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From *splitting* to *priming* associations

An interdisciplinary approach to a linguistically based therapy for obsessive-compulsive disorder

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 The image symbolizes the “cathedral effect”, which describes the relationship between the perceived height of a ceiling and cognition. High ceilings promote abstract thinking and creativity, and low ceilings promote concrete and detail-oriented thinking (Lidwell, Holden & Butler, 2010, p. 38)

Table of contents

Abstract

Association Splitting (AS) is a self-help therapy for obsessive-compulsive disorder which finds its basis in linguistic theories. Multidisciplinary principles were used to argue that AS is mechanistically based on the fan effect. Using different cross-disciplinary evidence, this thesis shows that AS takes place in semantic memory, where there is no fan effect. This leaves AS without a solid theoretical basis. I will therefore propose a different approach to AS, namely, *Association Priming* (AP). I will argue that priming processes are not only able to explain the workings of the treatment, but also imply several clinical advantages compared to AS.

Key words: */Association splitting, obsessive-compulsive disorder, fan effect, association priming/*

Introduction

We are now entering "the age of hyperspecialization", MIT Professor Thomas Malone proclaims (2011). According to Malone, much of the wealth our world enjoys from the productivity gains of dividing work smaller tasks performed by more specialized workers (p.56). However, specialization can also be an obstacle for the growth of knowledge, "for specialists become prisoners of their expertise" (Popper, 1997). Only freedom from "such orthodoxy" makes science possible, Popper proclaims (1997).

A similar belief is the basis of interdisciplinary research, which has gained increasing popularity over the past decades and has even become the "mantra" of science policy (Metzger & Zare, 1999). In contrast with Popper's statement, Rhoten and Parker (2004) argue that this increased popularity is not because of "simple philosophical belief", but has everything to do with the complexity of scientific problems currently under study. Especially in broad fields, such as mental health, the need to understand the problem in its entirety has encouraged disciplines to strengthen cross-disciplinary cooperation (Pellmar & Eisenberg, 2000). From my own background, of both medicine and linguistics, I definitely recognize the importance of interdisciplinary research. At the same time, I am fully aware of the weaknesses and limitations of interdisciplinary studies that lack in theoretical foundations, and the difficulties encountered in transposing theories from one discipline to the other (Cornell & Fahlander, 2000). Crucial in interdisciplinary research is therefore an exploration of the metatheory, that is, "theories about the creation and influence of theory in scientific […] research studies" (Salter & Hearn, 1997, p. 11). With my educational background, I will attempt to provide the metatheoretical background for both linguistics and medicine that is needed to conduct a well-grounded interdisciplinary research in these fields.

The most renowned crossroad of these two disciplines is aphasia: a field in which neurologists and linguists often work in cooperation. In psychiatric diseases, language - and thus linguistics - also proved to be influential. For instance, the language of schizophrenic patients has been studied and described by both psychiatrists and psycholinguists (Kuperberg, 2010a; 2010b; see also Ditman & Kuperberg, 2010). Additionally, studies on pathogenesis demonstrate that disorganized speech in schizophrenia is related to a lessened language lateralization (Sommer, Ramsey & Kahn, 2001; Sommer, Ramsey, Kahn, Aleman & Bouma, 2001).

In addition to these applications of language in diagnosing and understanding the etiology of psychiatric illnesses, psycholinguistic knowledge has recently contributed to the development of a promising "linguistic" treatment for Obsessive-Compulsive Disorder (OCD). This therapy, called Association Splitting (AS), was developed by a group of researchers from the Universitätsklinikum Hamburg-Eppendorf. Psychologists Prof. Dr. Steffen Moritz and Dr. Lena Jelinek were the main contributors in the development of the treatment, which is described in a self-help manual (Moritz,

2006) that can be downloaded at no cost in German, English, Italian, Montenegrin and Russian language via http://www.uke.de/kliniken/psychiatrie/index_31780.php.

Moritz and his colleagues understand AS to depend on a phenomenon called the "fan effect" (Anderson, 1974), which is defined as "the finding that response times to an item are increased with the number of other items associated with that item" (Neath & Surprenant, 2003, p.460). According to the authors, this indicates that the overall associative strength of a cognition[1] is limited and that the sum of the activation is divided by the number and strength of neighboring cognitions (Moritz, Jelinek, Klinge & Naber, 2007; see also Moritz & Jelinek, 2011). Applied to obsessions, the authors suggest that increasing and strengthening the number of positive or neutral associations, lessens the strength of existent, negative associations (Hottenrott, Jelinek, Kellner & Moritz, 2011). So far, AS has been tested in four different experiments with OCD patients, all of which showed positive effects of AS on the severity of OCD (Moritz et al., 2007; see also Hottenrott et al., 2011; Moritz & Jelinek, 2011; Moritz & Russu, 2013).

Despite its promising potentials as an easily accessible form of therapy for OCD, this thesis will show that AS is in fact founded on some wrongly generalized theoretical assumptions. Since this is possibly due to an ill-founded application of interdisciplinary research, this thesis will provide a broad cross-disciplinary framework. This framework will consist of both psychiatric and psycholinguistic literature, in order to fully understand all theories involved in the workings of AS. The main focus will be to determine what the psycholinguistic foundations are for AS as a treatment for OCD, and what the clinical implications of such a basis would be. Before turning to these fundamental questions, we will first define the research variables in chapter 2. We will look at the current thoughts on OCD and the present-day guidelines for treatment. After this we will discuss the underlying theories and experiments concerning AS in more detail. In chapter 3 we will expand on the theoretic foundations for AS by placing it in the context of psycholinguistic literature. The assumptions Moritz et al. (2007; see also Hottenrott et al., 2011; Moritz & Jelinek, 2011) make in explaining AS, will here be discussed one by one. More specifically, this chapter will include discussions on semantic networks, different kinds of memory (e.g. episodic and semantic memory) and the fan effect. In this chapter we will see that some of the assumptions Moritz and his colleagues make, are in fact not supported in the literature. Especially their way of using the fan effect will proof to be incorrect. Because AS fully depends on the fan effect for its explanation, it is in need of a different approach. Therefore, in chapter 4, I will propose a different explanation for AS; namely, that of priming mechanisms. Since this thesis shows that there is no *splitting* involved in AS, I will propose to rename this new approach Association *Priming* (AP). Priming works by facilitating

[1] Moritz et al. (2007) define cognitions as "mental events such as memory episodes, words, images" (p. 631). To avoid confusion, we will use this term accordingly here.

the paths leading *away* from the obsession, thereby easing the way to other associations. We will see that AP has some clinical advantages compared to AS, which will be discussed in the second part of chapter 4. In conclusion, chapter 5 will provide a general discussion, which will show that AS, intended to be on an interdisciplinary basis, was in fact founded on some incorrect transpositions from one disciplinary to the other.

1. Defining the variables

Before we turn to the theoretical basis of AS and the corresponding clinical implications for OCD, we will first discuss these variables separately. Starting with OCD, we will look at the current thoughts on diagnosis and treatment. Hereafter we will define AS, what it entails and how this is applied in treating OCD.

2.1. Obsessive-Compulsive Disorder

OCD is a psychiatric disorder that is typically characterized by patients that spend hours a day washing their hands, checking that a stove is turned off, or that a door is locked. The disorder may be so severe that people are unable to work, although milder forms can be easily underdiagnosed. As a result, OCD was long considered to be a rare condition, but data from past decades revealed it is in fact a common illness (with a life time prevalence of 2 to 3 percent) (Jenike, 1995).

Up until the last *Diagnostic and Statistical Manual of Mental Disorders* (4th ed., text rev.; DSM-IV-TR, *American Psychiatric Association* [APA], 2000) OCD was categorized as an anxiety disorder. However, in the recently released DSM-5 (APA, in press) it is classified in the newly defined group of "obsessive-compulsive and related disorders". The main diagnostic criterion for OCD is the presence of either "obsessions", "compulsions" or both. Obsessions are defined by the APA (2002[2]) as "recurrent and persistent thoughts, impulses, or images that […] cause marked anxiety and distress" (Obsessive-Compulsive Disorder section, para. 300.3). Compulsions are considered to be the result of obsessions, since they are defined as "repetitive behaviors or mental acts that the person feels driven to perform in response to an obsession" (Obsessive-Compulsive Disorder section, para. 300.3). Obsessive-compulsive and related disorders further include hoarding disorder, body dismorphic disorder, trichotillomania (hair-pulling), excoriation (skin-picking) disorder, substance- or medication-induced obsessive-compulsive and related disorders, and obsessive-compulsive and related disorders due to another medical condition (APA, 2013). The diagnostic criteria for this group of disorders are related in terms of diagnostic validators, since obsessions or compulsions are the main criterion for all these disorders.

Since current guidelines are still based on the DSM-IV-TR, treatment for OCD is described in the context of anxiety disorders, and therefore do not include the newly defined related disorders. Treatment for OCD involves a multidisciplinary approach that includes both psychological therapy

[2] Since the DSM-5 was still in press while writing the current thesis, the mentioned diagnostic criteria for OCD used are based on the DSM-IV-TR. There may be some changes in the DSM-5, however, the APA (2013 – "highlights of changes from DSM-IV-TR to DSM-5") suggest no great changes in the criteria for OCD.

and pharmacotherapy. The initial approach in a nonclinical setting is psychological therapy based on exposure in vivo[3] with response prevention, during 10 to 20 weeks. If necessary, cognitive therapy is added to the exposure therapy, which discusses and tests the interpretations of the patient. In severe or persisting OCD, and in the case of depressive comorbidity, the adding of pharmacotherapy is advised. Two groups of drugs have so far been proven effective in OCD in double blind placebo controlled studies; namely, Selective Serotonine Reuptake Inhibitors (SSRI's) and clomipramine, a tricyclic antidepressant (2nd rev.; Multidiscipinaire Richtlijn Angststoornissen, Balkom, van Vliet, Emmelkamp, Bockting, Spijker, Hermens & Meeuwissen, 2012).

AS was developed solely for treating obsessions in OCD, but literature about the DSM-5 (APA, 2013) suggests that obsessions are also present in other disorders. Since these disorders are considered to be related to OCD, their obsessions are likely to be related as well. As we will see in the following section, AS was mainly tested in patients with OCD, but the release of the DSM-5 now provides future grounds for testing it in closely related disorders as well.

2.2. Association Splitting

AS was developed as a new self-help method to treat obsessive thoughts in OCD by "splitting" the associations that a patient has with his or her obsession. The process of splitting these obsessive thoughts is based on a mental exercise that should be done daily for several weeks, and takes around 10 minutes. The exercise consists of first writing down a word that forms the basis of the obsession, the so called "core cognition" (e.g., if the obsession is the idea that you might not have locked the door, "lock" could be a core cognition). Next, patients are instructed to write down at least three positive or neutral "associations" with this core cognition. These associations should "make sense", which means they should either connect in content or word form (Moritz, 2006). For example, sensible association pairs would be "door-The Doors" (band) or "door-four" (Moritz, 2006, p. 17). After writing down such associations, they should be repeated in order to consolidate them. The reasoning behind this exercise is that, by adding and repeating more neutral or positive associations, the focus on the obsession will decrease (Moritz, 2006). Although AS is developed to treat obsessions only, we have seen that compulsions result from obsessions, and therefore they might be influenced by AS as well.

Besides this simplified explanation from the manual, a more extensive and theoretically based description of the workings of AS can be found in the articles on AS (Moritz et al., 2007; Moritz &

[3] Exposure in vivo therapy is a type of behavioral therapy in which a patient is confronted with his or her fear in real life (e.g. patients with arachnophobia are confronted with real spiders).

Jelinek, 2011; Hottenrott et al., 2011). In the next section we will first look at the theoretical foundations behind AS, after which we will discuss its effectiveness in experimental settings.

2.2.1. Theoretical foundations

According to Moritz et al. (2007), AS is based on the understanding of human information processing to be a semantic network. In semantic network models, concepts are assumed to be "nodes" in a network, stored according to their semantic relatedness. Moritz et al. (2007) explain that "cognitions within a semantic network communicate through spreading activation, which on a neural level corresponds to the exchange of electric impulses exchanged between cells" (p. 631). A further claim the authors make is that increasing co-occurrence of cognitions in network models, strengthens the associative connection between the cognitions (p. 631). Central to the approach of Moritz et al. (2007) is that these associations are not always symmetrical: asymmetrical, or "one-way associations", are also common (p.632). The authors claim that one-way associations are more prevalent in obsessive thoughts, since they noticed in clinical observations that patients can easily associate towards their obsession, but are hardly ever led away from it (Moritz et al., 2007; Jelinek, Hottenrott & Moritz, 2009a). AS is aimed at reducing the strength of these one-way associations by splitting them into multiple associations.

The reasoning behind splitting obsessive associations is explained by the "fan effect". This phenomenon, first described by Anderson (1976), is summarized as that the associative strength of a cognition is limited, and that the sum of activation is divided by the number of neighboring cognitions (Moritz et al., 2007). Therefore, increasing the number of associations will reduce the strength of the other associations. The fan effect is defined as a "principle of semantic priming" (Moritz et al., 2007, p. 632), a "cognitive phenomenon" (Moritz & Jelinek, 2011, p. 575) and "an effect of associative priming" (Hottenrott et al., 2011, p. 109; Jelinek, Hottenrott & Moritz, 2009b, p. 86), which Moritz et al. (2007) transposed to obsessive thoughts. Moritz et al. (2007) assumed that "the sprouting of new meaningful associations to OCD cognitions and the strengthening of "buried" ones that are neutral or positive in content, respectively (e.g. *knife–spoon*), will both divert attention from OCD cognitions towards neutral associations and decrease the strength of obsessive cognitions via the fan effect" (p. 632). This assumption has been tested in different experimental settings, which will be discussed in the following section.

2.2.2. Experimental studies

AS has so far been studied in five different experiments, using different experimental settings and patient selection criteria. The first study used an uncontrolled design, in which 38 persons with self-reported OCD participated in an internet survey (Moritz et al., 2007). Assessments were made through the Internet at baseline and after 3 weeks using the Yale-Brown Obsessive-Compulsive Scale (Y-BOCS), the Maudsley Obsessive Compulsive Inventory (MOCI), and the Beck Depression Inventory (BDI). Analyses showed marked improvement in one third of the patients, defined by a 35% decline on the Y-BOCS. Effects were primarily seen for obsessions and depressions, while no effect was reported for compulsions.

To control for confounding factors, such as motivation and placebo effects, a randomized control design was used in the second experiment (Moritz & Jelinek, 2011). Participants were either assigned to AS or a waitlist control. Evaluations were again conducted through the Internet with a 4 weeks interval, using the Y-BOCS, BDI and the Obsessive-Compulsive Inventory Revised (OCI-R). The Y-BOCS showed a symptom decline, now of approximately 25%. Positive effects were also reported for the obsessions subscales on the OCI-R and for the BDI. This design was repeated in rural regions of Russia (Moritz & Russu, 2013), where patients were included that had never been treated for their OCD. This study showed similar effects (with a decline on the Y-BOCS of four points), suggesting that AS can be an effective alternative when other therapies are either not available or affordable to patients.

Another study (Rodríguez-Martín, Moritz, Molerio-Pérez & Gil-Pérez, 2012) used AS not in patients with OCD, but as a method of reducing unwanted intrusive thoughts[4] in the general population. They tested the effect of AS in 49 participants who reported unwanted intrusive thoughts to be a regular presence in their everyday life. The participants were randomly allocated to either AS or waitlist control. The White Bear Suppression Inventory was used at baseline and after two weeks to monitor the ability to suppress unwanted intrusive thoughts. Relative to waitlist control, AS was found to exert a positive effect on this ability after only 6 days. These results suggest that AS can also be suitable to help reduce unwanted intrusive thoughts. According to Rodríguez-Martín et al. (2012), unwanted intrusive thoughts are a possible risk factor for developing OCD. AS might therefore be a prophylaxis for the development of OCD in people with unwanted intrusive thoughts. Additionally, a case report, in which the technique was used as an add-on intervention in a clinician based setting, suggests that AS can also be used in clinical settings (Hottenrott et al., 2011), Re-assessments here showed a similar pattern in symptom decline, with a decrease of the Y-BOCS of 55%.

In short, these studies provide evidence that AS can be effective in treating obsessions in OCD in several situations, and in different clinical settings. Since it is an inexpensive and noninvasive form

[4] Unwanted intrusive thoughts are defined as “unwanted thoughts that enter conscious awareness, and that are experienced as nonvolitional, ego-dystonic, distracting, discomforting, and difficult to control” (Rodríquez-Martín et al., 2012) .

of treatment, the authors recommend using AS in waitlisted patients or adding AS when traditional treatment is not available, advisable or affordable for a specific patient (Moritz et al., 2007; Moritz & Russu, 2013).

3. Metatheoretical framework

In the previous section we have discussed the workings of AS and its promising effects in diverse applications, and we briefly considered the theoretical basis for AS. In this section we will have a closer look at this theoretical basis and the corresponding metatheories, with the aim of acquiring a well-founded understanding of AS on a psycholinguistic level. In order to do this, we will examine all explicit and implicit assumptions of Moritz and his colleagues (Moritz et al., 2007; see also Hottenrott et al., 2011; Jelinek et al., 2009a; 2009b; Moritz & Jelinek, 2011; Moritz & Russu, 2013) and relate them to the corresponding literature. We will first discuss the assumptions that AS is based on (§3.1) *semantic networks* and on (§3.2) *spreading activation models*. Subsequently we will focus on the idea that *co-occurrence strengthens the association,* in paragraph 3.3. Thereafter we will look at the *fan effect* (§3.4), which the authors *transpose to obsessive thoughts* (§3.5).

3.1. Semantic network models

The first assumption of Moritz et al. (2007) is that semantic memory should be explained in terms of network models. They assume that concepts in a semantic network can be represented as “nodes”, which are connected to other nodes by associations (i.e. “edges”). According to Moritz et al. (2007), these associations are typically symmetric (i.e. not directed); but crucially, asymmetric (i.e. directed) associations are also common. Network models in general are based on the theory that each lexical concept is represented as a node, and that meaning as a whole is defined by the connection to other nodes in the network. A concept is thus not a solitary thing; instead it is connected to a whole network of other concepts.

An early influential network model is the hierarchical model by Collins and Quillian (1969). In their model, nodes reflect simple concepts and the links between them represent both feature associations and hierarchal relations. According to cognitive economy, general features are only stored at a basic level. For example, “bird” is a basic level term, which can be divided into specific kinds of birds (e.g. “canary”). Since having *feathers* is a feature all *birds* share, it can be stored at this basic level (i.e. “bird”). However, only *canaries* are typically *yellow*. Information about these *yellow feathers* will therefore be stored at the level of “canary”. The cognitive economy of the model is found in the fact that general information thus needs only be stored at one level.

When a person accesses a certain concept in memory, the corresponding node in the network is activated and this activation then spreads through the (hierarchal and associative) links emanating from this node. The level of activation decreases by both time and distance, so the speed of activation is directly determined by the length of the path between two nodes. Therefore, the greater the hierarchal distance from a specific node to the corresponding basic level information, the longer it takes to verify it. This model predicts then that verifying a sentence only depends on the number of nodes one has to traverse. So the reaction times required for verifying the sentence "an ostrich is a bird", or "a robin is a bird", should be equal. As it turns out, people find it much easier to recognize a *robin* to be a *bird* than an *ostrich*, because a *robin* is a much more "typical" kind of bird (Rosch, 1973). Another challenge for hierarchal models is the finding that people find it much harder to judge "a dog is a mammal" than "a dog is an animal", an effect called the "category size effect".

To resolve these challenges, an elaboration of the model was done by Collins and Loftus (1975). Concepts were no longer ordered by hierarchy, but by association. A further modification is that the links between some nodes became more weighted than others. Weighted links are represented by short lines, since the weight of the link determines the time needed for activation. For example, the link between a robin and a bird would be shorter than between an ostrich and a bird. Further elaboration was done by Bock and Levelt (1994), who added multiple levels to the network. They distinguished a level of conceptual information, a lemma and a lexeme level. Each of these levels can be accessed separately, so one can for instance already know some information about the phonological properties of a word (lexeme level), without knowing the meaning (conceptual level). As such the model offers an explanation for the tip of the tongue phenomenon.[5]

The first assumption Moritz et al. (2007) made, i.e., that language (or at least the lexicon) is represented in the mind as a semantic network, seems widely supported in literature. Contrarily, the idea that one-way associations are common (Moritz et al., 2007), finds less scholarly support. According to Moritz et al. (2007) one-way associations are found in superordinate and subordinate items (e.g. that *pheasant* will activate the superordinate *bird* more than vice versa). Their idea that one-way associations are common in semantic networks, therefore stem from hierarchal network models. However, we have seen that hierarchal models are generally considered outdated, since both the typicality- and the category size effect could not be incorporated in such models. The more recent models have therefore rejected hierarchy in semantic networks (Bock & Levelt, 1994; Collins & Loftus, 1975). Although these newer models do not exclude one-way associations, they certainly do not predict them to be common. The observation that one-way associations are more common in OCD, are thus unlikely to be explained by network models alone.

[5] The tip of the tongue phenomenon is a phenomenon in which some level of knowledge about a concept has been reached, but the person is not yet able to name it.

3.2. Language activation models

A further claim Moritz et al. (2007) made is that activation in a semantic network occurs through spreading activation, but they do not determine their exact definition of spreading activation. The idea of spreading activation was proposed by Posner and Snyder (1975), in the context of the so called "logogen model" (Morton, 1969). In this model, each concept is represented by a "logogen", which is similar to a node in the network. The logogen accumulates sensory input and input from context producing mechanisms until a certain threshold of information is reached. Immediately after reaching the threshold, a response follows – in the form of a word that is made available. The threshold is determined by several factors; for instance, high-frequency and more recent words have lower thresholds than ancient or low-frequency words (Morton, 1964). Posner and Snyder (1975) proposed that the activation of a logogen involves two mechanisms in the retrieval of information from long-term memory; namely, an "automatic spreading-activation" and a "limited-capacity conscious-attention" mechanism. The first is the process in which a stimulus automatically activates a logogen. This activation automatically spreads to semantically related logogens, but not to unrelated logogens. The limited-capacity conscious-attention mechanism also involves facilitation, but only in the processing of stimuli that activate logogens upon which attention is being focused.

Forster's (1976) "search model" of written word recognition, divides the lexicon into "bins" on a basis of their orthographic features. Within each bin words are ordered by frequency, which makes it faster to select high-frequency words compared to low-frequency words. In a modification of the model the search becomes parallel so that bins that differ slightly from the original "hash-code"[6] are searched simultaneously (Forster, 1992). This model suggests that not the absolute frequency of a word determines processing, but the "relative frequency": the frequency within one bin (also called the "rank" of a word (Murray & Forster, 2004; 2008)). Orthographic features also play a crucial role in the "interactive model" (McClelland & Rumelhart, 1981; Rumelhart & McClelland, 1982), since language processing is herein organized into a *feature*, *letter* and *word* level. Each level consists of a set of nodes that resemble the possible elements on the regarding level. A node that reaches a threshold of activation excites other nodes with which it is consistent, and inhibits nodes with which it has no consistency. When the input ends and the system has been run, the nodes return to their resting level of activation. This resting level is again determined both by frequency and recency.

Instead of orthographic features, Marslen-Wilson (1987) stresses the importance of phonetic properties in his "cohort model". He proposes that a word is recognized by the successive reduction

[6] "Hash-code" is a term borrowed from computer programming, which Forster (1992) explains as follows: "Whenever data about a particular pattern is to be stored, the hash-code is used to decide where to store this information. Similarly, whenever data about a particular pattern are to be retrieved, the hash-code can be used to determine where that information has been stored."

of the amount of possible word candidates as more phonemes are perceived. When only one candidate remains, the so called “recognition point” is reached. This model stresses the importance of the *initial phonemes* of a word, since they determine which cohort is to be searched. This cohort with the same initial phonemes is called the “word initial cohort”.

These paragraphs show that while communication within a semantic network is indeed mostly considered to occur through spreading activation, there is less consensus about the way this activation spreads. While Moritz et al. (2007) propose activation spreads freely through association, the described models predict more restricted activation (e.g. activation within bins). This is also reflected in the AS manual, since Moritz (2006) instructs patients to associate freely, as long as it makes sense. The activation models predict *specific patterns* of automatic spreading activation instead. In terms of thresholds, spreading activation causes an automatic lowering of thresholds in neighboring concepts. It would then seem most convenient to follow the predicted activation patterns in AS, since the thresholds for activating those concepts are already lowered. The way activation spreads automatically, might aid in consolidating new associations with a core cognition. For instance, writing down word initial cohorts could be an effective way of splitting associations, which will be discussed in more detail in chapter 4.

3.3. Associative strength

According to Moritz et al. (2007), the associative connection between two concepts is strengthened with increasing co-occurrence. Associative learning (i.e. Hebbian learning[7]) through co-occurrence is indeed a recognized factor in language processing and is often described in for instance research on Latent Semantic Analysis (Hoffman, 2001; Landauer & Dumais, 1997). However, it is surely not the only factor that influences language processing. Moritz et al. bypass important other notions that are closely related with semantic networks, such as *word neighborhoods* or *similarity neighborhoods.*

A neighborhood is defined as the collection of words that are formed by the addition, substitution or deletion of one phoneme in a target word (Landauer & Streeter, 1973). One example of a neighborhood is the word initial cohort (Marslen-Wilson, 1987), since it consists of words that start with the same phoneme. A related concept is “neighborhood density”, which is defined as the count of all neighboring words. This is an important notion in language processing, since neighborhood density was proven to affect the speed and accuracy of both spoken word recognition (Luce & Pisoni, 1998) and speech production (Baus, Costa & Carreiras, 2008). The neighborhood

[7] The theory of Hebbian learning can be understood from the following. "The general idea is an old one, that any two cells or systems of cells that are repeatedly active at the same time will tend to become 'associated', so that activity in one facilitates activity in the other" (Hebb, 1949, p. 70).

effect is also closely related to the concept of frequency, since high-frequency words were proven to have larger neighborhoods than low-frequency words (Landauer & Streeter, 1973). Furthermore, high-frequency words appear to have high-frequent neighbors, whereas low-frequency words have low-frequency words in their neighborhood (Landauer & Streeter, 1973; Vitevitch, 2002; Vitevitch & Sommers, 2003). The frequency of the neighboring words has been shown to influence speed in both word recognition (Vitevitch, 2002) and word production (Vitevitch & Sommers, 2003).

That frequency in itself influences language processing, was already found by D. Scarborough, Cortese and H. Scarborough (1977). Their results show that low-frequency words are more difficult to recognize, which results in a longer processing time. Scarborough et al. propose this effect to be influenced by the recency of processing. Since language processing is seen as an increase in the activation level of a word, recently processed words are thought to still have a higher level of activation; for activation takes some time to decrease. Since more frequent words are more likely to be processed recently, their level of activation will be higher and processing will become easier.

Summarizing we can state that, besides the influence of co-occurrence, neighborhood effects also have a substantial effect in language processing. We have seen that the strength of an association is not only influenced by the frequency of the concepts itself, but also by the frequency of its neighborhood. In the AS manual it could thus be encouraged to write down associations that are high in frequency, or that have large neighborhoods.

3.4. The fan effect

Moritz et al. (2007) state in their articles that AS is based on the fan effect, which was first studied by Anderson (1976). According to Anderson, associations interfere with each other. Therefore, learning additional associations with a certain concept makes it harder to retrieve one of these associations from memory. In his experiment, Anderson gave students list of sentences they had to memorize, such as “a hippie is in the park”, and varied the number of learned associations to either a person or a location (e.g. “hippie” or “park”). After memorizing these sentences, a recognition test was given in which participants had to recognize whether a given sentence was previously studied or not. This test showed that an increase in learned associations corresponds with an increase in response time (Anderson, 1976).

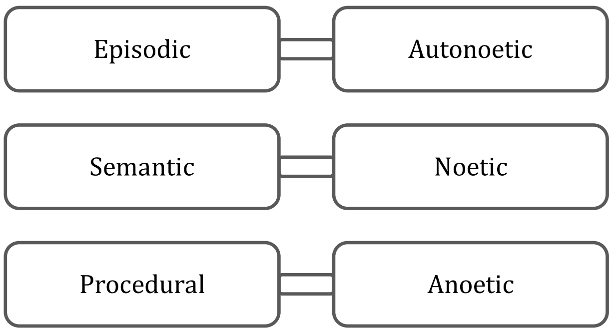
Since a correct understanding of the fan effect crucially depends on its relation to mechanisms underlying human memory, we will focus on these memory mechanisms in the following sections.

3.4.1. Models of memory

An influential model of memory is the modal model (Atkinson & Shiffrin, 1968), which divides memory into three structural components and control processes. The structural division separates memory into independently functioning registers; namely, the sensory register, the short term store (or working memory), and the long term store. The memory component we will be focusing on is the long-term store, which contains a great variety of different types of long-term knowledge.

One attempt to classify these different types of long-term memory is Tulving's (1985) triarchic theory of memory (Fig. 3.1). This divides long-term memory into three components: episodic, semantic and procedural memory. According to Tulving these memory systems differ essentially in that they imply different kinds of consciousness. He proposed that procedural memory is associated with anoetic consciousness (nonknowing), semantic memory with noetic- (knowing) and episodic with autonoetic (self-knowing) consciousness. Anoetic consciousness refers to the ability to react to a stimulus, an ability other organisms like plants or animals also exhibit. Noetic consciousness is a person's awareness of the world, its internal representation or knowledge of the world. Autonoetic consciousness is the awareness of a person's identity, of his or her own existence in the world (Tulving, 1985).

Figure 3.1. Triarchic theory of memory

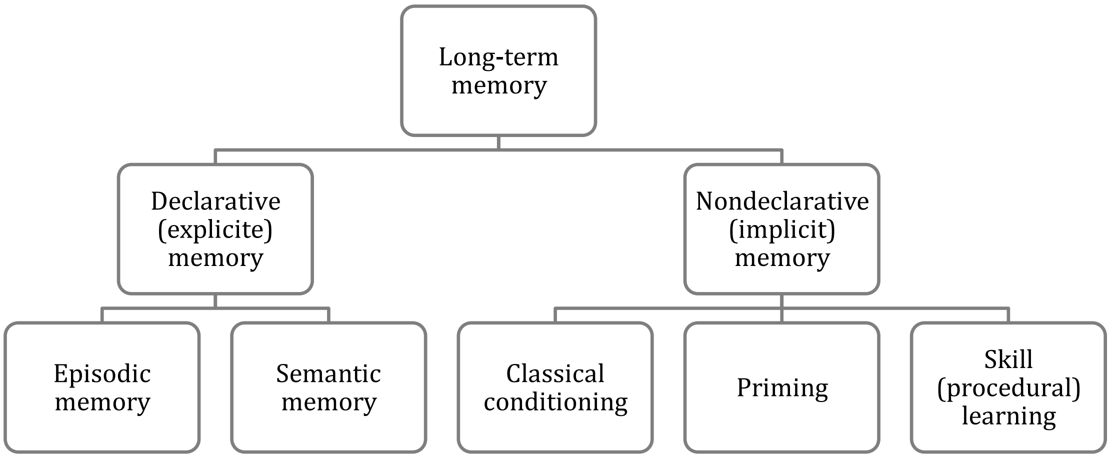


The terms "episodic", "semantic" and "procedural" refer to the different memory types that imply autonoetic (self-knowing), noetic (knowing) and anoetic (nonknowing) consciousness respectively (Tulving, 1985).

Soon thereafter Squire (1986) proposed a model in which procedural memory was renamed into "nondeclarative memory", in contrast with semantic and episodic memory, which were grouped together into "declarative memory". Declarative memory is accessible to conscious awareness, whereas procedural knowledge is only accessible through operations in memory. In declarative memory semantic and episodic memory are still viewed as separate systems. Semantic memory includes facts and general information, which is not specific to time or space. In contrast, episodic memory "involves specific episodes or events in our lives" (Radvansky, 2006, p. 16). Nondeclarative memory was subdivided (Squire, 1992; 1993) into priming, classical conditioning and procedural memory (skill learning) (Fig. 3.2.).

In addition to these different memory systems, other differences can be found in how memory is *used*. A prominent distinction that can be made in this regard is the explicit-implicit distinction (Schacter, 1987), which roughly corresponds to declarative and nondeclarative memory respectively. Explicit memory refers to situations in which a person consciously tries to remember something, whereas implicit memory refers to when a person is unaware of memory being used. One of the most extensively studied forms of implicit memory is priming, which will return in great detail in the next chapters.

Figure 3.2. Components of long-term memory



Division of long-term memory as proposed by Squire (1992; 1993). Explicit and implicit memory correspond to declarative and nondeclarative memory respectively (Schacter, 1987).

3.4.2. The fan effect in memory

The above overview of the different memory components enables us to determine where in memory the fan effect takes place. The fan effect was first recognized in by Anderson in 1974. In his experiments participants first had to study a list of sentences, after which they were asked whether they had studied a particular sentence or not. The participant was thus asked to (consciously) try to remember a certain sentence, which makes it a test of explicit or declarative memory. The participant was surely aware of memory being used.

In an attempt to further distinguish between episodic and semantic memory, we can look at the type of consciousness that is needed for the task Anderson designed. We have seen that episodic memory is associated with auto-noetic, whereas semantic memory is associated with noetic consciousness (fig. 3.1). In the experiment people were asked whether they had studied a certain sentence before. This question already reveals that this involves auto-noetic consciousness; since people were asked whether they themselves had studied a particular sentence. They were asked to remember the event of studying a particular sentence, an episode in their lives. The original fan effect was thus described as an effect of episodic memory; however, we have seen that Moritz et al. (2007) call it a semantic effect, which will be the subject of the following paragraph.

3.5. Transposing the fan effect

We have seen that the fan effect was originally described as an effect of episodic memory, which Moritz et al. (2007) transposed to the field of obsessive thoughts. In their articles Moritz and his colleagues do not determine where in memory they consider obsessions to take place. Therefore, they do not explicate the nature of the transposition they make. Since Moritz et al. (2007) call the fan effect in AS a *semantic* effect, it would seem that they transposed it from episodic to semantic memory. Hence, in this section, we will first review the literature on differences between episodic and semantic memory, that Moritz et al. (2007) disregard. This will demonstrate that they are in two separate functioning systems. Both observational and experimental studies will show there is in fact no fan effect in semantic memory. Therefore, transposing the fan effect from episodic to semantic memory, as done by Moritz et al. (2007), is incorrect. Since I will argue AS *does* take place in semantic memory, the absence of a semantic fan effect leaves AS without a proper foundation.

3.5.1. The episodic-semantic distinction

By definition, episodic memory is a system that stores information about episodes or events along with their corresponding temporal and spatial relations. Semantic memory, however, "is the memory necessary for the use of language. It is a mental thesaurus, organized knowledge a person possesses about words and other verbal symbols, their meaning and referents, about relations among them, and about rules, formulas, and algorithms for the manipulations of the symbols, concepts, and relations" (Tulving, 1972, p. 386). Even though episodic and semantic memory are similar in that they are both subdivisions of declarative memory, observations reveal a number of differences between the two. These differences were classified by Tulving (1983, p.35) into three categories; that is, differences in information, in operations and in applications (the role memory plays in human affairs). These differences are summarized in Table 3.1 (Tulving, 1984); for an overview see Tulving (1983).

Table 3.1. Episodic and semantic memory

Diagnostic feature	**Episodic**	**Semantic**
Information		
Source	Sensation	Comprehension
Units	Events; episodes	Facts; ideas, concepts
Organization	Temporal	Conceptual
Reference	Self	Universe
Veridicality	Personal belief	Social agreement
Operations		
Registration	Experiential	Symbolic
Temporal coding	Present: direct	Absent: indirect
Affect	More important	Less important
Inferential capability	Limited	Rich
Context dependency	More pronounced	Less pronounced
Vulnerability	Great	Small
Access	Deliberate	Automatic
Retrieval queries	Time? Place?	What?
Retrieval consequences	Change system	System unchanged
Retrieval mechanisms	Synergy	Unfolding
Retrieval report	Remember	Know
Developmental	Late	Early
Childhood amnesia	Affected	Unaffected
Applications		
Education	Irrelevant	Relevant
General utility	Less useful	More useful
Artificial intelligence	Questionable	Excellent
Human intelligence	Unrelated	Related
Empirical evidence	Forgetting	Analyses of language
Laboratory tasks	Particular episodes	General knowledge
Legal testimony	Admissible; eye-witness	Inadmissible; expert
Amnesia	Involved	Not involved
Bicameral men	No	Yes

Summary of the differences between episodic and semantic memory (Tulving, 1983).

Besides these observational differences, also empirical research has demonstrated several differences between episodic and semantic tasks. For instance, McKoon and Ratcliff (1979) found a double dissociation using two tasks; a recognition task[8] (which tests episodic memory) and a lexical decision task[9], testing semantic memory. In both tasks participants had to study lists of words that were either related semantically, episodically, or both. Their results showed that the priming of semantic information does not lead to improved recognition, and that episodic information does not lead to priming in semantic tasks. Another study (Jacoby & Dallas, 1981) showed that the accuracy of recognition was influenced by modulating the subject's level of attention during the test, but that attention did not affect identification. Further evidence comes from Kilhstrom (1980), who used hypnosis in instructing subjects to forget the list of words they had studied after awakening. Results

[8] Recognition tasks are always episodic tasks.
[9] Semantic tasks include lexical decision, identification and fragment-completion tasks.

show that in episodic tasks subjects indeed forget the studied words, but no such effects were seen in semantic tasks. Furthermore, priming in semantic tasks is uncorrelated with performance on episodic tasks (Jacoby & Witherspoon, 1982; Tulving, Schacter & Stark, 1982). Jacoby and Witherspoon (1982) found that studying a word improves identifying it when it is presented briefly, but the probability of identification is independent of the probability of recognition. Likewise, Tulving et al. (1982) did a recognition and a fragment-completion task and found a clear independence between the two. In conclusion, experimental research confirms the observational conclusions that episodic and semantic memory are indeed independent functioning systems. These studies also show that some processes take place in only semantic *or* episodic memory. Therefore, processes cannot always be directly transposed from episodic to semantic memory, or vice versa. In the next paragraph we will examine whether this also holds for the fan effect.

3.5.2. The semantic fan effect

We have previously established that the traditional fan effect is rooted in episodic memory, but Moritz et al. (2007) call it a semantic effect instead. For this argument, they only seem to rely on the work of Anderson (1976), even though his research does not involve semantics.

However, other scholars did test the fan effect in semantically related sentences. For example, Smith, Adams and Schorr (1978) showed that when you teach people sentences that are connected by theme, no increase in response time is found. So no fan effect occurred when participants had to study semantically related sentences. Smith et al. (1978) explain this by proposing that people learn the *theme* instead of the separate facts. Further research showed that, similarly to simple fan effect, the greater number of themes studied, the longer it takes to respond (Reder & Ross, 1983). This last finding is explained by a shift in strategy: instead of searching an exact match, a *plausibility strategy* is used. Since a sentence that is in concord with the theme is plausible to be studied, people "guess" they have studied it before. Response times increase with the number of themes studied, since the plausibility of a sentence has to be judged for each theme. This also explains why participants have such difficulties rejecting distractors (sentences they did not study, but that do fit the studied theme): the matching theme makes it plausible that the sentence was studied before (Reder & Wible 1984; see also Reder & Anderson, 1980; Smith et al., 1978).

Even stronger evidence against a semantic fan effect comes from Shoben, Wescourt and Smith (1978), who did a "fanning" experiment in which subjects had to perform both a semantic and an episodic task. In the semantic task participants had to judge the truth of sentences, in the episodic task they made judgments of recognition about the same sentences. This experiment revealed a double dissociation since the semantic task was influenced by semantic relatedness, but not by fanning; whereas recognition was influenced by fanning, but not by relatedness. This dissociation is recognized by McKoon, Ratcliff and Dell (1986) as they conclude that episodic memory differs from semantic memory in that it does not exhibit a fan effect. Further evidence asserts the absence of a fan effect in semantic memory, since data revealed that concepts in semantic memory with more associations are retrieved faster, not slower (Kroll & Klimesch, 1992).

In conclusion, these scholars have all demonstrated that, contrary to the claim of Moritz et al. (2007), there is no semantic fan effect.

3.5.3. Transposing the fan effect to obsessive thoughts

Having stated there is no semantic fan effect, our previous assumption that Moritz et al. (2007) transpose the fan effect to semantic memory, seems highly problematic. Unfortunately, Moritz et al. do not explicate the nature of the transposition they make (2007). In this section, we will therefore elaborate more on the characteristics of this transposition, which first of all requires a more detailed assessment of the tasks the patient has to perform in AS.

The first step in the AS manual is to think of and write down one's core cognitions. We have seen in Table 3.1 that episodes or events are the basic unit of episodic memory and that semantic memory consists of facts, ideas or concepts. A cognition, in the way Moritz and his colleagues use the term, is thus more likely a unit of semantic memory. After writing down their core cognitions, patients are instructed to think of positive or neutral associations with these cognitions. Associations should "make sense" Moritz (2006) says, which means they should either connect in meaning or form. This implies that associations are connected conceptually (semantic memory), not temporally (episodic memory). Also the process of thinking of new associations seems to be more involved with knowledge (semantic) than with remembering of the past (episodic). Finally, that an association can be judged to "make sense", indicates that verification occurs through social agreement (semantic) instead of personal beliefs (episodic). Summarizing, Tulving's (1983) observational differences all point towards AS being a process of semantic memory.

But if AS involves semantic memory, the finding that there is no fan effect in semantic memory (Kroll & Klimesch, 1992; Mckoon et al., 1986; Shoben et al., 1978) is troublesome, to say the least. For if there is no fan effect in semantic memory, how can we explain the symptom decline found by Moritz and his colleagues (Hottenrott et al., 2011; Moritz et al., 2007; Moritz & Jelinek, 2011; Moritz & Russu, 2013)?

Summary

By reviewing all the assumptions of Moritz and his colleagues in the metaliterature, we have come to some important conclusions. First of all, we have seen that the lexicon is commonly considered to be a semantic network. While Moritz et al. (2007) claim one-way associations are common in semantic networks; this claim is based on outdated hierarchal models (Collins & Quillian, 1969). Newer models do not predict such asymmetrical associations (Bock & Levelt, 1994; Collins & Loftus, 1975). Consequently we discussed spreading activation models, which were more complex and diverse than implicated by Moritz et al. (2007). Especially the way activation spreads was disregarded by Moritz and his colleagues. Furthermore, we have seen that increased co-occurrence is not the only factor influencing associative strength, as Moritz et al. (2007) suggest. Also frequency, recency and neighborhoods proved to be important. Hereafter, we turned to the fan effect, which Moritz et al. (2007) called a *semantic* effect, although it was traditionally seen as a process of episodic memory. We have seen that both observational and experimental research attested the distinction between episodic and semantic memory, crucially demonstrated by the absence of a fan effect in semantic memory. Since we then established that AS involves semantic memory and not episodic, this led to the conclusion that the transposition of the fan effect, that Moritz et al. (2007) make, is in fact incorrect. Since AS can no longer be explained by the fan effect, in the following chapter I will propose a new explanation for AS.

4. A different approach

In the previous sections we have closely examined the assumptions Moritz et al. made in explaining AS and put them in the framework of psycholinguistic literature. One of the major findings herein was that we have seen that AS involves semantic memory, and that the fan effect on which Moritz et al. rely, is only present in episodic memory. The workings of AS are therefore in need of a different explanation, which I suggest can be found in priming processes. However, we have already seen that priming is a process of nondeclarative memory, so we would encounter a similar problem as Moritz and his colleagues did before us. Where the transposition of Moritz and his colleagues was involved with episodic and semantic memory, ours involves the declarative-nondeclarative distinction. In the first part of this chapter (§ 4.1) I will therefore explain that priming is in fact strongly related to semantic memory, and should not be considered as being *purely* nondeclarative memory. Subsequently I will discuss how priming could work in relation to AS (§ 4.2), and the corresponding clinical implications in paragraph 4.3.

4.1. Priming and semantic memory

Priming is defined as the situation "where hearing or seeing one processing unit, e.g. a word, can affect a participant's speed and accuracy in responding to a subsequent, related processing unit" (Warren, 2013, p.247). Even though priming is considered to be part of nondeclarative memory, most scholars do agree that it *also* affects semantic memory. For instance the experiments by Scarborough et al. (1977), on low- and high-frequency words, indicate that priming should be understood to affect semantic memory through recency. According to his theory, priming causes activation of the corresponding concept in semantic memory. Assuming that activation decays slowly to a resting level, the activation level will still be relatively high while processing the probe. This is also congruent with their finding that priming has more effect on low-frequency words than on high-frequency ones (Scarborough et al., 1977), since we can then assume that high-frequency words just never fully reach resting levels. In other words; high-frequency words always have lowered activation thresholds. In this line of thinking, priming thus influences semantic memory by influencing the activation level of primed concepts.

Tulving (1983) opposed to this hypothesis on the grounds of long lasting priming effects. Priming effects were shown to be stable for 7 days (Tulving, 1982) and even found to be largely at the same level after 48 weeks (Cave, 1997), and even after 12 months (Kolers, 1976). According to Tulving, these long-lived priming effects are difficult to reconcile with the assumption that priming reflects the slowly fading excitation of lexical nodes or logogens. If this were the case, all frequently used words should be in a continual state of activation. According to Tulving (1983), priming should rather be considered as procedural memory; it facilitates cognitive operations by skill learning. A similar explanation is put forward by Oliphant (as cited in Forster & Davis, 1984), he states that priming is not due to recency, but depends on subjects becoming aware of the repetitions, which results in them adopting a strategy to recognize the repeated words faster. Even though Tulving (1983) argues that long-lived priming is an argument *against* the idea of slowly fading excitation, the finding that high-frequency words are permanently facilitated (Scarborough et al., 1977) is in fact evidence *for* this theory. For in this line of thinking, high-frequency words are always reactivated before previous priming effects have worn out. Hence they are permanently (slightly) activated, have lowered thresholds, and are therefore easier reactivated.

Yet another explanation of repetition priming is found in the *instance theory of automaticity* (Logan, 1990). This theory assumes three mechanisms; obligatory encoding, obligatory retrieval and instance representation. Obligatory encoding asserts that when attention is focused on something, it has to be encoded in memory. Similarly, obligatory retrieval entails that attention to an item, causes the retrieval of earlier occurrences from memory. The assumption of instance representation entails that each instance of an item has to be encoded in memory. Applied to automaticity, a process is automatic when processing it occurs by the retrieval of prior instances from memory instead of by general algorithmic computation. This theory further assumes that the choice between retrieval from memory or algorithmic computation relies on the speed of both processes. At the first instance algorithms will be faster, but the more instances there are in memory, the faster memory becomes. Repetition priming can thus be viewed as the first step towards automaticity, in which a combination of memory and algorithms are used. In the automaticity theory it remains unclear what kind of memory priming itself reflects, but Tulving and Schacter (1990) do make this clear in later work, where they made the distinction between *perceptual* and *conceptual priming*. In perceptual priming tasks processing is largely determined by the physical properties of test cues. In contrast, conceptual priming requires semantic priming. Tulving and Schacter consider perceptual priming to be part of the “Perceptual Representation System” (PRS). The PRS is a procedural, pre-semantic memory that enhances skill-learning and includes both perceptual priming and perceptual identification. Contrastingly, conceptual priming is not part of the PRS. Instead it is seen as a way of construing semantic memory; it changes the semantic system.

In summary, priming is mostly seen as a way of facilitating processing in semantic memory. This facilitating process can be (very) long lasting; high-frequency words can therefore be permanently facilitated. There are different opinions on how to interpret priming, ranging from higher levels of activation, lowered thresholds to increased automaticity, but there is no doubt that priming does change semantic processing.

4.2. Association Priming

In the previous section we have seen that priming makes language processing faster and more economic, since it facilitates the processing of the most probable and most frequent words. In the case of obsessive thoughts, which are by definition very high in frequency, this would mean that obsessions are permanently facilitated. Because obsessive thoughts are so high in frequency, they are always reactivated before they can return to a resting level of activation. Such high activation levels could surface as one-way associations, for only the way *towards* the obsession is high in frequency, not the associations leading *away* from it. The increased one-way associations Moritz et al. (2007) observed in OCD can thus be explained by the idea that only the ways towards the obsession are primed automatically. Exactly this is crucial for my new approach to AS; one should aim to facilitate the paths leading away from the obsession.

AS was designed with the idea in mind that associative strength is limited and that the sum of activation is divided by neighboring cognitions (Moritz et al., 2007; Moritz & Jelinek, 2011). However, we have seen that this might be true for episodic memory, but not for semantic memory. In the semantic system associative strength is *not* limited and is *not* divided by neighboring cognitions, instead higher numbers of neighboring cognitions enhance processing (Kroll & Klimesch, 1992). Therefore I would rather see association splitting as *association priming (AP)*; by priming neighboring associations, you facilitate the way *away* from the obsession. Instead of the obsession being the only high-frequency concept, related concepts also become higher in frequency and are thus more easily activated. Where the obsession used to be the only facilitated concept, priming neutral neighboring concepts makes them facilitated as well. In this approach, AS does not work by *splitting* the strength of the obsessive association, but by *priming* related associations.

One advantage of the approach of AP is that it is designed to lead away from the obsession. The aim is to enhance the associations related to the obsession, which also involves enhancing the neighborhood of the neighboring concepts. For example, if a patient is obsessed with the idea that "God" read backwards is "dog", both "God" and "dog" will be obsessive concepts. In this case, "cat" is a neighboring association of "dog", and "mouse" is of "cat". So by priming the association towards "cat", you also facilitate "mouse", and so on. AP would lead the patient further and further away from his or her originating obsessive thought. Instead in AS, the patient is instructed to take the obsessive thought in mind and think of neutral concepts associated with the obsession. After writing down this new association, the patient has to start over and think of another association with the obsession. Since this forces the patient to keep returning to his or her obsession, this seems counterproductive to me.

Another advantage of the AP approach is that it is designed to navigate away from the obsession, regardless of the nature of the obsessive thought. Contrastingly, AS instructs patients to think of neutral associations instead of the original negative ones. However, obsessive thoughts do not necessarily involve negative associations: some are already neutral. For instance, patients can be obsessed with how electrical or mechanical devices, such as motors or computers, are able to work (Penzel, 2000, p. 235). They feel the need to perfectly understand the principles behind these things and cannot stop thinking about them. Even though such obsessions involve neutral concepts, patients experience a lot of anxiety if they cannot figure out the exact principles behind them (Penzel, 2000). The AS manual does not anticipate the existence of neutral obsessions: it is only aimed at reduce negative associations. AP can still work in these cases, since it is intended to navigate away from *any* obsession.

Summarizing, I propose AP as a new approach to AS, by explaining the underlying mechanisms in terms of priming instead of splitting associations. This new approach has some theoretical advantages compared to AS, since it is aimed at leading away from an obsession instead of neutralizing it. As AP fully depends on a correct understanding of priming processes, this will be the focus of the next section.

4.2.1. Priming processes

The priming experiments used in the models above (Scarborough et al., 1977; Oliphant, 1983; Logan, 1990) were *repetition priming* experiments, which is priming in which the probe and the prime are exactly the same (e.g. house-house). Other research confirmed the facilitating effects of repetition priming (Forbach, Stanners & Hochhaus, 1974), which was found to be independent of the subjects' expectations, since people are unable to tell whether they have seen the prime earlier in the experiment (Scarborough, Gerard & Cortese, 1979). In later fMRI studies the most common finding in repetition priming was a decrease of the haemodynamic response[10] for repeated, repetition primed, stimuli (Raposo, Moss, Stamatakis & Tyler, 2006). Besides this haemodynamic reduction which is mostly referred to as "repetition suppression", some studies also found an enhancement of neural activity, called "repetition enhancement" (Henson, 2003). Repetition enhancement was only found in experiments which used unfamiliar primes, suggesting that it involves processes of forming new representations (Henson, 2003). Raposo et al. (2006) also did an fMRI study with *semantic*

[10] A heamodynamic response is the rapid supply of blood (i.e. nutrients) in response to activation of neural tissue. Higher levels of neural activation are related to a greater heamodynamic response. This can be measured with fMRI (functional magnetic response imaging), that measures neural activation by detecting changes in blood flow.

priming experiments. In semantic priming tasks the probe and the prime are only semantically related, instead of being the same. In semantic priming tasks there was no repetition suppression, but only an enhanced activation in bilateral fronto-temporal areas (Raposo et al., 2006).

Some of the earliest semantic priming tasks were done by Neely (1976; 1977). Neely (1976) found that a semantically related prime facilitated the recognition of the probe, whereas semantically unrelated words slowed down recognition of the probe compared to a neutral prime. According to Neely (1977) semantic priming is consistent with the theory of Posner and Snyder (1975), where priming causes facilitation through an automatic spreading-activation process and a limited-capacity conscious-attention mechanism.

Another focus for research was the differentiation between *associative links* and *feature overlap*. Feature overlap is seen as pure semantic priming (e.g. canary-pigeon), while associative links are the result of words co-occurring (e.g. bread-butter). Lucas (2000) found that pure semantic priming is effective, however adding an associative link gives a so called "associative boost". Semantic priming is then the result of both feature overlap and associative links (Hutchison, 2003).

A special type of semantic priming is *indirect semantic priming*, in which a certain concept primes an unrelated concept, through a mediating concept (e.g. lion-tiger-stripes) (Sass, Krach, Sachs & Kircher, 2009). Other forms of priming include *structural priming* (for a review see Pickering, 2008), which involves the priming of syntactical properties (e.g. the priming of passive constructions), *orthographic priming* (e.g. char-chat) and *phonological priming* (e.g. tribe-bribe). Orthographic and phonological priming effects were observed in different tasks (Grainger & Ferrand, 1996) but seem to depend on certain conditions. For instance, in semantic transparent words, suffixed and prefixed derived words, and their stems, prime each other, but in opaque words no such orthographic priming was found (Marslen-Wilson, Komisarjevsky, Waksler & Older, 1994). Also *form priming* (e.g. mature-nature) was found mostly when there is phonetic overlap, since priming is found in pairs like "tribe-bribe", but not in "couch-touch" (Meyer, Schvaneveldt, Roger & Ruddy 1974). Form priming was also found only in words with low-density neighbors (Forster & Davis, 1991), which is consistent with the finding that low-frequency words benefit more from repetition priming (Scarborough et al., 1977).

4.3. Clinical implications

This new approach of AP opens up a lot of opportunities for the association instructions in a self-help manual. We have already briefly touched on a few implications that resulted from our review of the literature, which will be discussed in more detail here. Consequently, we will deliberate on the implications of the different priming types discussed in the previous section.

Firstly, by looking at semantic networks, we have seen several different models that could be implemented in AP. One of which is the idea that language representation consists of a concept, lemma and lexeme level (Bock & Levelt, 1994). This implies that in strengthening associations, one can strengthen these three levels separately. A self-help manual could therefore encourage patients to think of semantic associations (conceptual level), of words from the same category (lemma level), and of words with similar orthographic or phonetic features (lexeme level).

Phonetic features were also influential in theories of language processing, where we have seen that language processing can be explained in terms of cohorts (Marslen-Wilson, 1987). Word initials proved to be crucial for language processing, therefore writing down word initial cohorts might aid in consolidating associations. Moreover, in relation to language processing, we have seen that high-frequency words and words with large neighborhoods are processed faster. Patients can be encouraged to focus on words that are high in frequency; words that are most common. For a list of the most common associations, patients (and/or clinicians) could use the Edinburg Association Thesaurus (Science and Technology Facilities Council, n.d.). This is a database that provides the most frequent associations for a given term, based on empirical data.

As mentioned above, also different priming types can readily be described in a self-help guide. For priming processes predict which associations are easily made. In the AS self-help guide (Moritz, 2006), patients are instructed to think of neutral associations quite randomly. These could involve anything, they could be “words, short sentences, pictures or refrains from songs” (Mortiz et al., 2007, p. 633), as long as it were a positive or neutral concept. In AP, patients could be instructed to use all kinds of priming, thereby exploiting all the possibilities. For example, patients could be instructed to look at suffixes or prefixes and see if their core cognition can be changed by affixation (orthographic priming). They could also be instructed to write down all the words that rhyme (phonological priming) or often co-occur (associative priming). Thinking of words that start with the same letters or phonemes (orthographic/phonological priming), or trying to make a new word by changing one letter (form priming), could also be implemented in a manual.

A further implication of AP is that it predicts that “practice makes perfects”. The more the patient practices the new associations, the higher in frequency they become and the easier it becomes to associate away from his or her obsession. This idea, that practice makes perfect, could be a strong motivator for patients, since the frequency with which they do the exercise determines the effect. However, doing this exercise should not become the patients’ next obsession. Therefore patients must be instructed to practice this only during a certain time a day and only in obsession-free intervals.

Conclusion

We have established in chapter 3 that the fan effect cannot be the process underlying AS, since there is no fan effect in semantic memory. In this chapter I have therefore proposed a new approach to AS; namely, Association Priming (AP). Priming is considered to facilitate processing in semantic memory, and can therefore explain the reduction of symptoms in patients practicing AS, for priming eases the way *away* from an obsession. We have seen that AP has several theoretical advantages over AS. Firstly, AP is designed to lead a patient further and further away from his or her obsession, instead of forcing the patient to keep returning to it - as in AS. AP also anticipates on the presence of neutral obsession, since it aims to lead away from any obsession. Contrastingly, AS was designed to neutralize them. Finally, we discussed the clinical implications of AS, which were deduced from the discussed metaliterature and from different kinds of priming.

5. Discussion

In summary, we have seen that association splitting (AS) is a promising new self-help technique for treating obsessions in OCD (Moritz et al., 2007), and further research showed that it also could be effective in a clinician based setting (Hottenrott et al., 2011). AS works by adding new neutral or positive associations to a patient's core cognition, thereby lowering the associative strength of the core cognition itself. Moritz and his colleagues explain in their articles that AS is based on the fan effect, which asserts that the total amount of activation is limited, and should be divided by the number of associations present. However, we have seen that AS takes place in semantic memory and the fan effect is only described in episodic memory. Therefore AS was in need for a different explanation, that we found in the process of priming. By adding and repeating new associations, one can prime these associations and thereby facilitate their processing. In the light of priming processes, it seems more fitting to replace the term "association splitting" by the similar "association priming" (AP). This shift in theoretic basis also has several clinical implications. Priming is known to occur in different situations (e.g. semantic, orthographic, associative); all of which could be integrated in the techniques used in AP. Furthermore, priming anticipates the possibility to follow primed roads to lead your attention further and further away from your core cognition.

An interesting field that was left untouched in this thesis is the influence of psychoactive drugs on these forms of therapy. Traditional treatment for OCD consists of cognitive therapy, and/or medication (SSRI's or clomipramine). SSRI's increase the amount of available serotonin in the brain, and clomipramine is a Tricyclic Antidepressant (TCA) that is known to inhibit the reuptake of norepinephrine and mainly of serotonin (5-hydroxytryptamine, or 5-HT). The role of 5-HT in reducing symptoms in OCD remains unclear, but that is has an effect is hard to refute. An interesting crossroad with priming is that research has shown that the altering of 5-HT synthesis trough dietary tryptophan[11] manipulations, influences priming mechanisms (Burgund, Marsolek & Luciana, 2003). This experiment showed that people with high tryptophan exhibited specific visual priming[12], but no amodal[13] priming. In contrast, tryptophan depleted participants displayed amodal priming, but no specific visual priming, and the controls exhibited both amodal and specific visual priming. Lowered levels of serotonin in OCD might therefore result in less specific visual priming. Since unwanted intrusive thoughts are thought to be a risk factor for developing OCD, the positive effects of AS in

[11] 5-HT is biochemically derived from the L-stereoisomer of tryptophan (L-tryptophan).
[12] Specific visual priming is defined as a "greater priming for stems presented in the same lettercase as their corresponding prime words than for stems presented in the different lettercase compared with their corresponding prime words" (Burgund et al., 2003, p. 162).
[13] Amodal priming is defined as "equivalent priming for stems presented in the same lettercase, different lettercase, and different perceptual modality (visual stems following auditory words) compared with their corresponding prime words" (Burgund et al., 2003, p. 162).

people with unwanted intrusive thoughts could be interpreted as a prophylaxis (Rodríquez-Martín et al., 2012). Enhancing priming may then not only influence the symptoms, but even the pathogenesis of OCD. Future research could therefore be directed at looking at a possible preventive effect of AP. Also the interaction of drugs that influence serotonin with the technique of AP forms an interesting basis for future research.

Another exciting area for study is expanding AP to an online form of therapy; for example, by incorporating it into a game like setting for smart phones. There are already game applications available that are based on semantic association (e.g. “Next Word – Word Association” (Bullbitz, 2013), “Word to Word: Fun Association” (MochiBits, 2012)) in which the goal of the game is to connect words as fast as possible. In these games the computer determines with which word you start your game and then you have to associate from there. In feasible future games the player could decide where to start, which in OCD would be the core cognition. Such a game should then be based on online semantic networks, such as WordNet® (Princeton University, 2010), for providing the possible associations. Therapy would then become more like a game, instead of a task.

Moreover we have seen that since OCD used to be considered as an anxiety disorder, therefore treatment of OCD also followed this approach. However, OCD is now regarded to be part of the obsessive-compulsive and related disorders (APA, in press). AS was so far mainly tested in patients with OCD, but the release of the DSM-5 provides grounds for testing it in closely related disorders as well.

This thesis has provided a broad framework for AS. Our conjecture is that this quite successful treatment, which was rooted in an interdisciplinary basis, was in fact confounded by incorrect transpositions from one discipline to the other. In my opinion, overgeneralizations and the disregarding of crucial metatheories, led to an incorrect mechanistic explanation. Indeed interdisciplinary research requires a broad knowledge of all relevant fields.

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