repression may reflect the action of executive control processes, directed at declarative memories. If so, one can decouple the study of the cognitive mechanism (executive control over memory retrieval) from the particular psychological uses to which that process is put. One might wish to control unwanted memories for a variety of reasons: to enhance concentration, update outdated knowledge, minimize embarrassment, reduce anger, control anxiety, focus a retrieval process, or even to deceive oneself or others. Even though each of these circumstances has a different intention, the same computational mechanism can be engaged; to propose a distinct mechanism for each would certainly not be parsimonious. If one separates the mechanism from the use to which it is put, repression would be construed as the use of executive control to control unwanted memories, for the purpose of reducing conflict, anxiety, or psychological pain.

This definition of repression has significant advantages. First, one might argue that the failure of the field to reach consensus on repression for over a century derives in part from inappropriately equating psychological defense with the underlying cognitive mechanism that implements that defense. By requiring that repression be a process unique to trauma or unbearable psychological conflict, one limits the potential to investigate its properties scientifically. One cannot ethically induce trauma or unbearable psychological conflict in the laboratory, and if one instead studies patients coping with these circumstances, one is limited to studying memories, feelings, and thoughts that are, of course, extremely difficult to objectively validate (who knows what a person actually experienced, and whether a repressed memory is accurate?). By acknowledging that the mechanism underlying repression is a general process engaged on behalf of psychological defense, we can study repression in the labora-

tory using procedures that do not require the induction of trauma or psychological conflict. If this mechanism can be established in a bland emotional context of this kind, one may imagine that when human beings have powerful motives for engaging memory control, it would be quite effective. Moreover, this approach allows repression to be integrated with a wealth of cognitive and neurobiological knowledge about the mechanisms of memory and emotion. Nevertheless, it remains important to progress from studying neutral stimuli and bland motivational contexts to studying stimuli and motives more akin to those likely to require repression outside of the laboratory.

Fortunately, the current findings have been generalized to emotional materials. Several investigators have manipulated the valence of the memories to be suppressed. In work from my laboratory, we took the small, but well-controlled step of manipulating whether the response word to be suppressed was negative or neutral, the stimulus word being always neutral (e.g., phone–bell, twine–rape), and with all other verbal attributes of the response words being held constant (e.g., length, number of syllables, concreteness, frequency). We found significant and nearly identical amounts of inhibition for both classes of stimuli, suggesting that subjects were as able to suppress negatively valenced material as they were neutral material. Other investigators have performed similar manipulations with word pairs and found greater memory inhibition for negative than for neutral response words [40.]

Perhaps the most interesting, however, is a recent demonstration using pairs composed of faces and scenes. Depue, Banich, & Curran [41] manipulated whether a face was paired with a negative scene (e.g., a picture of a car crash) or a neutral scene. One might think that vivid depictions of emotionally aversive scenes might provide a stronger manipulation of valence than presentations of negative words, and thus provide an important test of whether negative experiences can truly be suppressed. Depue et al. [41] found impaired retention of suppressed material, with greater impairment for negative scenes than for neutral scenes. These findings indicate that the mechanisms studied by Anderson and Green [10] provide a viable model of how people suppress memories with affective content. Clearly, additional mechanisms will be involved in regulating accessibility of more intensely traumatic experiences, such as extinction, reappraisal, and other affect regulation processes [42, 43].

Unconscious Influence and Recoverability as Necessary Features of Repression

Even if intentional suppression can be considered repression, and even if this process can be profitably studied outside the context of psychological defense, one might insist that memories that are truly repressed must (a) exert an unconscious influence on behavior, and (b) be recoverable. Freud discussed the "return of the repressed," suggesting that he viewed unconscious influences as important to the phenomenon. Because unconscious influences and recovery have not yet been demonstrated for memory inhibition in the think/no-think procedure, one might question whether this phenomenon is truly repression.

Although it is true that unconscious influences and memory recovery have not been demonstrated for suppressed items in the think/no-think paradigm, these are not good reasons to conclude that this phenomenon is unrelated to repression. They are, at worst, reasons to defer judgment. Empirical work must be conducted to evaluate these possibilities, and this work is quite tractable with the methods we have developed. In fact, memory inhibition is very likely to exhibit these attributes. First, the fact that these effects are linked to modulation of hippocampal activation indicates that suppression is affecting declarative memory for the suppressed events. If the effect primarily occurs in declarative memory, we might see preserved implicit memory for nondeclarative aspects of the suppressed experiences, including perceptual priming, and even affective learning, given a suitable adaptation of the think/no-think procedure. Second, other related inhibition effects (e.g., retrieval-induced forgetting) have been found in some studies to dissipate over time, allowing for memory recovery [44]. These implicit memory and recovery effects are similar to those observed in other related phenomena such as retroactive interference and directed forgetting [45-47]; see also [34] for discussion of related findings). If these phenomena are truly related, memory recovery may be possible with the think/no-think procedure. Thus, if the proper experiments are conducted, the current phenomena may have most of the core characteristics of repression envisioned by Freud.

Conclusions

In this chapter, I have reviewed our efforts to understand repression in terms of processes that are widely studied in cognitive neuroscience today. These efforts have led to procedures and findings that strongly confirm the existence of a process of active forgetting with several of the key characteristics envisioned by Freud. By conceptualizing repression in terms of attention and executive control, we have begun to demystify how such a process might function. Although one might wish to reserve judgment about whether the process under study here is the same as the one proposed by Freud, one point bears emphasis: whatever one may decide, one cannot deny the relevance of the problems addressed in work on memory control to situations confronted by people dealing with unpleasant experiences. Very often in life, we confront reminders of things that we would rather not think about, and when we do, we often take action to stop the unwanted material from entering awareness. Skill at this process is essential to coping in the aftermath of traumatic experiences [48]. The current work addresses this functional situation directly, and, as such, can illuminate the mechanisms involved in exercising control over memory. Whether this work satisfies Freud's original definition of repression ultimately is not the most important question to ask; the most important questions are whether this work can establish things that go beyond or that even correct Freud's initial assertions through careful, systematic study, and whether these new insights can help people. Nevertheless, we believe that this work addresses what Freud had in mind. By conceptualizing the mechanism that implements repression as executive control, we may, after decades of uncertainty, gain traction on an unnecessarily controversial proposal about the human mind.

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