Effects of Retrieval Cues in Episodic Memory: The Many Faces of Part-List Cuing

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Preface

How can we gain re-access to contents and experiences that we have stored in our memory? This is one of the key issues in human memory research. If information were encoded and stored in memory but could not be re-accessed at a later point, it would be worthless. The concept of retrieval, i.e. the reactivation of acquired memories, remained somewhat neglected until the 1960s when Endel Tulving as one of the first reseachers of his time began to emphasize the importance of retrieval processes against the background of the previous behaviouristic view of stimulus-response associations and the main focus on storage. From the behaviouristic point of view, there was no need to distinguish between storage and retrieval and it was considered that recall performance directly reflected the information that had been successfully encoded and stored. Tulving, however, argued that much more information is stored in our memory than we can remember at a certain point in time and introduced the distinction between the availability and the accessiblity of particular memories. According to his view, information that is stored and theoretically available in our memory is accessible to retrieval only under certain circumstances (see Tulving, 1979). Thus, it is of great importance for human memory research to identify factors that determine successful retrieval.

An “extremly important factor in determining the level of recall” (Tulving & Pearlstone, 1966, p. 216) is the presence of adequate retrieval cues, i.e. hints or clues that are present during a retrieval attempt and that have the capacity to evoke a particular memory. Tulving and his colleagues (Tulving & Osler, 1968; Tulving & Pearlstone, 1966; Tulving & Psotka, 1971) demonstrated in numerous studies that the amount of information that we can retrieve depends crucially on retrieval cues provided at the time of recall. In a seminal study, Tulving and Pearlstone (1966) observed that people were able to recall more items of a categorized word list when the items' category names were reexposed at test to serve as retrieval aid and thus provided first empirical evidence that retrieval cues allow us to get access to information that we otherwise would not be able to retrieve.

There is a multiplicity of things that can aid and guide our retrieval as cues. For instance, the shopping bag on the chair may remind us that we have planned to do our weekly shopping today. Or, when a workmate tells us about a delicious meal in a fancy restaurant last night, it will remind us of our great birthday party in the same restaurant two months ago. In a diary study, Wagenaar (1986) showed that the recall of autobiographical events can significantly improve if information about single aspects of the event - like persons involved or the location of the event - is provided during retrieval. Eventually, Wagenaar found that he was able to recollect most of the events even after six years, given a sufficient number of retrieval cues. Similarly, retrieval may benefit also from more general, contextual cues like the environment in which a memory trace was originally encoded (see Smith & Vela, 2001). In a often-cited study, Godden and Baddeley (1975) impressively demonstrated that items studied and tested in the same environment were better recalled than those for which study and test contexts differed. To this end, deep-sea divers learned a list of words either on dry land or under water and subsequently engaged in a recall task either in the same environment as during encoding or in the different one. Actually, when the divers learned and retrieved the words only on land or only under water, recall was better than when the environment changed.

The associative and organizational theories of memory that became influential in the 1960s and 1970s explain the beneficial effects of retrieval cues by associative connections that were formed between cue and target memory during encoding (see Anderson, 1972; Collins & Loftus, 1975). Ever since

Aristotle (cf. Roediger, 1978), it has been assumed that associations between single memory items may, at least in part, guide and support the retrieval of a particular memory. The activation of one of these items during retrieval, like the presentation of a category label or even the original environment as retrieval cue, may increase the accessibility of related items by a process called spreading activation. The main idea of spreading activation is that a given memory trace automatically spreads activation to other associatively related memories, which in turn increases the likelihood that these related memories get retrieved. The concept of spreading activation across interitem associations is a core feature of many theories of memory, and can illustrate clearly how retrieval cues make memories accessible. It found its way also into applied memory research and is implemented, for example, in the cognitive interview of eyewitnesses (Geiselman, Fisher, MacKinnon, & Holland, 1985), an interrogation technique that provides known details of an event as retrieval cues.

However, during about the same period, a number of studies started to question the generality of spreading activation processes by showing that the provision of retrieval cues does not always improve retrieval but may even hinder it (e.g., Roediger, 1973; Slamecka, 1968). The results of a study of Slamecka (1968) constituted a cornerstone for it and initiated a rethinking process on the effects of retrieval cues. Originally, Slamecka (1968) also intended to prove the theoretical view that making an item accessible may aid the retrieval of associated items and reasoned that the faciliative effect of associative connections might be demonstrated in a rather direct way when a subset of items from a previously studied word list was provided as retrieval cues for the rest of the list. For this purpose, he conducted a series of experiments, in which he varied the testing conditions between two groups of participants. After study of a word list, an experimental group received a random subset of the list items as retrieval cues and were asked to recall the remaining items. In contrast, the control group received no such cues and tried to recall the entire list in a free recall task. Slamecka expected to demonstrate that the recall of the uncued target items would be superior in the experimental group than in the control group because of the activation of otherwise inaccessible associative connections. However, to his big surprise, he repeatedly found that the presentation of retrieval cues did not facilitate but even impaired the recall of the remaining items - a finding that became known as *part-list cuing impairment* in memory research.

Even though the finding seems quite counterintuitive and at odds with the common theories of human memory, it has been replicated and extended in a vast number of subsequent studies that consistently reported detrimental effects of *part-list cues* (for reviews, see Nickerson, 1984; Roediger & Neely, 1982). Part-list cuing impairment has proven to be very robust and has arisen over a wide range of study materials (Brown, 1968; Slamecka, 1968; Sloman, 1991), testing procedures like recall, recognition, and reconstruction tasks (Kelley & Bovee, 2007; Oswald, Serra, & Krishna, 2006; Todres & Watkins, 1981), and in different participant groups (Bäuml, Kissler, & Rak, 2002; Christensen, Girard, Benjamin, & Vidailhet, 2006; Marsh, Dolan, Balota, & Roediger, 2004; Zellner & Bäuml, 2005). Numerous theoretical explanations have been also developed to account for the effects of part-list cuing. However, even 30 years after its first demonstration by Slamecka (1968), part-list cuing continued to remain "something of an enigma in memory research" (Nickerson, 1984, p. 551) and it was still unclear how the effect arises. The basic assumptions that nearly all of the theories during this period had in common were that part-list cuing is always detrimental to the recall of the remaining items and that a single mechanism is responsible for the effect.

In more recent years, new findings have challenged these basic assumptions and have thus influenced the way of thinking about part-list cuing. One of these findings is the demonstration that part-list cuing impairment cannot be sufficiently explained by one cognitive mechanism, but that more than one mechanism may mediate the effect. Two studies of Bäuml and Aslan (Aslan & Bäuml, 2007; Bäuml & Aslan, 2006) showed for the first time that quite different mechanisms may be involved, depending on the encoding situation.

Items can be encoded in very different ways, and also in everyday life, we use different strategies to encode and store contents in our memory. For instance, we either may encode items each one by one or we may try to develop connections between the single items and build a serial retrieval plan. When part-list cues are provided at test, the way of encoding can then lead to the involvement of different cognitive mechanisms and can thus influence the effects of part-list cuing.

For decades, research focused almost exclusively on negative effects of part-list cuing on target recall. Thus, the second novel finding that part-list cuing may, under certain circumstances, also be beneficial for the remaining items came as a big surprise. Goernert and Larson (1994) examined the effects of part-list cues on a list of items that was intentionally forgotten after studying. Subjects studied a word list and were afterwards asked to forget the list and study another one. Nevertheless, at test, they were tested on even that list and received either a random selection of the list items as part-list cues or performed a free recall task. Goernert and Larson found that part-list cues enhanced the recall of the forgotten items and thus provided first evidence that part-list cuing can also improve target recall. The finding had not been replicated for a long time and remained almost disregarded in part-list cuing research during the following years until Bäuml and Samenieh (2012) took up, replicated, and generalized the finding. They demonstrated that beneficial effects of part-list cuing can emerge with different forms of forgetting when the access to the original study context is impaired during testing, like after the instruction to forget the encoded material or after a prolonged retention interval between study and test (see also Bäuml & Schlichting, 2014), and reasoned that the presentation of part-list cues may reactivate the original context and thus improve recall performance.

The present thesis is dedicated to clarify the open questions that arise from these two lines of research, which are based on the findings of part-list cuing impairment in different encoding situations and on the finding of part-list cuing facilitation when study context access at test is impaired. Thus, it is intended to contrast part-list cuing in different encoding situations and to underline that the way of encoding plays a crucial role for effects of part-list cues and the involved cognitive mechanisms. Additionally, the thesis aimes to examine if beneficial effects of part-list cues that, to date, have been demonstrated for one type of encdoing only generalize to further encoding situations. Indeed, current empirical support for beneficial effects is restricted to single study situations in which typically hardly any serial retrieval plans are formed by subjects. Thus, in the present thesis, part-list cuing effects are investigated in conditions in which study context access is impaired at test and encoding conditions are employed that provoke the development of serial retrieval plans. In a further step, a repeated testing procedure is used in order to draw more precise conclusions about how part-list cues may affect the usage of a serial retrieval plan and thus influence recall performance in this type of encoding situations. Finally, the present findings shall help to understand the mechanisms that may underly the effects of part-list cuing in different encoding and testing situations in order to determine the conditions in which part-list cuing may be beneficial or detrimental. As Roediger stated already 1973, it is a major challenge to the understanding of human memory to specify the conditions under which retrieval cues may improve or impair recall, and to develop a compelling theoretical account (see Roediger, 1973, p. 645). It is also of high practical relevance to be aware of the differing effects of cues depending on encoding and testing conditions in order to provide retrieval cues in an appropriate and useful manner in applied situations like educational or clinical settings or in eyewitness testimony.

The purpose of chapter 1 of this thesis was to give an overview of basic concepts and empirical findings in research on part-list cuing. In a first step, it introduces the basic experimental paradigm and findings. Then, the question of the cognitive mechanisms mediating the detrimental effects of part-list cuing and their dependence on encoding is discussed. In the second step, the findings from more recent studies, that reported beneficial effects of part-list cuing, are reviewed, and a theoretical account of the beneficial effect is provided. With regard to the current state of research, chapter 2 specifies the goals of the present experiments. In chapter 3, the experiments are introduced, methods and results reported and subsequently discussed. Finally, in chapter 4, the main findings are summarized and discussed. A multi-mechanisms account is introduced that combines the findings on the detrimental and beneficial effects of part-list cuing in different experimental conditions.

Contents

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Abstract

Retrieval cues play a crucial role for successful remembering in episodic memory. In contrast, research on part-list cuing - the presentation of a random selection of studied items as retrieval cues at test - has consistently reported a detrimental effect of part-list cues on recall of the remaining items. Depending on the encoding situation, which may favor the development of serial retrieval plans to varying degrees, part-list cuing impairment has been attributed to quite different cognitive mechanisms. In more recent years, some studies demonstrated that part-list cuing can not only impair, but also improve recall when context conditions after study are changed and thus access to the original study context at test is impaired. Current empirical support for the beneficial effect of part-list cuing is restricted to encoding situations in which typically hardly any serial retrieval plans are formed by subjects.

This thesis investigated how the type of encoding and access to study context at test affect the effects of part-list cuing. Experiments 1 and 2 showed that, depending on the combination of encoding and and study context access, part-list cuing impaired, improved, or did not influence recall of the target items. Experiment 3 and 4 focused on encoding situations in which serial retrieval plans were developed and demonstrated beneficial effects on the second test of a repeated-testing task, when part-list cues were provided on the first recall test but were removed on the second test. From these findings, a multimechanisms account is derived to explain how part-list cuing affects target recall in different conditions.

Chapter 1

The Effects of Retrieval Cues in Episodic Memory

1.1 Part-List Cuing

Imagine you came back from a journey in Africa and you are asked by your friends to remember as many animals as possible that you have encountered on your trip. Then, when you have already listed all of them that came to your mind and someone else will provide you with the category name *birds*, you will probably be able to remember much more animals than before. Retrieval cues can play an important role for episodic recall. Analogous to the example above, laboratory work has consistently shown that recall of a previously studied categorized word list can be facilitated if the items' category names or one instance of each category are presented as retrieval cues at test (e.g. Hudson & Austin, 1970; Tulving & Pearlstone, 1966; Tulving & Psotka, 1971). In the first of these studies, Tulving and Pearlstone (1966) asked participants to study word lists comprising instances from different semantic categories with the items of the same category presented together and each preceded by the category name. Afterwards, during the test phase, participants either recalled as many items as possible in a free-recall condition or additionally received the category labels in the cued-recall condition. The main result was a large advantage of the cued-recall condition over the free-recall condition. Additionally, when the latter uncued participant group subsequently received the category names as cues, they were able to recall many more words than in the free recall task before.

Recall can also benefit strongly from contextual features that are present during encoding and retrieval and that may act as retrieval cues. The term context refers to the general setting or circumstances in which an event occurred and which are stored with the particular contents in our memory. For instance, it was repeatedly demonstrated that the overlap of the physical environment, like the room in which material was learned and tested, can improve recall performance (Godden & Baddeley, 1975; Smith, Glenberg, & Bjork, 1978; Smith & Vela, 2001). However, the concept context contains also the learners internal environment like their physiological state (e.g., being tired, excited, drunk, or tranquilized). Goodwin and his colleagues (Goodwin, Powell, Bremer, Hoine, & Stern, 1969), for example, reported clinical and laboratory evidence that information that was encoded when participants were drunk was remembered best when participants were drunk again at recall. Another internal context that may influence retrieval is mood or emotion; memory contents that are encoded in a given mood, whether positive, negative or neutral, are best recalled in even that mood (Bower, 1981; Eich, Macaulay, & Ryan, 1994). The influence of contextual information on recall performance is reflected in the so-called *encoding specifity principle* (Thomson & Tulving, 1970; Tulving & Thomson, 1973). Encoding specifity means that the ability to retrieve particular memory entries depends critically on the match between encoding and retrieval contexts.

However, an opposing line of laboratory research suggests that retrieval cues do not always improve recall performance. About five decades ago, first empirical evidence emerged that the beneficial effect of cuing may even reverse into a detrimental effect when a subset of previously studied items are presented during recall (Slamecka, 1968; Roediger, 1973). In the following years, the detrimental effect of cues was replicated by a large number of studies, employing the so-called *part-list cuing paradigm*. Considering the multitude of empirical evidence for beneficial effects of retrieval cues, the finding is indeed surprising and quite counterintuitive and has motivated much research and theorizing on this topic. In the following, the basic paradigm will be introduced and the variety of replications in different experimental settings will be described.

The Part-List Cuing Paradigm

In a typical part-list cuing experiment, participants study a list of words and, after a short distractor task, receive either several items as retrieval cues for recall of the remaining items or perform a free recall task in the absence of any retrieval cues. This paradigm was originally introduced by Slamecka (1968) in a series of experiments in which he repeatedly varied the presentation of retrieval cues on a final recall test. For example, subjects studied a list of 30 words and subsequently attempted to recall the items. However, on the final test, participants in the experimental condition were given a randomly chosen half of the list items as cues and were asked to recall the remaining (target) items. Participants in the control condition were asked to recall as many of the items as possible of the entire list in a free recall task. Recall performance for the target items in the experimental condition was compared with recall for the same items when no cues were given in the control condition. As an intriguing finding, recall of the target items was impaired by the presentation of part-list cues in the experimental condition relative to recall in the uncued control condition (see Fig. 1).

Although initially dismissed as a procedural artifact (Slamecka, 1968, p. 510), research on part-list cuing has attracted the attention of many memory researchers in the following decades after Slamecka's discovery. For instance, Roediger (1963) presented word lists consisting of blocked exemplars of several semantic categories and then conducted a recall test in which participants were provided with either category names as retrieval cues or additionally received a varying number of category instances. Subjects who were cued with additional instances recalled a significantly smaller proportion of the target items than subjects in the control condition who received category names as cues only. Additionally, the detrimental effect of part-list cuing increased as the number of instances given as cues increased. Roediger reasoned that cuing may impair recall when more cues are presented than is necessary to activate higher order units such as categories. Numerous studies have reported analogous findings of a detrimental effect of part-list cuing, referred to as *part-list cuing impairment* in the following (for reviews, see Nickerson, 1984; Roediger & Neely, 1982).

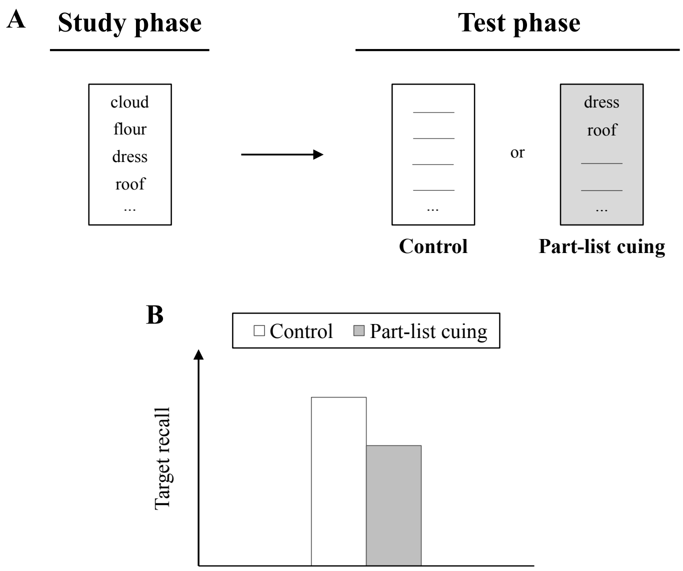

Figure 1. (A) Illustration of the Part-list cuing task. Participants study a list of items and, on a later test, are either asked to recall the items in the absence of any retrieval cues (*Control*) or receive a random selection of the studied items as retrieval cues for recall of the remaining (target) items (*Part-list cuing*). **(B)** Typical finding. Recall of the target items is impaired in the part-list cuing relative to the control condition.

The Generality of Part-List Cuing Impairment and its Limitations

Part-list cuing impairment has proven to be a very robust effect that emerges in a variety of experimental settings. It has been found in episodic as well as semantic memory. In episodic memory tasks, part-list cuing impairment is not limited to a specific type of previously studied material and has been demonstrated for both categorized and uncategorized word lists (Slamecka, 1968; Roediger, 1973; Roediger, Stellon, & Tulving, 1977), for paired associates (Mueller & Watkins, 1977), and for materials in applied settings such as grocery lists (Bovee, Fitz, Yel, Parrot, & Kelley, 2007). Additionally, part-list cuing impairment has been generalized also to more general semantic knowledge (Brown, 1968; Kelley & Parihar, 2018; Sloman, 1991). For instance, Brown (1968) had subjects either study a list of 25 U.S. states or read an unrelated distractor task. Subsequently, subjects were asked to remember freely as many U.S. states as possible. Recall performance for the noncued (target) states was compared between the two experimental conditions. Subjects in the initial state-study group generated significantly less additional instances than subjects in the control condition who engaged in an unrelated reading task, demonstrating detrimental effects of part-list cues on semantic recall. Part-list cuing impairment also arises in intentional and incidental memory tasks (Peynircioğlu & Moro, 1995) and was even extended to nonmemory tasks such as detecting differences between highly similar pictures (Peynircioğlu, 1987).

Part-list cuing impairment has been robustly found in a wide variety of memory tasks. It has been observed when memory for the target items was assessed by means of a recognition task (Oswald et al., 2006; Todres & Watkins, 1981), in word fragment completion (Peynircioğlu, 1989) as well as initial-letter cued recall tasks (Aslan & Bäuml, 2007). Additionally, it has been demonstrated with intralist and extralist cues (Roediger et al., 1977; Watkins, 1975; Mueller & Watkins, 1977). In these studies, participants were provided with lists of items that were instances of common semantic categories. At test, they receceived the names of each category and, additionally, zero, two, or four category instances as cues. The instances were either taken from the studied list (intralist cues) or were not presented during studying (extralist cues). The probalility of recalling target items decreased as the number of presented intralist cues increased. Additionally, as a novel finding, the extralist cues impaired target recall to almost the same extent as intralist cues.

Part-list cuing impairment also occurs in veridical and false memory settings (Bäuml & Kuhbandner, 2003; Kimball & Bjork, 2002; Kimball, Bjork, Bjork, & Smith, 2008; Reysen & Nairne, 2002). In the so-called Deese-Roediger-McDermott paradigm (Deese, 1959; Roediger & McDermott, 1995) of false memory, participants study word lists comprising items that are semantically strongly associated with a non-presented critical item. In a subsequent test, such lists can produce high levels of false recall or recognition of the unstudied critical item. In several studies, providing part-list cues at test consistently reduced recall of the remaining studied words and intrusions of the critical word. In fact, Kimball and Bjork (2002) reported that the magnitude of the impairment for studied and critical items increased as the number of part-list cues increased (see also Kimball et al., 2008).

Finally, part-list cuing impairment is observable over a wide range of different age groups and has been demonstrated for older adults (Andrès, 2009; Andrès & Howard, 2011; Marsh et al., 2004) as well as for young children (Zellner & Bäuml, 2005). Zellner and Bäuml, for example, reported that already first graders showed the same amount of part-list cuing impairment than second and fourth graders as well as young adults. Furthermore, evidence for detrimental effects of part-list cues also occurred in different clinical populations. For instance, comparable part-list cuing impairment was found in amnesic patients (Bäuml et al., 2002), patients with schizophrenia (Christensen, Girard, Benjamin, & Vidailhet, 2006; Kissler & Bäuml, 2005) and patients who suffer from Parkinsons Disease (Crescentini, Marin, Del Missier, Biasutti, & Shallice, 2011). These findings indicate that part-list cuing impairment is a general and very robust finding across the whole lifespan.

In addition to the multiplicity of replications, it seems equally important to consider boundary conditions of part-list cuing impairment in order to acquire a deeper understanding of the phenomenon part-list cuing. In free recall situations, the typical detrimental effect of part-list cuing may not occur when part-list cues are provided that are consistent with the original order of list presentation. Basden and Basden (1995), for instance, examined the effects of part-list cuing in an experiment, in which participants encoded items that were displayed in different columns on a screen as separate subsets, and, at test, were provided with an entire column of items as retrieval cues (consistent part-list cuing), with half of the items from each column as retrieval cues (inconsistent part-list cuing), or without any retrieval cues (no part-list cuing).

Whereas inconsistent part-list cues impaired recall of the remaining items, the consistent cues reduced, or even eliminated, the detrimental effect (for related results, see Sloman, Bower, & Rohrer, 1991).

Further limitations of part-list cuing impairment were especially found when consistent part-list cues were provided in different types of testing conditions, such as serial recall or serial reconstruction tasks. Basden and colleagues (Basden, Basden, & Stephens, 2002), for instance, reported even beneficial effects of consistent part-list cues when participants were asked to recall the items in the order they were presented during study. Using serial reconstruction rather than recall at test, several studies that employed verbal (Kelley & Bovee, 2007; Serra & Nairne, 2000) as well as visuospatial material (Cole, Reysen, & Kelley, 2013; Kelley, Parasiuk, Salgado-Benz, & Crocco, 2016) also showed that consistent part-list cues can improve memory performance. However, the testing situation differs considerably from the original part-list cuing paradigm so that quite different mechanisms may mediate the effects of part-list cues that are beyond the scope of the present thesis.

The effects of part-list cuing in different experimental settings have theoretical implications for the underlying mechanisms of part-list cuing impairment that will be outlined in the following section. Additionally, some of the studies mentioned above will be discussed as evidence supporting or challenging the respective account of part-list cuing impairment.

1.2 Mechanisms underlying Part-List Cuing Impairment

Over the years, a large number of theoretical explanations have been devised to account for part-list cuing impairment, but the most discussed and prominent accounts are *retrieval blocking, retrieval inhibition* and the *strategy disruption* hypothesis. The blocking and inhibition accounts explain the detrimental effects of part-list cues by assuming that part-list cuing induces covert retrieval processes, which, similar to how overt retrieval does in output interference and retrieval induced forgetting (Anderson, Bjork, & Bjork, 1994; Tulving & Arbuckle, 1963), impair target recall. The strategy disruption account, however, assumes that a subject's preferred retrieval plan may be disrupted by the presentation of part-list cues during testing (Basden, Basden, & Galloway, 1977). Finally, a more recent account combines the different views and points to the critical role of encoding for the underlying mechanisms of part-list cuing impairment (Aslan & Bäuml, 2007; Bäuml & Aslan, 2006).

Single-Mechanism Accounts

Blocking Account. The blocking account is based on the idea of response competition between items that share a common cue (e.g. a word list, a category). The reexposure of items as part-list cues strengthens these items' representation and enhances their accessibility relative to that of the remaining (target) items. During recall, the resulting competition bias favors the repeated covert retrieval of the stronger cue items and blocks the access to the weaker target items (Roediger, 1973; Rundus, 1973). The blocking account was based on the observation that part-list cuing impairment generaly increases as the number of cues does, which is consistent with the assumption of an increased competition bias (see also Kimball & Bjork, 2002).

Inhibition Account. More recently, the blocking account of part-list cuing impairment has been questioned by a study of Bäuml and Aslan (2004) that directly compared the detrimental effects of strengthening by relearning and cuing. In their experiment, participants learned a categorized list consisting of target and nontarget items. After a short distractor task, the nontarget items were reexposed, either for relearning or as retrieval cues for an upcoming final memory test. At test, subjects were asked to recall the target items in the presence of category-plus-first-letter cues to control for output order effects. Whereas the reexposure of the noncue items for use as part-list cues at test impaired target recall, the reexposure for relearning did not. This finding indicates that part-list cuing differs from relearning and that strengthening and blocking cannot solely account for part-list cuing impairment.

Thus, the difference in results between cuing and relearning suggests that part-list cuing impairment reflects an instructional effect. Bäuml and Aslan (2004) reasoned that the explicit instruction to use the presented items as retrieval cues causes covert retrieval of the cues at test, which then triggers inhibitory processes on the interfering (target) items. The inhibitory mechanism is assumed to be very similar to how overt retrieval has been shown to trigger inhibition of the non-retrieved material in retrieval-induced forgetting (Anderson et al., 1994; for a review of retrieval-induced forgetting, see Anderson, 2003). In the so-called retrieval practice paradigm, participants study items from different semantic categories and subsequently engage in retrieval practice of half of the items of half of the categories. On a final category-cued test, participants are asked to recall all of the originally studied items. Relative to the control items from unpracticed categories, recall of the practiced items is improved and recall of the unpracticed items is impaired.

Further results of the above mentioned study (Bäuml & Aslan, 2004) support this view by demonstrating equivalent forgetting by part-list cuing and retrieval practice. Therefore an additonal retrieval practice condition was included in the experiment, in which the nontarget items were not reexposed but, rather, had to be retrieved by means of their word stems. Parallel to part-list cuing, retrieval practice impaired recall of the remaining target items. In line with this finding, several studies have also shown parallel forgetting in part-list cuing impairment and retrieval-induced forgetting, for instance including effects on false memories (Bäuml & Kuhbandner, 2003) or effects on childrens' memory performance (Zellner & Bäuml, 2005).

Additional evidence for the inhibition acccount comes from a number of studies reporting part-list cuing impairment in item recognition (Oswald et al., 2006; Todres & Watkins, 1983) and in the presence of item-specific or independent probes for the target items (Aslan, Bäuml, & Grundgeiger, 2007). Aslan et al. (2007), for instance, introduced a repeated-testing procedure, in which, at the first test, part-list cues were presented and half of the target items were tested in the presence of their unique initial letters. At the second test, no part-list cues were presented and the remaining half of the targets was tested in the presence of independent probes, that is, novel unstudied retrieval cues. Part-list cuing impairment was found in both tests, demonstrating forgetting in the presence of item-specific and independent probes. This finding supports the view that part-list cuing causes inhibitory processes that directly suppress the targets' memory representation.

Strategy Disruption Account. A different account of part-list cuing impairment is strategy disruption (Basden & Basden, 1995; Basden et al., 1977). According to this account, subjects try to develop individual retrieval plans during encoding based on their subjective organisation of the list items. When in the part-list cuing condition a randomly selected subset of items is presented at test, these part-list cues disrupt the preferred recall order and the participants switch to a less effective order, thus reducing recall performance. The strategy disruption account is consistent with numerous studies employing serial recall tasks (Basden & Basden, 1995; Basden et al., 2002). As already mentioned above (see chapter 1.1), these studies reported that the detrimental effects of part-list cues were reduced or even eliminated if the cues were consistent with the participants' retrieval strategy induced during encoding.

Additionally, results from a number of studies, that reported a release of part-list cuing impairment in repeated-testing conditions, support the strategy disruption account (Basden & Basden, 1995; Basden et al., 1977). Part-list cuing impairment as observed on a first recall test when part-list cues are present were eliminated on a later second test when the cues were removed on that test. This finding was taken as evidence that the participants' original retrieval strategy was disrutpted by the part-list cues in the first test, but quickly reinstated after the removal of the cues in the second test. In fact, after the removal of the cues, the participants should be able to return quickly to their initial retrieval plans and the negative effects of part-list cuing should dissappear.

Challenges for the single accounts. Each of the three accounts can deal with a number of findings in research on part-list cuing, but none of them can sufficiently explain the whole range of results. For instance, the finding of part-list cuing impairment in item recognition (Oswald et al., 2006; Todres & Watkins, 1981) and forced-order recall tests (Aslan et al., 2007) is consistent with the inhibition account which proposes that part-list cuing affects the targets' representations per se. However, the blocking account cannot explain recall impairment, when strengthening-induced output order biases are circumvented by a recognition task or the presentation of item-specific or independent probes (see Bäuml, 2008). The strategy disruption account is also inconsistent because an experimenter-imposed random recall order at test should disrupt the learners' retrieval plan with and without part-list cuing (e.g., Basden & Basden, 1995). Thus, part-list cuing impairment should only arise in tests in which subjects have the possibility to rely on individual retrieval plans that may be then disrupted by the presentation of part-list cues, and thus predicts no forgetting in recognition and forced-order recall tests.

The finding that part-list cuing impairment can be eliminated in repeated testing situations, in which part-list cues are present on a first recall test but are removed on a second recall test (Basden & Basden, 1995; Basden et al., 1977), is consistent with the strategy disruption account which assumes that the disrupted retrieval strategy is quickly reinstated after the removal of the cues. However, the reversibility of part-list cuing impairment challenges the blocking and inhibition accounts that attribute forgetting to persisting blocking or suppression of the target items (Anderson et al., 1994; Slamecka & McElree, 1983). More recent work therefore asked whether a combination of the mechansims may do better and explain a wider range of part-list cuing findings.

The Critical Role of Encoding for Part-List Cuing Impairment

Indeed, Bäuml and Aslan (2006) combined the different theoeretical views to a two-mechanisms account of part-list cuing impairment, arguing that both inhibitory processes and strategy disruption contribute to the effect, though in different encoding situations. They emphasized the distinction between so-called low associative and high associative encoding conditions. In low-assciative encoding conditions, subjects create a relatively low level of interitem associations during study, for instance, by encoding to-be-learned items within a single study trial, in which no instruction for associative encoding is provided. In contrast, in high associative encoding conditions, subjects create a high level of interitem associations, for instance by receiving repeated study-test cycles (Tulving, 1962) or the instruction to encode the study items in the presented order (e.g. Basden et al., 2002) or in terms of a common story (Bower & Clark, 1969; Sahakyan & Delaney, 2003). The main idea of the account then is that the degree of interitem associations determines which cognitive mechanism is involved. A low degree of interitem associations may result in a high amount of interitem interference so that part-list cuing can trigger blocking and inhibition at test. In contrast, a high degree of interitem associations may reduce or even eliminate interitem interference (Smith, Adams, & Schorr, 1978) and may result in an elaborated retrieval plan, in which the items are associatively chained together, with one items serving as the retrieval cue for the next list item (see Murdock, 1983). At test, the preferred recall order of the retrieval plan can easily be disrupted by the presentation of a random set of studied items serving as part-list cues.

The two-factors account can explain the findings above, that question each single-mechanism account, and is also consistent with many further findings in part-list cuing research (for a summary, see Bäuml & Aslan, 2006). Additionally, Bäuml and Aslan tested the account more directly, investigating detrimental effects of part-list cuing in different encoding situations. In the first step, Bäuml and Aslan (2006) examined whether the effects of repeated testing - in which part-list cues are present on a first recall test, but absent on the second test - depend on encoding. In the second step, Aslan and Bäuml (2007) examined whether the presence of unique initial-letter cues, serving as item-specific probes for the target items, influences the effects of part-list cuing, and whether this influence varies with encoding. In both studies, they therefore compared a low associative encoding condition, in which study items were presented once without any specific encoding instruction, with high associative encoding conditions, in which two successive study-test cycles or the instruction to encode the items in terms of a common story were provided. Encoding influenced the results in both studies: Whereas, with repeated testing, part-list cuing impairment disappeared after the removal of the cues with high associative encoding, it persisted with low associative encoding (but see Muntean & Kimball, 2012). When item-specific probes were provided at test, part-list cuing impairment was present with low associative encoding, but it was absent with high associative encoding. These findings fit with the two-mechanisms account and support the incorporated view that primarily inhibition operates with low associative encoding and primarily strategy disruption operates with high associative encoding. Thus the two-mechanisms account seems to provide a promising account of part-list cuing impairment.

1.3 Part-List Cuing Facilitation

Research from the past decades has focused almost exclusively on part-list cuing impairment (for exceptions, see Basden et al., 2002; Serra & Nairne, 2000) and the numerous demonstrations of detrimental effects of part-list cuing suggest that part-list cuing typcially impairs recall performance. However, our daily life experiences suggest that cues such as an conversation, that brings up parts of already forgotten memories, help us to retrieve an entire memory episode. For instance, when you tell your friends about the animals that you have seen on your journey in Africa and one of your friends asks for animals that she has seen on a similar trip two years ago, the interjections from your friend will eventually remind you of episodes of your journey that you have already forgotten. Analogous to our daily experiences, three studies from more recent years, that used low associative encoding situations, have demonstrated that part-list cuing does not always impair recall, but under some circumstances, may also improve recall of the remaining items. In the following, these studies will be described in more detail from which a theoretical account of the facilitation effect will be derived.

Evidence for Beneficial Effects of Part-List Cuing

First evidence has come from a largely overlooked study of Goernert and Larson (1994) that investigated the effects of part-list cuing in listwise directed forgetting. In this paradigm, subjects study a list of items and then, after study, receive the instruction either to continue remembering or to forget the list. After subsequent study of another list, first-list items are tested, regardless of whether subjects were originally instructed to remember or to forget the items. Typically, recall performacne is lower in the forget than in the remember condition, reflecting directed forgetting of first-list items (Bjork, 1970). Goernert and Larson (1994) employed this paradigm but additionally used two different testing conditions. In the one condition, participants were asked to recall all first-list items in the absence of any retrieval cues. In the other condition, participants were provided four or eight of the first-list items as part-list cues for recall of the list's remaining (target) items. The results showed typical detrimental effects of part-list cuing in the remember condition, but showed beneficial effects in the forget condition. Both effects were larger with eight than with four part-list cues.

Bäuml and Samenieh (2012) replicated Goernert and Larson's (1994) basic finding and additionally showed that it generalizes to context-dependent forgetting. Subjects studied two lists of items and, between study of the two lists, completed a neutral counting task or changed their internal context by means of an imagination task (see Sahakyan & Kelley, 2002). After study of the second list, participants were asked to recall predefined target items of the first list with or without receiving the list's remaining items as part-list cues. Part-list cuing impaired target recall after the counting task, but improved target recall after the imagination task. The analogous pattern of results was observed for memories that were subject to time-dependent forgetting (Bäuml & Schlichting, 2014). In this study, recall performance for an previously studied word list was tested either after a short distractor task of a few minutes or after a prolonged retention interval of 48 hours. Again, at test, participants were asked to recall predefined target items in the presence or abesence of the list's remaining items serving as part-list cues. As expected, detrimental effects of part-list cuing were demonstrated when testing occurred after a few minutes, while beneficial effects of part-list cuing arose when the retention interval was increased.

A Context Account of Part-List Cuing Facilitation

The finding of beneficial part-list cuing effects in list-method directed forgetting, context-dependent forgetting, and time-dependent forgetting suggests that the degree of overlap between study and test contexts can influence the effects of part-list cuing. Indeed, prolonged retention intervals and context-change tasks induce contextual drift after study and, thus, at test, create a mismatch between study and test contexts (e.g., Bower, 1972; Estes, 1955; Mensink & Raaijmakers, 1988), which impairs study context access. Similarly, a forget cue after study may also change context (Sahakyan & Kelley, 2002), or alternatively inhibit access to the whole study episode (Geiselman, Bjork, & Fishman, 1983), thus again reducing study context access. On the basis of the view that contextual factors play a role in all these types of forgetting, the above results suggest that part-list cuing may induce detrimental effects on target recall when the test context is similar to the study context - like after a short retention interval in which no context-change task is employed and no forget instruction is provided -, but can induce beneficial effects when study and test contexts differ - like after a forget instruction, a context-change task, or a prolonged retention interval.

The beneficial effects of part-list cuing on target recall have been attributed to context reactivation processes (Bäuml & Samenieh, 2012). According to this view, part-list cuing in low associative encoding situations may trigger not only inhibition and blocking of interfering target memories, but may also reactivate the original study context. The relative contribution of the two types of mechanisms is assumed to depend critically on study context access when part-list cues are provided at test. When access to study context is maintained and the studied items show a high activation level, interference between items may be high, so that part-list cuing induces inhibition and blocking of the target items. Thus, part-list cuing may impair target recall. In contrast, when access to study context is impaired at test, not much room may be left for interference and inhibitory processes, but part-list cuing may induce reactivation of the original study context. The reactivated context may then serve as an additional retrieval cue for the remaining memories and improve target recall. This proposal is consistent with research in other areas, like the spacing effect (e.g., Greene, 1989; Kahana, 1996), i.e. the beneficial mnemonic effect when learning episodes are spaced over a longer time period than repeated in immediate succession, or the contiguity effect (e.g., Howard & Kahana, 1999, 2002), i.e. the tendency to successively recall items presented in nearby serial positions in the study list, in which selective items' repetition, be it via restudy or retrieval, has also been suggested to induce context reactivation. Thus, context reactivation processes may also contribute to the effects of part-list cuing and influence recall performance, at least in low associative encoding situations. However, while prior work suggests that context reactivation can induce beneficial effects of part-list cuing with low associative encoding, this work leaves it open whether there is a similar role of context reactivation with high associative encoding. To date, empirical support for beneficial effects of part-list cuing is restricted to recall processes after low associative encoding and there is no evidence that part-list cuing can also improve recall after high associative encoding situations. The present study addresses this issue.

Chapter 2

Goals of the Present Study

A large number of laboratory studies of the past decades have demonstrated that part-list cuing - the presentation of a random selection of studied items as retrieval cues at test - typically reduces recall of the remaining target items compared to a condition in which such cues are absent (for reviews see Nickerson, 1984; Roediger & Neely, 1982). There is now evidence that the detrimental effect of part-list cues is mediated by two different mechansims, depending on the type of encoding situation (Aslan & Bäuml, 2007; Bäuml & Aslan, 2006). In low associative encoding situations, the presentation of part-list cues at test can trigger inhibitory processes, while in high associative encoding situations, the presentation of part-list cues can disrupt a individual retrieval strategy built during encoding. As a further critical finding in part-list cuing research, more recent studies demonstrated that part-list cues can not only hinder but also improve target recall, when access to study context at test is impaired (Goernert & Larson, 1994; Bäuml & Samenieh, 2012; Bäuml & Schlichting, 2014). The beneficial effect of part-list cuing was demonstrated in listwise-directed forgetting, context-dependent forgetting, and time-dependent forgetting, but only in low associative encoding situations.

To date, no study has yet examined whether the observation of beneficial effects of part-list cuing generalizes from low associative to high associative encoding situations. Thus, it was the major goal of the present study to complete the picture of part-list cuing effects and examine such effects in a wide range of encoding and testing conditions. In particular, it was intended to examine whether part-list cuing can improve target recall also in high associative encoding situations when study and test contexts differ at test. As described above, high associative encoding situations, like repeated study-test cycles or study phases with explicit instructions to encode the presented items strategically, are supposed to enhance the formation of chainlike interitem associations and elaborated retrieval plans, leading to preferred recall orders. Likely, a forget cue, or a prolonged retention interval can cause forgetting of a list also after high associative encoding and thus reduce accessibility of the original retrieval plan; and likely, part-list cuing will also be able to reactivate the study context in this encoding situation. Still, it is unclear whether part-list cuing will also improve target recall with high associative encoding when study and test contexts differ. Indeed, expectations depend on when during the recall period the original retrieval plan is supposed to get reactivated.

Goernert and Larson (1994) found that the beneficial effect of part-list cuing increased with the number of provided part-list cues (see above). On the basis of the assumption that part-list cuing reactivates the study context when study and test contexts differ (e.g., Bäuml & Samenieh, 2012), this finding indicates that the amount of context reactivation increases with the number of provided part-list cues, suggesting that part-list cuing reactivates the study context gradually (for a similar result in selective retrieval, see Bäuml & Samenieh, 2010). If this result generalizes to high associative encoding situations and reconstruction of the original retrieval plan requires a high amount of context reactivation, then reconstruction of the retrieval plan may occur relatively late in the recall period, when quite a number of target items have already been reactivated and recalled. Context reactivation processes may then operate over most part of the recall period and facilitate recall of the target items, whereas the originally encoded retrieval plan may influence recall only late in the recall period and thus affect recall of only few items at best. In such case, part-list cuing may improve recall and lead to results similar to those found for low associative encoding, i. e., beneficial effects of part-list cuing.

Alternatively, even if part-list cuing reactivated the study context gradually, the original retrieval plan may get reconstructed already early in the recall period. Because in high associative encoding conditions, chaining strategies create strong associations between single items, strategy reconstruction may require the reactivation of only few items, with many of the remaining items being filled in quickly to reinstate the original retrieval plan (see Murdock, 1983; Raaijmakers & Shiffrin, 1981). If so, the potentially beneficial effect of context reactivation as caused by the part-list cues may quickly be masked by the detrimental effect of strategy disruption caused by the same part-list cues. In fact, although the reactivated retrieval plan would allow subjects to recall many of the target items, the presence of the part-list cues may disrupt this plan, keeping recall performance at a level that is similar to the recall level observed in the absence of any part-list cues. In such case, part-list cuing would not improve recall in high associative encoding and part-list cuing facilitation would be restricted to low associative encoding situations.

In a first step, the present thesis intended to specify the role of encoding, that was already proven to be critical for detrimental effects of part-list cuing, also for possible beneficial effects. It was intended to provide first specific evidence how part-list cuing may affect target recall when a serial retrieval plan was developed during encoding and when access to study context was impaired at test. As described above, it is still unclear whether part-list cuing may improve target recall also in high associative encoding situations. Additionally, the results in high associative encoding situations might allow first conclusions to be drawn about whether and how fast a serial retrieval plan can be reactivated by the presentation of part-list cues. Hence, in Experiment 1, part-list cuing effects were examined in low associative as well as high associative encoding when access to study context at test was manipulated. This was done in order to replicate previous findings in low associative encoding and to extend the findings to high associative encoding. Holding material and the manipulation of study context access constant, the effects of part-list cuing in the two types of encoding situations were directly compared to demonstrate the possible impact of encoding on part-list cuing. Experiment 2 was designed to examine the generality of the pattern of results of the first experiment, using a different method to introduce high associative encoding and a different method to manipulate study context access.

In a second step, the thesis focused on high associative encoding situations and intended to examine in more detail whether and to what extent part-list cuing can induce context reactivation processes even in high associative encoding situations and, in doing so, can also affect serial retrieval plans. Therefore, in Experiments 3 and 4, only high associative encoding conditions were employed and study context access was manipulated analogously to Experiments 1 and 2. In order to isolate potential effects of context reactivation from potential effects of strategy reconstruction, a repeated testing procedure was introduced in which part-list cues were presented in a first critical test, but not in a second final test (see Basden & Basden, 1995; Basden et al., 1977). This testing procedure was used to reveal possible disruptive effects of part-list cues on a serial retrieval plan, that would be present during the presentation of cues but absent on a second uncued test. Thus, when access to study context at test was impaired, recall levels in a second uncued test might reflect more directly possible beneficial effects of part-list cuing-induced context reactivation processes only.

Finally, the present thesis intended to specify the conditions in which part-list cues may impair or improve target recall and to derive a comprising theoretical account of the underlying cognitive mechanisms. Thus, the results are of theoretical relevance for part-list cuing research, but may also be useful for research in other areas, like testing in educational settings or collaborative inhibition, in which part-list cuing has been suggested to play a critical role (see General Discussion).

Chapter 3

Experiments

The goal of the first experiments was to examine whether the effects of part-list cuing vary with encoding when study and test contexts differ. In each of the experiments, subjects studied a list of items and recalled the list items on a later memory test, in either the presence or the absence of some of the items serving as retrieval cues. Following previous studies, access to study context at test was manipulated by employing a remember or a forget instruction after study (Experiments 1; Bäuml & Samenieh, 2012; Goernert & Larson, 1994) and by varying the length of the retention interval between study and test (Experiments 2; Bäuml & Schlichting, 2014). Additionally, encoding was varied by inducing either low or high associative encoding situations. To induce high associative encoding, a story building task (Experiments 1b) or repeated study-test cycles (Experiments 2b) were employed; to induce low associative encoding, single study learning without any explicit instruction to encode the items strategically was employed (Experiments 1a and 2a; Aslan & Bäuml, 2007; Bäuml & Aslan, 2006). The direct comparison of the results will provide detailed information on the roles of encoding and study context access for the effects of part-list cuing.

3.1 Experiment 1a: Effects of Part-List Cuing in List-Method Directed Forgetting (Low Associative Encoding)

Goernert and Larson (1994) were the first to demonstrate that part-list cuing does not always impair but may also improve target recall in a free recall setting. Employing a listwise directed forgetting task, they found detrimental effects of part-list cuing after a remember instruction, but beneficial effects after a forget instruction. Bäuml and Samenieh (2012) replicated the finding and concluded that, when context access is impaired by a forget instruction, providing part-list cues may trigger processes that reactivate the original study context, which may then serve as a retrieval cue for the target items and thus improve recall performance. The goal of Experiment 1a was to replicate the results of Goernert and Larson (1994) and Bäuml and Samenieh (2012) by showing that with single study learning, i.e., low associative encoding, part-list cuing can both improve and impair recall of the other items, depending on whether a forget or a remember instruction is provided after study.

Therefore, subjects studied a word list, consisting of predefined target and nontarget (cue) items, and subsequently received the instruction to either forget the items or remember the items for an upcoming memory test. After learning of a second list, memory for the first-list items was tested, regardless of whether the participants were originally cued to remember or to forget the items (Bjork, 1970). At test, participants were either asked to remember both target and nontarget items in a free recall task or nontarget items were provided as retrieval cues for recall of the remaining items. Following Goernert and Larson (1994) and Bäuml and Samenieh (2012), the expectation was that, due to blocking and inhibition processes, part-list cuing impairs recall when study and test contexts overlap - i. e., after the remember instruction and the short retention interval - but that, due to context reactivation processes, part-list cuing improves recall when study and test contexts differ - i.e., after the forget instruction and the prolonged retention interval (Bäuml & Samenieh, 2012; Bäuml & Schlichting, 2014; Goernert & Larson, 1994).

Method

Participants. 48 students of Regensburg University participated in the experiment (M= 23.3 years, range = 18-30 years, 77.1% female). They were equally distributed across the two experimental conditions, resulting in n=24 participants in each condition. All subjects spoke German as native language. They were tested individually and received monetary reward or course credit for participation.

Materials. Item material contained four lists (A-D), each consisting of 20 unrelated concrete German nouns. List A and List B were taken from Aslan and Bäuml (2007) and were designated to be used as List 1. List C and List D consisted of items employed in Bäuml and Samenieh (2010) and were designated to be used as List 2. For both List A and List B, 10 randomly selected items were defined as target items and the remaining 10 items as nontarget (cue) items. The distinction was unknown to the participants. Within each list, all items had unique initial letters.

Design. The experiment had a 2 × 2 mixed factorial design. INSTRUCTION (remember, forget) was varied within participants, whereas CUING (no-part-list cuing, part-list cuing) was manipulated between participants. In the remember condition, List 1 was followed by the instruction to remember the list for a later recall test. In the forget condition, List 1 was followed by the instruction to forget the list. Participants were told that a wrong list had been presented and that they could forget the preceding items, because they would not be tested later. At test, half of the participants were asked to recall the previously studied items in a free-recall task (no-part-list cuing condition). The other half was provided with the nontarget items as retrieval cues and were asked to recall the remaining target items (part-list cuing condition; see Fig. 2).

Procedure. In the study phase, the items of each list were exposed successively and in random order on a computer screen for 5 s each. Participants were asked to encode the items of each list for an upcoming memory test in a single study trial without any additional encoding instruction. After study of List 1, an instruction to continue remembering the preceding items and to additionally encode the items of List 2 was provided in the remember condition. In the forget condition, a software crash was simulated to make the coverstory more plausible that a wrong list had been presented (e.g., Abel & Bäuml, 2017; Barnier et al., 2007). Subjects were asked to forget the first list and to focus on the list coming up next instead. Subsequently, items of List 2 were presented. The study phase was followed by a 1-min backward

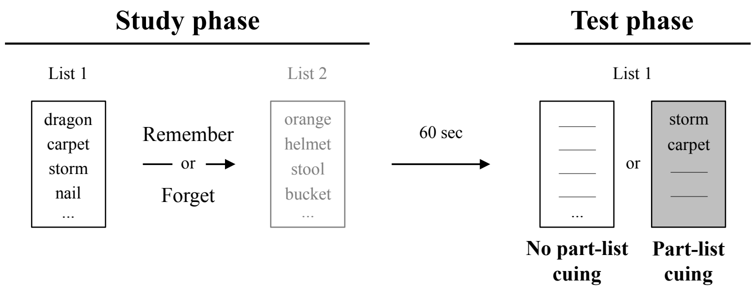

Figure 2. Illustration of the conditions and procedure employed in Experiment 1a. Subjects studied two lists of items and, after study of the first list, were instructed either to forget or to continue remembering that list. In the test phase, participants recalled as many first-list items as possible in a free recall task or were provided with half of the items serving as part-list cues for recall of the remaining (target) items.

counting task as a recency control.

At test, participants were asked to remember List-1 items first, regardless of the original instruction. In the no-part-list cuing condition, participants performed a free-recall task and wrote down previously learned items in any order they wished; in the part-list cuing condition, participants were provided with half of the studied items in two randomly ordered columns of five items on top of the test sheet and were instructed to read these items aloud and use them as retrieval cues for recall of the remaining items. Participants wrote down recalled target items below the columns with the nontarget items, which remained present during target recall. In both cuing conditions, List-2 items were tested subsequently in a free-recall test. Participants were given 2 min for each list to write their answers on separate sheets of paper.

After a break of 5 minutes, participants underwent a second experimental block, in which the instruction provided after study of List 1 was changed within participants. Participants, who had been told to remember List-1 items in the first block, received now the instruction to forget List-1 items. In contrast, participants, who had been told to forget List-1 items in the first block, were now instructed to continue remembering List-1 items (see also Bäuml & Samenieh, 2012, or Zellner & Bäuml, 2006). Order of instruction conditions and assignment of study lists to conditions were counterbalanced.

Results

Following prior part-list cuing work, analysis of first-list items was restricted to target items.[2] Fig. 3 shows mean recall rates for the target items as a function of instruction and cuing conditions.

A 2 × 2 analysis of variance (ANOVA) with the within-participants factor of INSTRUCTION (remember, forget) and the between-participants factor of CUING (no part-list cuing, part-list cuing) revealed a significant main effect of INSTRUCTION, $F(1, 46) = 4.79$, $MSE = 105.34$, $p = .034$, $\eta^2 = 0.09$, with higher recall in the remember than the forget condition (59.38% vs. 54.79%), and a significant interaction between INSTRUCTION and CUING, $F(1, 46) = 35.60$, $MSE = 105.34$, $p < .001$, $\eta^2 = 0.44$, indicating that cuing affected recall differently in the two instruction conditions. There was no main effect of CUING, $F(1, 46) < 1$. Follow-up pairwise comparisons showed that whereas in the remember condition part-list cuing attenuated target recall (65.42% vs. 53.33%), $t(46) = 2.85$, $p = .007$, $d = 0.82$, part-list cuing enhanced target recall in the forget condition (48.33% vs. 61.25%), $t(46) = 2.84$, $p = .007$, $d = 0.82$. Target recall in the no-part-list cuing condition was significantly higher in the remember than the forget condition (65.42% vs. 48.33%), $t(23) = 5.86$, $p < .001$, $d = 1.20$, demonstrating typical directed forgetting of first-list items.

[2] In the no-part-list cuing conditions, subjects recalled both the target and the nontarget items. Had we included the nontarget items into the analysis, results would not have changed, however. Indeed, in no single condition of this experiment was there any difference between target and nontarget recall, all $ts(23) < 1$. An analogous picture arose for Experiments 1b-4 to be reported below.

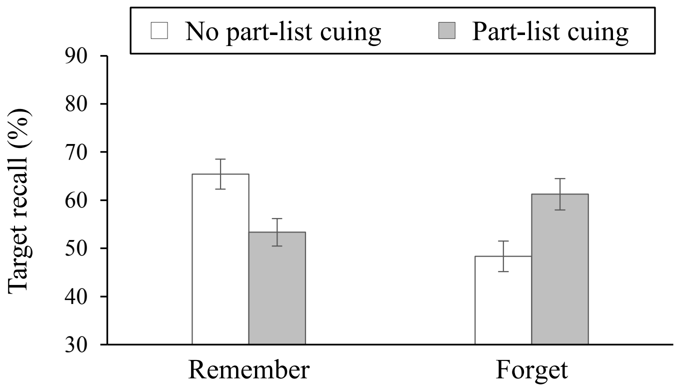

Figure 3. Results of Experiment 1a. Percentage of recalled target items is shown as a function of instruction (remember, forget) and part-list cuing condition (no-part-list cuing, part-list cuing). Error bars represent standard errors.

Further analysis. Whereas part-list cuing was varied between participants in this experiment, interlist instructions were manipulated within participants. Order of instruction conditions, however, did not affect target recall. There was no main effect of order and no interaction effect of order with any of the other variables, all $ps > .399$.

Recall of second-list items was also analyzed. A 2×2 ANOVA with the factors of INSTRUCTION and CUING yielded no main effects nor an interaction effect, all $ps > .744$. These results are consistent with prior work, showing that preceding recall of List-1 items often affects recall results for List-2 items and eliminates possible beneficial effects of the forget cue on List-2 items (e.g. Golding & Gottlieb, 2005; Pastötter, Kliegl, & Bäuml, 2012).

Discussion

In line with the results of previous studies (Bäuml & Samenieh, 2012; Goernert & Larson, 1994), two faces of part-list cuing were found. When a remember instruction was provided after study, the presence of part-list cues reduced recall of the target items. In contrast, when a forget instruction was provided, the presentation of part-list cues improved target recall. Results are consistent with the view that part-list cuing can both trigger inhibition/ blocking and context reactivation and that the relative contribution of these two types of processes determines recall levels. When access to the study context at test is maintained and the level of interference between the single items remains high, the relative contribution of inhibition and blocking may be larger than of context reactivation processes, leading to part-list cuing impairment. When access to the study context is impaired and not much room may be left for interference and inhibitory processes, however, the relative contribution of context reactivation may be larger than of inhibition/ blocking, leading to part-list cuing facilitation. Experiment 1b examined whether these results generalize to a high associative encoding situation.

3.2 Experiment 1b: Effects of Part-List Cuing in List-Method Directed Forgetting (High Associative Encoding)

Experiment 1b followed prior part-list cuing work and employed a story building task to induce high associative encoding (Aslan & Bäuml, 2007; Bäuml & Aslan, 2006). Subjects were asked to formulate a meaningful sentence with each presented word and to interrelate the sentences to a common story (see Bower & Clark, 1969; Sahakyan & Delaney, 2003).

Similar to low associative encoding, part-list cuing was expected to impair recall in the remember condition (Aslan & Bäuml, 2007; Bäuml & Aslan, 2006). Expectations in the forget condition depend on when during the recall period strategies are supposed to get reconstructed when part- list cues are provided: If strategy reconstruction occurrs only late in the recall period, then mainly context reactivation processes should influence recall, part-list cuing may improve target recall, and show a pattern similar to the one for low associative encoding. In contrast, if strategy reconstruction occurrs already early in the recall period, then the presence of part-list cues should disrupt retrieval strategies and thus mask the beneficial effect of context reactivation. If so, recall should be similar to recall in the no-part-list cuing condition and show no beneficial effect of cuing. The effects of part-list cuing would then be different after high associative than low associative encoding, indicating an effect of encoding on part-list cuing when study and test contexts differ.

Method

Participants. Another 48 students of Regensburg University participated in the experiment ($M=$ 20.1 years, range: 18-30 years, 81.3% female). None of them had been tested in Experiment 1a. All participants spoke German as native language and were tested individually with 24 participants in each of the two experimental conditions. Monetary reward or course credit was provided for participation.

Materials. Item material was the same as in Experiment 1a. Again, List A and List B were employed as List 1, each consisting of the same 10 target items and 10 cue items as used in Experiment 1a. List C and List D were used as List 2.

Design. Analogous to Experiment 1a, the experiment had a 2 $\times$ 2 mixed factorial design, with the between-participants factor of CUING (no-part-list cuing, part-list cuing) and the within-participants factor of INSTRUCTION (remember, forget).

Procedure. The procedure was largely identical to Experiment 1a and differed only in the study phase. Like in Experiment 1a, the items of each list were exposed successively and in random order on a computer screen for 5 s each and participants were asked to encode the items for an upcoming memory test. However, to introduce a high associative encoding situation, participants were additionally asked to form a meaningful sentence with each presented word and to interconnect these sentences to a coherent story. They were instructed to say the sentences aloud so that the experimenter was able to control whether the subject had understood the instruction and was compliant (e.g., Sahakyan & Delaney, 2003). The remaining procedure followed the one employed in Experiment 1b; after study of List 1, participants received the instruction either to continue remembering or to forget the list. After learning the second list, List-1 items were tested first, either in the presence or absence of part-list cues. Subsequently, participants recalled List-2 items in a free-recall task and completed a second experimental block after a break of 5 minutes.

Results

Again, analysis of first-list items was restricted to target items. Fig. 4 shows mean recall rates for the target items as a function of instruction and cuing conditions.

A 2 × 2 ANOVA with the within-participants factor of INSTRUCTION (remember, forget) and the between-participants factor of CUING (no part-list cuing, part-list cuing) yielded a significant main effect of INSTRUCTION, $F(1, 46) = 28.76$, $MSE = 172.42$, $p < .001$, $\eta^2 = 0.39$, with higher recall in the remember than the forget condition (72.29% vs. 57.92%), and a significant interaction between INSTRUCTION and CUING, $F(1, 46) = 4.40$, $MSE = 172.42$, $p = .041$, $\eta^2 = 0.09$, indicating that the effects of part-list cuing differed between instruction conditions. No main effect of CUING emerged, $F(1, 46) = 2.46$, $MSE = 518.98$, $p = .124$, $\eta^2 = 0.05$. Follow-up pairwise comparisons showed that target recall in the remember condition was significantly lower when part-list cues were present than when they were absent (78.75% vs. 65.83%), $t(46) = 2.46$, $p = .018$, $d = 0.71$, but that target recall was unaffected by the part-list cues in the forget condition (58.75% vs. 57.08%), $t(46) < 1$. When part-list cues were absent, participants recalled significantly more target items in the remember condition than in the forget condition (78.75% vs. 58.75%), $t(23) = 4.75$, $p < .001$, $d = 0.97$, indicating that the directed forgetting manipulation was successful.

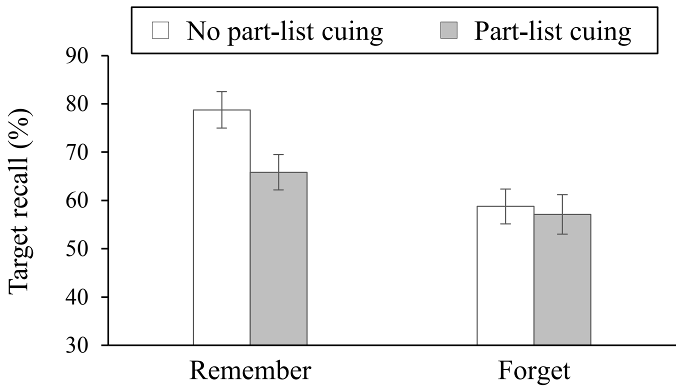

Figure 4. Results of Experiment 1b. Percentage of recalled target items is shown as a function of instruction (remember, forget) and part-list cuing condition (no-part-list cuing, part-list cuing). Error bars represent standard errors.

Further analysis. Analogous to Experiment 1a, part-list cuing was varied between participants in this experiment, whereas interlist instructions were manipulated within participants. Again, order of instruction conditions, did not influence target recall. No main effect of order and no interaction effect of order with any of the other variables were found, all $ps > .122$.

Recall of second-list items was also analyzed. A 2 × 2 ANOVA with the factors of INSTRUCTION and CUING showed a marginal significant main effect of CUING, $F(1, 46) = 3.58$, $MSE = 430.79$, $p = .065$, $\eta^2 = 0.07$, with higher recall in the no-part-list cuing than the part-list cuing condition (73.85% vs. 65.83%). However, there was no main effect of INSTRUCTION, $F(1, 46) < 1$ nor an interaction effect, $F(1, 46) < 1$. Given that List 2 was recalled after List 1 and that this recall sequence may have biased List-2 performance, the results are in line with previous findings and the results of Experiment 1a.

Discussion

After high associative encoding, i.e., a story building task during encoding, part-list cuing impaired target recall in the remember condition but left target recall unaffected in the forget condition. Importantly, because material and other procedural features were held constant for Experiment 1a and b, the results allow the direct comparison of part-list cuing effects in the different encoding situations and thus point to the critical role of the type of encoding, especially when study context access is impaired at test. Thus, these results provide first evidence that the beneficial effect of part-list cuing as observed with low associative encoding may not generalize to high associative encoding. But before drawing more firm conclusions on the issue, it was the goal of Experiment 2 to replicate this pattern of results using a different method to create a mismatch between study and test contexts and a different method to induce high associative encoding.

3.3 Experiment 2a: Effects of Part-List Cuing after Short and Long Retention Intervals (Low Associative Encoding)

Experiment 2a was aimed to replicate the results of Experiment 1a, i.e., employing the same low associative encoding condition. In contrast, the present experiment followed previous work by Bäuml and Schlichting (2014) and induced a mismatch between study and test contexts by varying the length of the retention interval between study and test. This previous study (Bäuml & Schlichting, 2014) reported part-list cuing impairment after a short retention interval, but reported reliable part-list cuing facilitation after a prolonged retention interval. As substantial external and internal contextual changes are assumed to arise when the time interval between study and test is extended (e.g. Estes, 1955; Mensink & Raaijmakers, 1988), these findings provided further evidence that, in low associative encoding situations, the presence of part-list cues at test can enhance recall of the remaining items when context access is impaired.

Subjects studied a word list, consisting of predefined target and nontarget (cue) items in a single study trial, which was followed by a delay of 1 minute or a prolonged retention interval of 30 minutes. At test, participants were asked to recall the target items in the presence of nontarget items serving as retrieval cues, or to perform a free recall task and recall all of the previously studied items. On the basis of the results of Bäuml and Schlichting (2014), we expected part-list cuing to impair target recall after the short retention interval but to improve target recall after the prolonged retention interval.

Methods

Participants. 48 students took part in the experiment (M = 22.4 years, range = 18-28 years, 81.3% female). They were equally assigned to the two between-subjects conditions, resulting in $n = 24$ participants in each condition. Sample size followed Experiment 1. None of the participants had been tested in Experiment 1. Again, all of the participants spoke German as native language, were tested individually, and received monetary reward or course credit for participation.

Materials. Materials were identical to List A and List B in Experiment 1. Each list consisted of the same 10 target and 10 nontarget items as employed in Experiment 1.

Design. The experiment had a 2 × 2 mixed factorial design. retention interval (short, long) was varied within participants, whereas cuing (no-part-list cuing, part-list cuing) was manipulated between participants. In the short retention interval condition, testing occurred 1 minute after study, in the long retention interval condition, it occurred after a delay of 30 minutes. At test, half of the participants in each encoding condition were asked to recall all of the previously studied items in a free-recall task (no-part-list cuing condition); the other half was provided with the nontarget items as retrieval cues and were asked to recall the remaining target items (part-list cuing condition; see Fig. 5).

Procedure. Like in Experiment 1a, items were presented successively and in a random order on a computer screen at a 5-s rate. Again, participants received one study cycle to encode the items. The study phase was followed by a 1-min backward counting task.

In the prolonged retention interval condition, another retention interval of 29 min followed, in which participants were engaged in several distractor tasks, which included counting backward from a three-digit number, resolving decision tasks, and doing three different imagination tasks (last trip abroad; a study trip at school; where will you be and what will you do in five years; see Delaney, Sahakyan, Kelley, & Zimmerman, 2010). The imagination tasks lasted 3 min each and were included to enhance contextual drift between study and test phases (for a similar procedure, see Wallner & Bäuml, 2017).

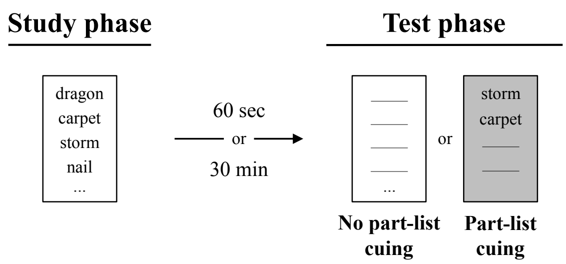

Figure 5. Illustration of the conditions and procedure employed in Experiment 2a. Subjects studied a list of items and, after a retention interval of either 60 s or 30 min, recalled as many items of the list as possible in a free recall task or were provided with half of the items serving as part-list cues for recall of the remaining (target) items.

Testing was identical to testing of List 1 in Experiment 1. In the no-part-list cuing condition, subjects were asked to recall and write down the previously studied items by means of a free-recall task; in the part-list cuing condition, half of the items were presented in two randomly ordered columns of five items on top of the test sheet and subjects were asked to use the items as retrieval cues for recall of the remaining items. Participants wrote down recalled target items below the columns with the nontarget items, which remained present during target recall. Recall time in both cuing conditions was 2 minutes.

After a break of 5 minutes, participants underwent a second experimental block, in which the retention interval after the study phase was changed within participants. Participants, who were tested after 1 minute in the first block, now completed the memory test 30 minutes after study. In contrast, participants, who were tested after 30 minutes in the first block, now completed the memory test 1 minute after study. Order of retention interval conditions and assignment of study lists to conditions were counterbalanced.

Results

Like in Experiment 1, we restricted analysis to target items. Fig. 6 shows mean recall rates for the target items as a function of retention interval and cuing conditions.

A 2 × 2 ANOVA with the within-participants factor of RETENTION INTERVAL (short, long) and the between-participants factor of CUING (no part-list cuing, part-list cuing) revealed a significant main effect of RETENTION INTERVAL, $F(1, 46) = 6.26$, $MSE = 181.30$, $p = .016$, $\eta^2 = 0.12$, with higher recall in the short than the long retention interval condition (70.21% vs. 63.33%), and a significant interaction between RETENTION INTERVAL and CUING, $F(1, 46) = 25.79$, $MSE = 181.30$, $p < .001$, $\eta^2 = 0.36$, indicating that cuing affected recall differently in the two retention interval conditions. No main effect of CUING arose, $F(1, 46) < 1$. Follow-up pairwise comparisons showed that whereas part-list cuing impaired target recall after the short retention interval (76.25% vs. 64.17%), $t(46) = 2.07$, $p = .044$, $d = 0.60$, it improved target recall after the long retention interval (55.42% vs. 71.25%), $t(46) = 3.23$, $p = .002$, $d = 0.93$. Target recall in the no-part-list cuing condition was significantly higher after the short retention interval than after the long retention interval (76.25% vs. 55.42%), $t(23) = 6.67$, $p < .001$, $d = 1.37$, demonstrating typical time-dependent forgetting.

Further analysis. Whereas part-list cuing was varied between participants in this experiment, retention interval was manipulated within participants. However, order of retention interval conditions did not affect the results. There was no main effect of order and no interaction effect of order with any of the other variables, all $ps > .114$.

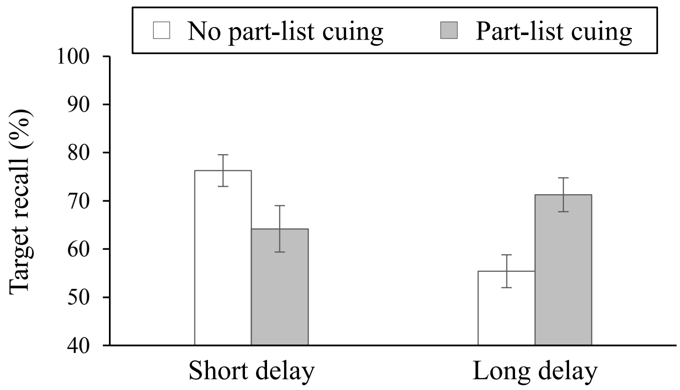

Figure 6. Results of Experiment 2a. Percentage of recalled target items is shown as a function of retention interval (short, long) and part-list cuing condition (no-part-list cuing, part-list cuing). Error bars represent standard errors.

Discussion

Consistent with the results of previous work (Bäuml & Schlichting, 2014), two faces of part-list cuing were demonstrated. After the short retention interval, the presence of the part-list cues reduced recall of the target items, whereas after the prolonged retention interval, it improved target recall. Given the fact, that employing a prolonged retention interval was assumed to induce substantial contextual drift between study and test, the present results agree with the assumption that study context access may critically influence the effects of part-list cuing. In low associative encoding situations, part-list cuing-induced inhibition/ blocking may mainly affect and thus impair recall when study context is maintained, whereas part-list cuing-induced context reactivation processes may mainly affect and thus improve recall when study context is impaired. As expected, the current results also mimic those of the remember condition and the forget condition of Experiment 1a.

3.4 Experiment 2b: Effects of Part-List Cuing after Short or Long Retention Intervals (High Associative Encoding)

The goal of Experiment 2b was to generalize the results of Experiment 1b to a different high associative encoding situation. Following previous studies (Aslan & Bäuml, 2007; Bäuml & Aslan, 2006), high associative encoding was induced by employing study-test cycles during learning. Tulving (1962), for example, demonstrated that the sequence of recalled items grows more consistent over trials, indicating that subjects might build up serial retrieval plans during repeated study-test cycles. Thus, in the present experiment, the word list was presented twice with a free recall test on the list after each list presentation. Additionally, analogous to Experiment 2a, study context access at test was varied by employing either a short or prolonged retention interval. On the basis of the results of Experiment 1b, we expected part-list cuing to impair target recall after the short retention interval but to leave recall of target items unaffected after the prolonged retention interval.

Methods

Participants. Further 48 students of Regensburg University took part in the experiment (M = 22.6 years, range = 18-28 years, 91.7% female), either for course credit or a small monetary reward. None of the participants had been in Experiment 1 or 2a. All of them spoke German as native language. They were tested individually with 24 participants in each of the two experimental conditions.

Materials. The same item material as in Experiment 2a was employed.

Design. Analogous to Experiment 2a, the experiment had a 2 × 2 mixed factorial design with the between-participants factor of CUING (no-part-list cuing, part-list cuing) and the within-participants factor of

RETENTION INTERVAL (short, long).

Procedure. The procedure was identical to Experiment 2a with the only exception that a high associative encoding situation was introduced during the study phase. Like in Experiment 2a, items were exposed successively and in random order on a computer screen for 5 s. However, participants completed two successive study-test cycles. After the first study cycle, they counted backward from a three-digit number for 30 s and were then told to write down as many of the previously studied items as possible in any order they wished. Immediately thereafter, a second study-test cycle was ran in exactly the same way. Presentation order of items during study was the same as in the first study cycle to boost the formation of associative interitem connections during encoding. In all other respects, the procedural details were the same as in Experiment 2a; study material was tested after either after a short distractor task of 1 min or a prolonged retention interval of 30 min, filled with different distractor and imagination tasks. At test, target items were tested either in the presence or absence of the nontarget items serving as part-list cues. A second experimental block followed after a break of 5 minutes.

Results

Again, analysis was restricted to target items. Fig. 7 shows mean recall rates for the target items as a function of retention interval and cuing conditions.

In the study phase, target recall increased from 69.38% in the first test to 89.79% in the second test, $F(1, 46) = 100.89$, $MSE = 198.32$, $p < .001$, $\eta^2 = 0.69$, indicating successful learning. Recall levels were unaffected by retention interval condition, $F(1, 46) < 1$, and cuing condition, $F(1, 46) < 1$, which was expected given that both manipulations were conducted after the study phase (see Tab. 1).

Table 1. Percentage of recalled target items for each of the two study-test cycles of Experiment 2b as a function of retention interval (short, long) and part-list cuing condition at test (no-part-list cuing, part-list cuing). Standard errors are shown in parentheses.

	Short		Long	
Study-test cycles	No-PLC	PLC	No-PLC	PLC
Cycle 1	70.4 (4.3)	66.3 (4.6)	71.3 (5.3)	69.6 (5.0)
Cycle 2	90.8 (3.4)	89.2 (2.8)	90.4 (3.2)	88.8 (4.1)

A 2 × 2 ANOVA with the within-participants factor of RETENTION INTERVAL (short, long) and the between-participants factor of CUING (no part-list cuing, part-list cuing) revealed neither a main effect of RETENTION INTERVAL, $F(1, 46) < 1$, nor a main effect of CUING, $F(1, 46) < 1$. There was a significant interaction between RETENTION INTERVAL and CUING, $F(1, 46) = 4.66$, $MSE = 151.00$, $p = .036$, $\eta^2 = 0.09$, however, indicating that the effects of part-list cuing differed between delay conditions. Follow-up pairwise comparisons demonstrated that, after the short retention interval, target recall was lower when part-list cues were present than when they were absent (90.83% vs. 80.83%), $t(46) = 2.05$, $p = .046$, $d = 0.59$, whereas after the long retention interval, recall was unaffected by cuing condition (82.92% vs. 83.75%), $t(46) < 1$. In the absence of part-list cues, participants recalled more target items after the short retention interval than after the long retention interval (90.83% vs. 82.92%), $t(23) = 2.40$, $p = .025$, $d = 0.49$, reflecting typical time-dependent forgetting.

Further analysis. Analogous to Experiment 2a, part-list cuing was varied between participants in this experiment, whereas retention interval was manipulated within participants. Again, order of retention interval conditions did not influence the results. No main effect of order and no interaction effect

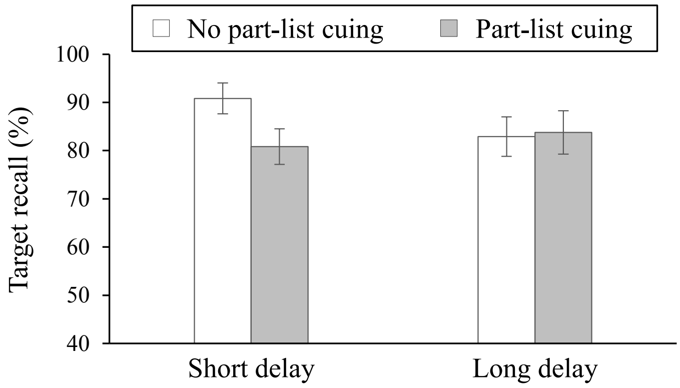

Figure 7. Results of Experiment 2b. Percentage of recalled target items is shown as a function of retention interval (short, long) and part-list cuing condition (no-part-list cuing, part-list cuing). Error bars represent standard errors.

of order with any of the other variables were found, all $ps > .277$.

Discussion

Going beyond prior findings, the present experiment, that introduced a high associative encoding situation by means of successive study-test cycles, demonstrated that part-list cuing impaired target recall after the short retention interval but left target recall unaffected after the prolonged retention interval. These results are consistent with the results of Experiment 1b, which used a different method to create a mismatch between study and test contexts and a different method to induce high associative encoding, indicating that the beneficial effect of part-list cuing as observed with low associative encoding may not generalize to high associative encoding.

3.5 Interim Summary

The above results indicate that the effects of part-list cuing varied with encoding condition, at least when study context access was impaired. Whereas part-list cuing impairment arose in all encoding conditions when study context access was maintained, i.e. after a remember instruction or a short retention interval, part-list cuing affected target recall differently when study context access was impaired, i.e. after a forget instruction or a long retention interval, showing a beneficial effect in the 1-study conditions but no such effect in the story or 2-study-test condition. To confirm the picture, data of Experiment 1 and 2 were combined and analyzed. A 2 × 2 × 2 ANOVA with the factors of CONTEXTUAL OVERLAP (context access maintained, context access impaired), CUING (no part-list cuing, part-list cuing), and ENCODING (low associative encoding, high associative encoding) revealed a significant three-way interaction, $F(1, 188) = 8.89$, $MSE = 158.74$, $p = .003$, $\eta^2 = 0.05$, and thus bolstered the suggestion described above.

In conclusion, the results of Experiment 1 and 2 converge on the view that low associative and high associative encoding situations can induce different part-list cuing effects: although the detrimental effects of part-list cuing on recall can be equivalent when access to study context is maintained, the part-list cuing effects differ when access to study context is impaired. Indeed, beneficial effects of part-list cuing arise with low associative encoding only but not with high associative encoding.

This finding is in line with the view that, with high associative encoding, part-list cuing triggers in general two types of processes, namely strategy disruption and context reactivation. When study and test contexts are largely identical - like after a remember instruction or a short retention interval - , strategy disruption may primarily operate and dominate the effects of part-list cuing. In contrast, when study and test contexts differ - like after a forget instruction or a prolonged retention interval - , part-list cuing may induce reactivation of the study context, and, fairly early in the recall period, reconstruction of the original retrieval plan. Although such context reactivation can potentially improve target recall, allowing subjects to recall many of the target items, the proposal has been that the beneficial effect may be masked by the detrimental effect of strategy disruption caused by the same part-list cues, thus keeping recall at a level similar to the one observed in the absence of any part-list cues.

While this theoretical view can explain the null effects of part-list cuing reported in Experiments 1 and 2 with high associative encoding and impaired study context access, the view must remain speculative because no separate evidence for the beneficial effect of context reactivation and the detrimental effect of strategy disruption was provided. The goal of Experiment 3 was therefore to isolate the putative beneficial effect of context reactivation from the detrimental effect of strategy disruption, showing that part-list cuing can improve recall also with high associative encoding, though only if strategy disruption processes are eliminated. To achieve this, we employed Basden et al.'s (1977) two-stage recall test to unpack the processes mediating part-list cuing with high associative encoding and impaired study context access.

Basden et al. (1977) employed a two-stage recall test in which, after inducing high associative encoding of study items, subjects participated in two successive recall tests that were separated by a short retention interval. In the first (critical) test, subjects in the part-list cuing condition received half of the list items as retrieval cues and were asked to recall the remaining (target) items; subjects in the control condition were asked to recall all of the previously learned items. In the subsequent (final) test, the part-list cues were removed in the part-list cuing condition and subjects in both cuing conditions were asked to recall as many list items as possible. The finding was that the typical detrimental effect of part-list cues was present in the critical test but was largely eliminated on the final test when the cues were removed. On the basis of this finding, Basden and Basden suggested that strategy disruption occurred in the presence of part-list cues but did no longer operate in their absence (for similar results, see Basden & Basden, 1995).[3]

Experiment 3 and 4 applied such two-stage recall testing with the goal to isolate the beneficial effect of context reactivation from the detrimental effect of strategy disruption when subjects employ high associative encoding and study and test contexts differ. Under such conditions, the putative common action of context reactivation and strategy disruption should again create the previously observed null effect of part-list cuing on target recall on the first, critical test (Experiments 1 and 2), but the beneficial effect of context reactivation may no longer be masked by the detrimental effect of strategy disruption on the second, final test. Indeed, on this final test, strategy disruption may no longer operate because, after the removal of the cues, participants may return to their initial retrieval plans, and subjects may thus be able to recall items that were reactivated by context reactivation during the critical test but due to strategy disruption processes were not recallable on that test. If so, a null effect of part-list cuing on target recall may arise on the critical test, but a beneficial effect of part-list cuing show up on the final test.

[3]Presentation of the part-list cues on the first test provides another study opportunity for the cue items in the part-list cuing condition, thereby facilitating the recall of these items on the final test. If this facilitatory effect somehow improved overall recall performance on the second test through a set of mechanisms different than release from strategy disruption, then this facilitatory effect may underlie the observed elimination of the detrimental effect rather than release from strategy disruption. There is evidence, however, that the facilitarory effect for the cue items and the recall improvement for the target items are unrelated (e.g., Bäuml & Aslan, 2006), which supports the proposal that the elimination of the detrimental effect is mediated by release from strategy disruption.

3.6 Experiment 3: Effects of Part-List Cuing in List-Method Directed Forgetting (High Associative Encoding) Using a Repeated-Testing Procedure

Like in Experiment 1, we employed (i) the listwise directed forgetting task to manipulate the overlap of study and test contexts and (ii) a story building task to induce high associative encoding. No single study condition was included in this experiment. In particular, a two-stage recall test with the critical test as the first and the final test as the second recall test was employed. Part-list cues were present on the critical test but were removed on the final test. We expected to replicate the results for the high associative encoding condition of Experiment 1 in the critical test, with a detrimental effect of part-list cuing in the remember condition but no effect of part-list cuing in the forget condition. However, following the reasoning above, we expected a different result on the final test. On the final test, strategy disruption processes should be largely eliminated and therefore recall levels in the part-list cuing conditions be increased, in both the remember and the forget conditions. If so, the detrimental effect of part-list cuing in the remember condition should be reduced and a beneficial effect of part-list cuing in the forget condition arise.

Methods

Participants. 64 students participated in the experiment (M = 21.4 years, range = 18-29 years, 76.6% female). They were equally distributed across the two between-subjects conditions, resulting in n = 32 participants in each condition. Sample size followed prior part-list cuing work employing two-stage recall testing (e.g., Aslan et al., 2007; Bäuml & Aslan, 2006). None of the participants had taken part in Experiment 1 or Experiment 2. All participants spoke German as native language, were tested individually, and received monetary reward or course credit for participation.

Materials. The same four study lists were used as in Experiment 1. Again, List A and List B were presented as List 1, whereas List C and List D were presented as List 2. Lists A and B consisted of the same 10 target and the same 10 nontarget (cue) items as in Experiment 1.

Design and Procedure. The experiment had a 2 × 2 × 2 mixed factorial design. INSTRUCTION (remember, forget) and TESTING (critical, final) were varied within participants, whereas CUING (no-part-list cuing, part-list cuing) was manipulated between participants. Design and procedure were largely identical to Experiment 1 with the following two exceptions: (1) In the study phase, we omitted the single study condition (see Exp. 1a); all participants were therefore asked to encode the items in terms of a common story. (2) In the test phase, we provided an additional final free recall test after the first (critical) test. On the final test, no part-list cues were present and the test was therefore identical for the two cuing conditions. Critical and final tests were seperated by a 30-second backward counting task. In both tests, participants had 2 minutes to recall and write down previously studied first-list items. List-2 items were tested after the final test (see Fig. 8).

Results

Again, we restricted analysis of first-list recall to target items. Fig. 9 shows mean recall rates for the target items as a function of instruction and cuing conditions, separately for the critical and the final test.

Critical test. A 2 × 2 ANOVA with the within-participants factor of INSTRUCTION (remember, forget) and the between-participants factor of CUING (no part-list cuing, part-list cuing) replicated the main results of Experiment 1b, yielding a significant main effect of INSTRUCTION, $F(1, 62) = 6.82$, $MSE = 253.00$, $p = .011$, $\eta^2 = 0.10$, with higher recall in the remember

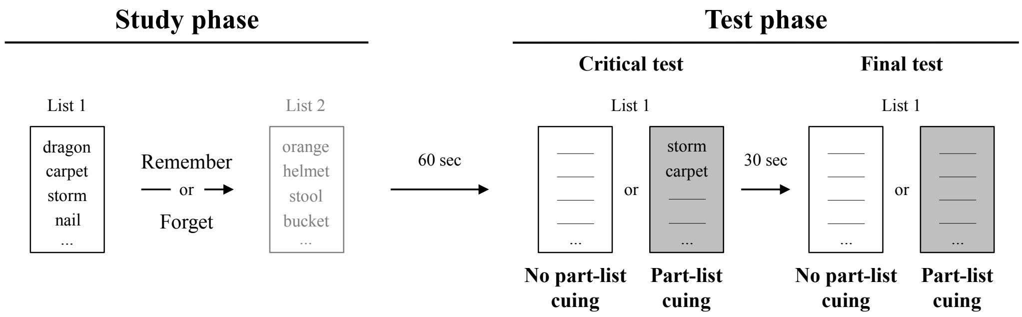

Figure 8. Illustration of the conditions and procedure employed in Experiment 3. Subjects studied two lists of items and, after study of the first list, were instructed either to forget or to continue remembering that list. All subjects were asked to formulate a meaningful sentence with each presented word and to interrelate the sentences to a common story. The test phase consisted of a two-stage recall test with a first critical test, in which part-list cues were provided or not, and a second final test, in which no part-list cues were provided at all.

than the forget condition (56.56% vs. 49.22%), and a significant interaction between INSTRUCTION and CUING, $F(1, 62) = 10.03$, $MSE = 253.00$, $p = .002$, $\eta^2 = 0.14$, indicating different effects of part-list cuing in the remember and forget conditions. No main effect of CUING arose, $F(1, 62) < 1$. Follow-up pairwise comparisons showed that whereas part-list cuing impaired target recall in the remember condition (62.81% vs. 50.31%), $t(62) = 2.79$, $p = .007$, $d = 0.70$, there was no difference in recall levels in the forget condition (46.56% vs. 51.88%), $t(62) = 1.13$, $p = .264$, $d = 0.28$. In the absence of part-list cues, target recall in the remember condition exceeded target recall in the forget condition (62.81% vs. 46.56%), $t(31) = 4.80$, $p < .001$, $d = 0.85$, demonstrating typical directed forgetting of first-list items.

Final test. A 2 × 2 ANOVA with the within-participants factor of INSTRUCTION (remember, forget) and the between-participants factor of CUING (no part-list cuing, part-list cuing) revealed a marginally significant main effect of INSTRUCTION, $F(1,62) = 3.93$, $MSE = 243.52$, $p = .052$, $\eta^2 = 0.06$, with numerically higher recall in the remember than the forget condition (59.22% vs. 53.75%), and a significant interaction between INSTRUCTION and CUING, $F(1,62) = 9.01$, $MSE = 243.52$, $p = .004$, $\eta^2 = 0.13$, indicating that part-list cuing on the critical test affected recall in the final test differently in the two instruction conditions. There was no main effect of CUING, $F(1,62) < 1$. Follow-up pairwise comparisons showed that, in contrast to the critical test, recall levels did not differ between cuing conditions in the remember condition (62.19% vs. 56.25%), $t(62) = 1.28$, $p = .207$, $d = 0.32$, indicating that part-list cuing impairment diminished in the final test. In the forget condition, a different picture emerged: Target recall was higher in the part-list cuing than in the no-part-list cuing condition (59.06% vs. 48.44%), $t(62) = 2.15$, $p = .036$, $d = 0.54$, which suggests that providing part-list cues in the critical test improved recall on the final test. Like in the critical test, a directed forgetting effect arose in the no-part-list cuing condition, with participants recalling more target items in the remember than the forget condition (62.19% vs. 48.44%), $t(31) = 3.90$, $p < .001$, $d = 0.69$.

Overall analysis. The above results indicate that recall increased from the critical to the final test in the two part-list cuing conditions, but did not do so in the two no-part-list cuing conditions. A 2 × 2 × 2 ANOVA with the factors of INSTRUCTION, CUING, and TESTING (critical test, final test) confirmed this picture, revealing a significant main effect of testing, $F(1,62) = 22.68$, $MSE = 36.44$, $p < .001$, $\eta^2 = 0.27$, with higher recall in the final than the critical test (56.48% vs. 52.89%), and a significant interaction between cuing and testing, $F(1,62) = 15.48$, $MSE = 36.44$, $p < .001$, $\eta^2 = 0.20$. Pairwise comparisons in fact showed that, both in the remember and the forget conditions, target recall increased in the part-list cuing condition from the critical to the final test (remember: 50.31% vs. 56.25%, $t(31) = 3.05$, $p = .005$, $d = 0.55$; forget: 51.88% vs. 59.06%, $t(31) = 3.86$, $p = .001$, $d = 0.68$). In contrast, in both the remember and the forget conditions, target recall in the no-part-list cuing condition did not change across tests (remember: 62.81%

vs. 62.19%, $t(31) < 1$; forget: 46.56% vs. 48.44%, $t(31) = 1.65$, $p = .110$, $d = 0.30$). There was no three-way interaction, $F(1, 62) < 1$, indicating that the increase in target recall when part-list cues were provided in the critical test was roughly the same in the two instruction conditions (5.94% vs. 7.19%), leading to a release of part-list cuing impairment in the remember condition and part-list cuing improvement in the forget condition.

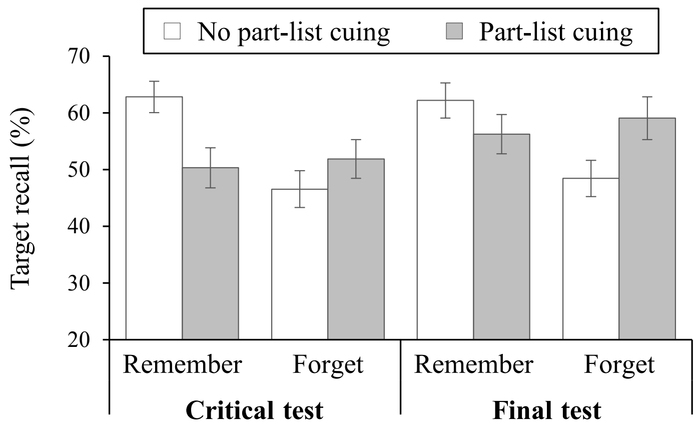

Figure 9. Results of Experiment 3. Percentage of recalled target items is shown as a function of instruction (remember, forget) and part-list cuing condition (no-part-list cuing, part-list cuing), separately for the two recall tests (critical test, final test). Error bars represent standard errors.

Further analysis. In this experiment, part-list cuing was varied between participants, but interlist instructions were manipulated within participants. Importantly, order of instruction conditions did not affect the results. There was no main effect of order and no interaction effect of order with any of the other variables, all $ps > .081$.

Like in Experiment 1, we also analyzed recall rates for List-2 items. A 2×2 ANOVA with the factors of INSTRUCTION and CUING showed no main effect of INSTRUCTION, $F(1, 62) = 1.15$, $MSE = 245.44$, $p = .288$, $\eta^2 = 0.02$, no main effect of CUING, $F(1, 62) < 1$, and no interaction between the two factors, $F(1, 62) < 1$. Like in Experiment 1, these results are not surprising, given that List 2 was recalled after List-1 items (see above).

Discussion

Results on the critical test replicate the results of Experiment 1b, again demonstrating that, with high associative encoding, the presence of part-list cues impairs target recall after a remember instruction, but leaves target recall unaffected after a forget instruction. Results on the final test provide a different picture, however. They demonstrate an elimination of the recall impairment in the remember condition and recall improvement in the forget condition. The elimination of the recall impairment in the remember condition replicates prior work, indicating that strategy disruption, which may operate on the critical test when part-list cues are present, is attenuated once part-list cues are removed in the final test (Basden & Basden, 1995; Basden et al., 1977). The recall improvement in the forget condition extends this prior finding, suggesting that strategy disruption can also be attenuated in the forget condition when the part-list cues are removed.

This latter finding is consistent with the theoretical view that, with high associative encoding and a difference in study and test contexts, both (beneficial) context reactivation processes and (detrimental) strategy disruption processes operate on the critical test when part-list cues are present, whereas strategy disruption processes may no longer operate on the final test when the cues are absent, thus creating a null effect of part-list cuing in the critical test but a beneficial effect on the final test. Experiment 3 was thus successful in separating the beneficial effect of context reactivation from the possible detrimental effect of strategy disruption. The goal of Experiment 4 was to replicate this finding using different method to create a mismatch in study and test contexts, and different method to induce high associative encoding.

3.7 Experiment 4: Effects of Part-List Cuing after Prolonged Retention Interval (High Associative Encoding) Using a Repeated-Testing Procedure

Like Experiment 3, Experiment 4 examined the proposal that, with high associative encoding and a difference in study and test contexts, part-list cuing may leave recall unaffected on a critical test in which the part-list cues are provided, but improve recall on a final test when the cues are removed. Doing so, Experiment 4 employed the same two-stage recall test as was used in Experiment 3. Besides, Experiment 4 followed Experiment 2b by using study-test cycles to induce high associative encoding and by using a prolonged retention interval between study and test to create a mismatch in study and test contexts. Unlike Experiment 2, Experiment 4 did not include a short delay condition. Rather, four different part-list cuing conditions were employed, providing subjects on the critical test with 0, 4, 8, or 12 part-list cues. This was done to measure the effects of part-list cuing on the critical and final tests in a more fine-graded way.

Participants in this experiment studied a list of words in two successive study-test cycles and were asked to recall the list items after a prolonged retention interval of one week. Recall was tested in two successive recall tests. The critical test, in which 0, 4, 8, or 12 part-list cues were provided, was followed by a final test, in which no part-list cues were present. On the basis of the results of Experiments 1-3, we expected recall to be largely unaffected by part-list cuing condition in the critical test. However, on the basis of the results of Experiment 3, we expected enhanced target recall in the final relative to the critical test when part-list cues were provided on the critical test, but no such recall enhancement in the no-part-list cuing condition, thus creating a beneficial effect of part-list cuing on the final test. In addition, if amount of context reactivation increased with number of provided part-list cues (e.g., Bäuml & Schlichting, 2014; Goernert & Larson, 1994), then the beneficial effect of part-list cuing on target recall in the final test may be expected to increase with the number of part-list cues provided on the critical recall test.

Methods

Participants. 96 students participated in the experiment ($M = 22.7$ years, range = 18-30 years, 82.3% female). None of them had taken part in any of the previous experiments. They were equally distributed across the four between-subjects conditions, resulting in $n = 24$ participants in each condition. All participants spoke German as native language, were tested individually, and received monetary reward or course credit for participation.

Materials. Materials were identical to List A and List B used in Experiment 2, but to avoid ceiling effects (see Fig. 7), four additional items were included in each list, which were drawn from published norms (Battig & Montague, 1969; Scheithe & Bäuml, 1995). Half of the participants studied List A, the other half studied List B. For each list, 12 target and 12 nontarget (cue) items were determined by the experimenter. The same 10 target and 10 nontarget items as employed in Experiment 2 were chosen and 2 further target and nontargets items were randomly selected from a list's four additional items. Within each list, no two items had the same initial letter.

Design and Procedure. The experiment had a 2 × 4 mixed factorial design. TESTING (critical, final) was varied within participants, whereas CUING (0, 4, 8, 12 part-list cues) was manipulated between participants. Design and procedure resembled Experiment 2 with the following three exceptions: (1) In the study phase, we omitted the single study condition (see Exp. 2a); all participants were therefore asked to encode the items in two successive study-test cycles. (2) We removed the short retention interval condition and extended the long retention interval condition to one week; after studying the list, all participants engaged in a 5-min unrelated distractor task (d2 test of attention, Brickenkamp

& Zillmer, 1998), left laboratory, and returned one week later to complete the experiment. (3) The test phase consisted of a critical and a final recall test. In the critical test, cuing conditions differed in the number of presented cue items: participants were provided with 0, 4, 8 or 12 of the nontarget items as retrieval cues and were asked to recall the remaining items. For each subject, the nontargets serving as part-list cues were randomly selected from the set of 12 nontarget items. After solving simple arithmetical problems for 30 seconds, all participants had 2 minutes to freely recall all previously studied items in the final test. No part-list cues were present at this test (see Fig. 10).

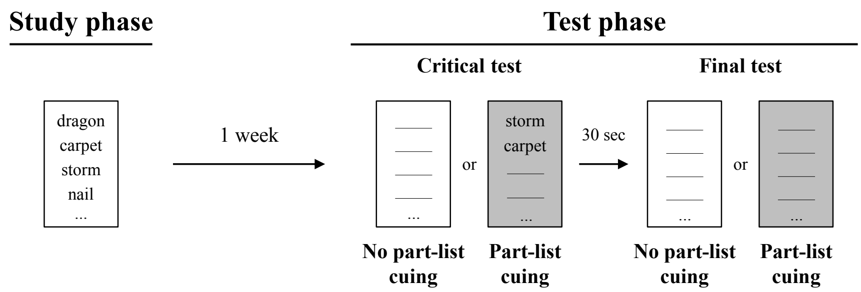

Figure 10. Illustration of the conditions and procedure employed in Experiment 4. Subjects studied a list of items by means of two successive study-test cycles. After a retention interval of one week, a two-stage recall test was conducted with a first critical test, in which part-list cues were provided or not, and a second final test, in which no part-list cues were provided at all.

Results

Again, we restricted analysis to target items. Fig. 11 shows mean recall for the target items in the single part-list cuing conditions (0, 4, 8, 12 cues), separately for the critical and the final test.

In the study phase, target recall increased from 68.40% in the first test to 88.19% in the second test, $F(1, 92) = 161.87$, $MSE = 116.16$, $p < .001$, $\eta^2 = 0.64$, indicating successful learning. Recall levels were unaffected by cuing condition, $F(3, 92) < 1$, which was expected given that part-list cues were provided after the study phase (see Tab. 2).

Table 2. Percentage of recalled target items for each of the two study-test cycles of Experiment 4 as a function of part-list cuing condition at test (0, 4, 8, 12 part-list cues). Standard errors are shown in parentheses.

	Number of part-list cues			
Study-test cycles	0	4	8	12
Cycle 1	70.1 (3.0)	64.6 (4.2)	69.1 (4.2)	69.8 (3.5)
Cycle 2	87.5 (1.9)	87.2 (2.6)	88.5 (2.6)	89.6 (2.1)

A 2 × 2 ANOVA with the factors of CUING (0, 4, 8, 12 part-list cues) and TESTING (critical, final) yielded a significant main effect of TESTING, $F(1, 92) = 38.94$, $MSE = 19.66$, $p < .001$, $\eta^2 = 0.30$, with higher recall in the final than the critical test (53.90% vs. 49.91%), and a significant interaction between CUING and TESTING, $F(3, 92) = 10.53$, $MSE = 19.66$, $p < .001$, $\eta^2 = 0.26$, indicating that the single cuing conditions affected recall in the two tests differently. There was no main effect of CUING, $F(3, 92) < 1$.

Pairwise comparisons showed that target recall increased from the critical test to the final test when 12 part-list cues were provided in the critical test (52.08% vs. 61.11%), $t(23) = 6.03$, $p < .001$, $d = 1.23$, and when 8 part-list cues were provided (48.61% vs. 54.17%), $t(23) = 4.29$, $p < .001$, $d = 0.88$. No significant difference between recall rates in the two tests emerged when 4 part-list cues were present in the critical test (49.99% vs. 51.72%), $t(23) = 1.31$, $p = .203$, $d = 0.27$, and when part-list cues were absent (48.96% vs.

48.61%), $t(23) < 1$. Consistent with these results, there were no differences in target recall between the control condition and the single cuing conditions in the critical test, all $ts(46) < 1$, whereas target recall in the final test was higher when 12 part-list cues were provided on the critical test than when part-list cues were absent (61.11% vs. 48.61%), $t(46) = 2.30$, $p = .026$, $d = .66$.

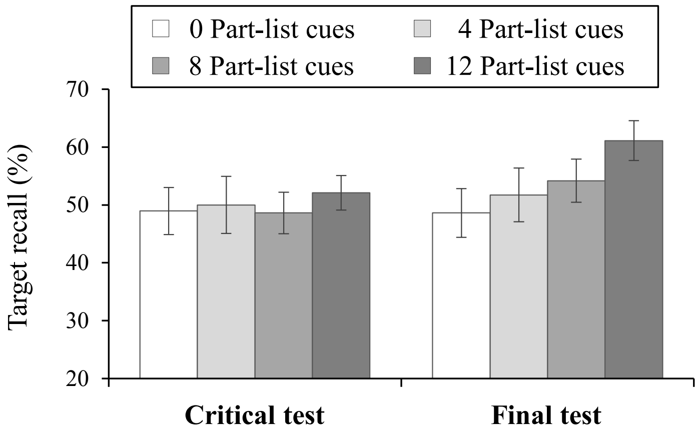

Figure 11. Results of Experiment 4. Percentage of recalled target items is shown for the different part-list cuing conditions (0 or 4 or 8 or 12 part-list cues), separately for the two recall tests (critical test, final test). Error bars represent standard errors.

Discussion

Results for the critical test replicate and extend those of Experiment 2 with high associative encoding and prolonged retention interval. There was no effect of part-list cuing when half of the items were provided as part-list cues (12 part-list cues) and this pattern generalized to the conditions in which a lower number of part-list cues were provided. Results on the final test differed from those on the critical test, showing a beneficial effect of part-list cuing when 12 part-list cues were present. This finding is consistent with the results of Experiment 3, providing another case for the proposal that, with high associative encoding and when study and test contexts differ, part-list cuing may leave recall on a critical test unaffected but may improve recall on a subsequent final test when the part-list cues are removed on that test. This pattern of results is in line with the view that, under the conditions examined, context reactivation and strategy disruption may operate on the critical test but context reactivation only influence recall on the final test.

Chapter 4

General Discussion

The major goal of the present thesis was to examine the effects of part-list cuing in different encoding and testing situations and thus to complement the findings of part-list cuing effects on memory performance and to develop a comprehensive account of the cognitive mechanisms involved. Therefore, following prior work on part-list cuing (Aslan & Bäuml, 2007; Bäuml & Aslan, 2006), in Experiment 1-2 low and high associative encoding conditions were induced by means of either a single study trial or a story building task or repeated study-test cycles. Additionally, study context access at test was manipulated by employing list-wise directed forgetting or by varying the retention interval after study (see Bäuml & Samenieh, 2012; Bäuml & Schlichting, 2014).

The results of Experiments 1 and 2 replicate prior work by showing that, with low associative encoding, like single study trial with no instruction to encode the study items strategically, part-list cuing induces detrimental effects on target recall when study and test contexts overlap but induces beneficial effects when study and test contexts differ (Bäuml & Samenieh, 2012; Bäuml & Schlichting, 2014; Goernert & Larson, 1994). Going beyond the prior work, the results demonstrate that, with high associative encoding, like repeated study-test cycles or an instruction to encode the study items in terms of a common story, a different pattern of results arises. Whereas part-list cuing again induces detrimental effects on target recall when study and test contexts overlap, it leaves target recall unaffected when study and test contexts differ. These findings indicate that encoding influences the effects of part-list cuing when study and test contexts differ, leading to improved recall of target items with low associative encoding only. The findings emerged both when a mismatch between study and test contexts was created by means of a forget cue and when it was created by prolonged retention interval (see also below).

In a next step, Experiments 3-4 were designed to clarify the mechanisms leading to the null effect of part-list cuing in high associative encoding when study-context access was impaired at test. Therefore, solely high associative encoding was induced, again either by a story building task or repeated study-test cycles. Analogous to Experiments 1-2, study-context access was varied by list-wise directed forgetting or the length of the retention interval. Additionally, a two-stage recall test was employed, in which part-list cues were present on the first recall test, but removed on the second test. The two-stage recall test was introduced to unmask possible opponent mechanisms that might cancel out each other, resulting in the null effect demonstrated in Experiments 1-2.

The results of Experiment 3 replicate prior work by showing that, with high associative encoding and when study and test contexts match, part-list cuing impairment can arise in a first, critical test when part-list cues are present, but be reduced, if not eliminated, in a second, final test when the cues are removed on that test (e.g., Basden & Basden, 1995; Basden et al., 1977). Indeed, in the remember condition of this experiment, target recall increased from the critical to the final test in the part-list cuing condition, whereas it was unaffected by test in the no-part-list cuing condition. As a result, the part-list cuing impairment observed in the critical test was reduced and statistically no longer present in the final test. Importantly, the results of Experiments 3 (forget condition) and Experiment 4 (prolonged retention interval) generalize this finding by demonstrating that, also when study and test contexts differ, target recall can increase from the critical to the final test in the part-list cuing condition, but be unaffected by test in the no-part-list cuing conditions. The null effect of part-list cuing observed on the first, critical test therefore turned into a beneficial effect of part-list cuing on the second, final test. This finding demonstrates that, also with high associative encoding, part-list cuing can improve recall of target items when study and test contexts differ, though only on a second test when the cues are removed. Again, the findings arose when a mismatch between study and test contexts was created by means of a forget cue and when it was created by prolonged retention interval.

In the following sections, the accounts of the cognitive mechanisms supposed to mediate part-list cuing effects in different encoding and testing situations will be reviewed and complemented by a theoretical explanation of part-list cuing effects.

4.1 A Multimechanisms Account of Part-List Cuing

Low Associative Encoding

Experiments 1-2 demonstrated two faces of part-list cuing with low associative encoding and thus replicated the findings of previous studies (Bäuml & Samenieh, 2012; Bäuml & Schlichting, 2014). While part-list cuing impaired target recall, when the overlap between study and test contexts was high, part-list cuing improved target recall, when the overlap between the contexts was small. Bäuml and Samenieh (2012) attributed the effects of part-list cuing in low associative encoding to inhibition/blocking and context reactivation processes. The proposal has been that, when study and test contexts overlap and access to study context at test is largely maintained, part-list cuing may trigger mainly inhibition and blocking processes with little need to reactivate the study context. As a result, part-list cuing impairment may arise. In contrast, when study and test contexts differ and study context access at test is impaired, the interference level of the items may be low and blocking and inhibition may hardly operate. Rather, part-list cuing may trigger context reactivation processes, with the reactivated context serving as an additional retrieval cue for the remaining items, thus improving target recall.

High Associative Encoding

The finding of Experiments 1-4 showed that, with high associative encoding (and on the first, critical test), part-list cuing impairs target recall when study and test contexts match, but leaves target recall unaffected when study and test contexts differ, is consistent with the view that the effects of part-list cuing in this type of encoding are mediated by two different mechanisms. The proposal is that, when study and test contexts overlap and access to study context at test is maintained, part-list cuing triggers strategy disruption processes, which cause part-list cuing impairment. Indeed, with high associative encoding, subjects may try to develop individual retrieval plans during encoding and the part-list cues may then disrupt the preferred recall orders (e.g., Basden & Basden, 1995; Basden et al., 1977). In contrast, when study and test contexts differ and access to study context at test is impaired, part-list cuing may trigger context reactivation and strategy disruption processes. Initially, part-list cuing may reactivate the study context and the reactivated context then serve as an additional retrieval cue for the remaining memories and facilitate target recall (e.g., Bäuml & Samenieh, 2012). However, already early in the recall period, such context reactivation may lead to reconstruction of the original retrieval plan. Although the reactivated retrieval plan would allow subjects to recall many of the target items, the presence of the part-list cues may disrupt this plan, so that the potentially beneficial effect of context reactivation as caused by the part-list cues is masked by the detrimental effect of strategy disruption caused by the same part-list cues. Part-list cuing may thus not much affect target recall, which is what the present results show.

This proposal is supported by the finding of Experiments 3 and 4 that, with high associative encoding and a difference in study and test contexts, no beneficial effect of part-list cuing may arise on a first, critical test when part-list cues are present but a beneficial effect emerge on a second, final test when the cues are removed on that test. Indeed, following the two-mechanism proposal above and the findings on the effects of part-list cuing in two-stage recall tests (e.g., Basden & Basden, 1995; Basden et al., 1977), the absence of the part-list cues in the final test should reduce, or even eliminate, strategy disruption processes and thus unmask the beneficial effect of context reactivation processes operating during the first, critical test. As a whole, the findings of Experiments 1-4 thus indicate that, with high associative encoding, strategy disruption mediates the effects of part-list cuing when study and test contexts match, but context reactivation *and* strategy disruption mediate the effects when study and test contexts differ. Both strategy disruption and context reactivation operate on the critical test when the part-list cues are present, but mainly the effects of context reactivation are present on the final test when the cues are removed.

A Multimechanisms Account

When combining the theoretical views on part-list cuing for low and high associative encoding, a multi-mechanisms account arises. The basic assumption of this account is that, in general, part-list cuing triggers both detrimental mechanisms (inhibition, blocking, strategy disruption) and beneficial mechanisms (context reactivation). This account suggests that, when study and test contexts match, detrimental effects of part-list cuing emerge, with different mechanisms operating in different encoding situations. Inhibition and blocking are supposed to underlie the impairment in low associative encoding, whereas strategy disruption is supposed to underlie the impairment in high associative encoding (e.g., Aslan & Bäuml, 2007; Bäuml & Aslan, 2006). In addition, the account suggests that, when study and test contexts differ, beneficial or null effects of part-list cuing emerge, partly mediated by similar mechanisms. While in low associative encoding, mainly context reactivation processes are supposed to operate, causing part-list cuing improvement, in high associative encoding, both context reactivation and strategy disruption may operate, which due to their opposing character may not much influence target recall (see Tab. 3). This multi-mechanisms account can explain the present set of experimental results as well as other findings in the part-list cuing literature as outlined below.

Table 3. Summary of observed effects of part-list cuing in the different encoding and testing conditions, together with suggestions on underlying mechanisms (see main text for further explanations).

	Study and test contexts match	Study and test contexts differ
Low associative encoding	Part-list cuing *impairment* caused (mainly) by inhibition and blocking	Part-list cuing *improvement* caused (mainly) by context reactivation
High associative encoding	Part-list cuing *impairment* caused (mainly) by strategy disruption	*Null effect* of part-list cuing caused by opposing effects of context reactivation and strategy disruption

4.2 Relation to Prior Part-List Cuing Work

The Role of Encoding

The present results demonstrate that when access to study context is impaired at test, the effects of part-list cuing are nonequivalent in different encoding conditions. These findings complement results from previous studies which showed that, when access to study context is maintained at test, the effects of part-list cuing are also nonequivalent in different encoding situations, depending on the test format of the recall test. Bäuml and Aslan (2006), for instance, contrasted retrieval dynamics of different encoding conditions in a repeated testing situation and found lasting detrimental effects of part-list cuing in a single study condition when no instruction for associative encoding is provided, but a release from the detrimental effect after the removal of part-list cues when items were encoded by means of a common story or during successive study-test cycles (see also present Experiments 3 and 4). While the lasting effect of part-list cuing after low associative encoding was regarded as indicative of inhibition and blocking (Anderson et al., 1994; Anderson & Spellman, 1995; but see Muntean & Kimball, 2012), the transient nature of part-list cuing after high associative encoding was regarded as evidence that an originally built retrieval plan was disrupted in the presence of part-list cues but reinstated when the cues are removed (Basden & Basden, 1995; Basden et al., 1977). The present results of Experiments 3-4 replicate and extend the previous findings with high associative encoding by demonstrating a release of part-list cuing impairment after the removal of part-list cues in a repeated testing procedure, both when study context access is maintained and impaired at test.

Similarly, Aslan and Bäuml (2007) demonstrated different part-list cuing effects when the targets' initial letters were provided as item-specific probes at test compared to a condition in which such letters were absent. While part-list cuing impairment was observed both with and without item-specific probes in a low associative encoding condition, i.e. one study trial without any instruction to encode the items strategically, part-list cuing impairment was found in the absence of item-specific probes only in high associative encoding conditions, i.e. study-test cycles or providing the instruction to interrelate the items to a common story. Together with the present results, these results demonstrate that encoding influences the effects of part-list cuing, both the detrimental and the beneficial effects. Both influences are consistent with the multi-mechanisms account outlined above, indicating a different role of context reactivation and a role of inhibition/ blocking vs. strategy disruption in different encoding situations.

The Role of Study-Context Access

The present results are not only consistent with prior work by showing that effects of part-list cuing can be nonequivalent in different encoding conditions (Aslan & Bäuml, 2007; Bäuml & Aslan, 2006), they are also consistent by demonstrating that the effects of part-list cuing can be nonequivalent depending on whether access to study context is impaired (Bäuml & Samenieh, 2012; Bäuml & Schlichting, 2014). For instance, Bäuml and Samenieh (2012) demonstrated that part-list cuing in a low associative encoding situation can both impair and improve target recall when study context access was varied by a remember or forget instruction in a listwise directed forgetting task. Bäuml and Schlichting (2014) confirmed the finding by demonstrating detrimental and beneficial effects of part-list cuing when the length of the retention interval was varied. Going beyond these prior findings in low associative encoding conditions, the present results also demonstrate that encoding and study context access can interact in their part-list cuing effects. While encoding may not influence the detrimental effect when access to study context is maintained (and no item-specific cues are provided at test), encoding may influence the beneficial effect (see Experiment 1 and 2). The present results thus add to the list of factors that can influence the effects of part-list cuing. The multimechanisms account introduced above may help to organize and clarify the different influences on part-list cuing effects.

4.3 An Evaluation of the Experimental Manipulations

Study-Test Cycles "versus" Story Building

High associative encoding refers to the finding that subjects are able to create chainlike interitem assocations during encoding, which lead to the formation of an elaborated retrieval plan and a preferred recall order. A priori there are several ways in which such retrieval plans may be created, like to encode the study items in terms of a common story (e.g., Bower & Clark, 1969) or to provide subjects with repeated study-test cycles during encoding (e.g., Tulving & Watkins, 1974). Both methods have been used in prior work on part-list cuing (e.g., Aslan & Bäuml, 2007; Bäuml & Aslan, 2006) as well as in the present study. In all this present and prior work, equivalent effects of part-list cuing arose for the two forms of high associative encoding, leading to part-list cuing impairment when study and test contexts matched and to null effects of part-list cuing when study and test contexts differed. This holds while, in the present study, the two forms of high associative encoding differed in their susceptibility to episodic forgetting: while story building did not differ much from single study in amount of (directed) forgetting, study-test cycles showed reduced (time-dependent) forgetting relative to single study.[4]

The reduced episodic forgetting after study-test cycles is consistent with the testing effect literature, which demonstrates that retrieval practice after study typically reduces episodic forgetting and may create a form of encoding not shared by other types of encoding, like single study or story building

[4] Single study and story building showed similar forgetting in response to the forget cue in Experiment 1 (single study: 65.4% recalled items after the remember cue, 48.3% recalled items after the forget cue; story: 78.8% recalled items after the remember cue, 58.8% recalled items after the forget cue). In contrast, study-test cycles showed reduced time-dependent forgetting relative to single study in Experiment 2 (single study: 76.3% recalled items after the short delay, 55.4% recalled items after the long delay; study-test cycles: 90.8% recalled items after the short delay, 82.9% recalled items after the long delay; see also Figs. 3-4 and 6-7).

(for a review, see Roediger & Butler, 2011).[5] Intriguingly, despite the putative difference in encoding between study-test cycles and story building, the present results provide no evidence for different effects of part-list cuing in the two forms of high associative encoding, while they show different effects of part-list cuing for low and high associative encoding. These findings fit with the view that it is the presence versus absence of chainlike structures after encoding that is critical for the effects of part-list cuing, regardless of whether such structures have been created by story building or study-test cycles.

Directed Forgetting "versus" Time-Dependent Forgetting

The present study followed prior work and employed two different methods to create a mismatch between study and test contexts: time-dependent forgetting and listwise directed forgetting (e.g., Bäuml & Schlichting, 2014; Bäuml & Samenieh, 2012). Although time-dependent forgetting can be due to a number of factors (see Baddeley, Eysenck, & Anderson, 2015), there is general consensus that prolonged retention intervals typically include a considerable amount of contextual change between study and test, so that contextual elements of the study phase can become inaccessible over time (e.g., Bower, 1972; Estes, 1955; Mensink & Raaijmakers, 1988). Directed forgetting has also been attributed to contextual change, assuming that the forget cue induces a change in participants' internal context, which then impairs first-list recall due to a mismatch between the context at study and the context at test (Sahakyan & Kelley, 2002), or assuming that forget-cued participants engage in active inhibitory processes that reduce access to the first-list context and thus induce first-list forgetting (Geiselman et al., 1983). While time-dependent forgetting and listwise directed forgetting may thus share the characteristic of inducing some form of contextual forgetting, in general, they are clearly nonequivalent,

[5] Retrieval practice has been shown to not only reduce time-dependent forgetting (Roediger & Karpicke, 2006) but to also reduce listwise directed forgetting (Abel & Bäuml, 2016). As a result, it appears likely that study-test cycles would also have reduced the directed forgetting in the present Experiment 1.

in particular, if time-dependent forgetting includes longer delay. For instance, with longer delay, time-dependent forgetting may arise in both recall and item recognition, whereas listwise directed forgetting is typically present in recall but is absent in item recognition (see Baddeley et al., 2015; Geiselman et al., 1983).

Despite this nonequivalence of the two forms of forgetting, the present results show that they are subject to equivalent effects of part-list cuing. In fact, in both forms of forgetting, part-list cuing improved recall with low associative encoding, and left target recall unaffected - or when using two-stage testing, enhanced target recall - with high associative encoding. While the effects of part-list cuing thus do not seem to depend much on the exact form of the contextual forgetting, they are not easily generalizable to noncontextual forgetting. Bäuml and Samenieh (2012), for instance, found part-list cuing to improve target recall when (contextual) forgetting was induced by a forget cue, but found part-list cuing to impair target recall when (noncontextual) forgetting was induced by proactive interference. These findings indicate that it is the presence versus absence of a contextual mismatch between study and test that is critical for the effects of part-list cuing, regardless of how exactly the mismatch has been created.

4.4 Individual Differences in Part-List Cuing

Working Memory Capacity

To date, only a few studies have examined how individual factors may influence the effects of part-list cuing. One of these factors that may exert an influence on part-list cuing effects is *working memory capacity*. The term working memory is used over a wide range of research fields and includes the interrelated abilities to control attention to one's goal and to maintain goal-relevant information despite of interfering sensations. Working memory capacity reflects the interindividual differences in these abilities (Miller, Galanter, & Pribram, 1960; Cowan, 2008). Cokely, Kelley, and Gilchrist (2006) examined how individual differences in attentional control may result in recall differences in part-list cuing. Therefore, participantes studied lists of unrelated items in a single study trial and received either a free-recall instruction or half of the items as part-list cues at test. The ability to control one's attention was measured by the operation span task that was developed by Turner and Engle (1989). In this task, subjects are asked to solve series of simple math problems while trying to remember single letters or unrelated words that a presented after each arithmetic equation. After three to seven operations, the participants are instructed to recall the letters or words in the order presented. Recall performance then serves as an indicator for attentional control. Cokely and colleagues (2006) found a linear relationship between the operation span scores and part-list cuing impairment. Participants with high spans showed a large negative effect of part-list cuing, whereas participants with low spans showed no effect. The authors concluded that subjects with high attentional control are more likely than subjects with low attentional control to develop more elaborate retrieval strategies and interitem associations during encoding, rendering them more susceptible to retrieval disruption or inhibition by part-list cues.

They supported their conlusion by the results of a subsequent experiment, in which individual differences in part-list cuing were eliminated by controlling the participants' encoding strategies. During encoding, all participants were encouraged to link the presented items in a common story in order to create strong interitem associations. In consequene of this manipulation, all participants, regardless of their abilities of attentional control, demonstrated typical part-list cuing impairment at test. The finding suggests that attentional control may affect part-list cuing impairment only indirectly by its impact on the development of elaborative retrieval strategies and interitem associations during encoding. A second study on the influence of executive control on part-list cuing impairment (Barber & Rajaram, 2011) confirmed this picture by introducing a executive depletion task before recall. While the depletion group was asked to write a story without using the frequently utilized letters “a” and “n”, the non-depletion group engaged in the same task while avoiding the letters “q” and “z”. However, there was no effect of the depletion task on recall performance. Part-list cuing impairment was found in both groups, demonstrating that differences in executive control did not influence part-list cuing effects on the retrieval stage. Indeed, scores of an operation span task conducted afterwards replicated the results of Cokely et al. (2006); subjects with high operation span scores showed typical part-list cuing impairment, whereas subjects with low operation span scores did not. These results suggest that working memory capacity may influence the (negative) effects of part-list cuing indirectly through the type of encoding. The studies mentioned employed encoding situations that enhanced the development of serial retrieval strategies and interitem associations so that part-list cuing impairment may have mainly been mediated by strategy disruption. To date, no study has examined in more detail the interaction of working memory and part-list cuing when inhibitory processes may play a more important role. Additionally, future research is needed to increase the focus on the influence of individual factors as working memory capacity on the beneficial effects of part-list cuing.

Individuals’ Age

Another individual factor that may influence part-list cuing effects is the subjects’ age. In the present thesis, part-list cuing effects in different encoding and testing situations were investigated in young adults. Only few studies investigated part-list cuing effects in further age groups. Prior work, that investigated detrimental effects of part-list cuing in both low and high associative encoding conditions, demonstrated persisting part-list cuing impairment into old age. For instance, Marsh et al. (2004) reported equivalent detrimental effects of category or instance cuing in low associative encoding situations. Andrés (2009) extended the finding to an incidental learning situation and found equivalent part-list cuing effects in younger and older adults after a word completion task. A more recent study (Andrés & Howard, 2011) showed that part-list cuing impairment in older age groups generalizes also to high associative encoding situations by employing successive study-test trials. Target recall was equally impaired by part-list cuing in younger and older adults. Equivalent part-list cuing impairment was also demonstrated in young children, at least in low associative encoding conditions (Zellner & Bäuml, 2005; Knott, Howe, Wimmer, & Dewhurst, 2011). First graders as well as fourth graders and young adults showed the same amount of forgetting when part-list cues were provided at test. The findings suggest that the detrimental effect of part-list cuing may develop early in life and may persist over the greater part of the lifespan. Further research is needed to examine in more detail how encoding may influence the effects of part-list cuing across the lifespan.

To date, there is no study that examined possible beneficial effects of part-list cuing in old age. However, there is one recent study (John & Aslan, 2018) that examined part-list cuing effects in young children, in dependence of the contextual overlap between study and test. Employing the listwise directed forgetting task, three different child age groups and young adults were asked to study a word list and afterwards, received an instruction either to remember or to forget the studied items. After study of a second list, first-list items were tested in the presence or absence of part-list cues. While all age groups showed equivalent detrimental effects of part-list cuing in the forget condition, only the oldest child age group (13-14 years) and the adults showed beneficial effects in the remember condition. In contrast, part-list cuing did not affect target recall in younger age groups (7-8, 9-11 years), indicating a developmental dissociation between the detrimental and beneficial effect of part-list cuing. The finding of different part-list cuing effects, depending on the testing situation and age groups, is of high practical relevance, for example in educational settings. Additionally, further studies are required to examine how the testing situation may affect the effects of part-list cuing in old age. Those findings may be also of high theoretical and practical relevance and may guide future treatment of age-related memory deficits by providing external cues.

4.5 Application of Part-List Cuing to Social Memory

In the past two decades, a growing number of studies investigated the effects of collaboration on memory performance and linked the observed recall impairment in collaborative groups to the detrimental effects of part-list cuing. In a typical collaborative memory experiment, participants individually study materials and, after a short retention interval, are asked to recall the studied items, either once again individually or in a collaborating group. Recall performance of the collaborating group is then compared with the performance of a so-called nominal group. A nominal group consists of an equal number of participants working individually and recall performance is calculated by pooling their nonredundant answers. While collaborative groups recall more than their individual members, collaborative groups recall less than nominal groups, a finding that is termed collaborative inhibition (Rajaram, 2011; Rajaram & Pereira-Pasarin, 2010; Weldon & Bellinger, 1997).

Following the strategy disruption account of part-list cuing impairment, the leading theoretical explanation of collaborative inhibition assumes that participants develop their individual retrieval strategies during encoding and that these strategies are disrupted by the outputs of the other group members during collaborative group recall (Basden, Basden, Bryner, & Thomas, 1997). The disruption hypothesis is, for example, supported by studies demonstrating a release of collaborative inhibition in a subsequent individual recall task (Basden et al., 1997; Finlay, Hitch, & Meudell, 2000). In contrast, a number of diverging findings - for example the demonstration of collaborative inhibition in forced-order tests, like cued recall or recognition tasks (Andersson & Rönnberg, 1996; Kelley, Reysen, Ahlstrand, & Pentz, 2012) - have questioned whether the effects of collaboration can be fully explained by strategy disruption. Alternative accounts of collaborative inhibition also follow part-list cuing research and suggest a role of blocking and inhibition in this form of recall impairment (for a meta-analysis, see Marion & Thorley, 2016), although no clear suggestions have yet been made about when the single mechanisms should operate. Future work may examine whether encoding plays a similar role in collaborative inhibition as it plays in part-list cuing impairment, which would help to understand whether similar mechanisms contribute to the two forms of recall impairment.

More recently, Abel and Bäuml (2017) investigated if, analogous to part-list cuing, study context access at test may also influence the effects of collaboration. Participants studied a list of unrelated words and were tested either individually or in collaborating groups. Additionally, access to study context was manipulated by employing a remember or a forget instruction after study or by varying the length of the retention interval between study and test. Typical detrimental effects of collaboration arose when study context access was intact, i.e., after a remember instruction or a short retention interval, but were eliminated when study context access was impaired, i.e., after a forget instruction or a prolonged retention interval. These results are consistent with two further studies (Congleton & Rajaram, 2011; Takahashi & Saito, 2004) that found collaborative inhibition after a short delay between study and test but found no recall impairment after a longer delay.

Abel and Bäuml (2017) proposed two different explanations to account for the disappearance of collaborative inhibition after a forget cue or prolonged delay. One reason may be that the role of strategy disruption or inhibition is reduced when study context access is impaired, be it because subjects no longer rely as heavily on their idiosyncratic retrieval strategies or because the interference level of the items is reduced (see Takahashi & Saito, 2004). Alternatively, the finding may reflect the action of context reactivation processes. Here the proposal is that when the overlap between study and test context is high, primarily strategy disruption or inhibition may operate and induce recall impairment, whereas when the overlap between study and test contexts is low, context reactivation may play a more important role and at least eliminate the impairment effect. Interestingly, the results by Abel and Bäuml (2017) parallel the part-list cuing effects observed in the present thesis with high associative encoding, which is consistent with the view that strategy disruption influences recall in social settings and both strategy disruption and context reactivation operate when access to study context at test is impaired. However, this assumption must remain speculative and further studies are required to examine the possible role of context reactivation in collaborative recall in more detail.

4.6 Part-List Cuing Effects in Other Paradigms

Like most research on part-list cuing, the present study examined the effects of part-list cuing by providing subjects with a random selection of the studied items as retrieval cues and asking them to recall the remaining (target) items. Typically, such random selection of study items causes recall impairment, at least when study and test contexts match (see Nickerson, 1984, and above). However, a different picture of part-list cuing arises when part-list cues are consistent with the individual's preferred recall strategy or when serial reconstruction rather than recall of previously studied items is tested. Employing study-test cycles for study, Basden and Basden (1995), for instance, demonstrated that inconsistent part-list cues led to the typically observed part-list cuing impairment, whereas consistent part-list cues reduced or even eliminated the impairment (see also Sloman et al., 1991). Serra and Nairne (2000) even demonstrated part-list cuing facilitation when consistent part-list cues were provided on a final reconstruction of order task, arguing that part-list can be both beneficial and detrimental, depending on whether they are consistent or inconsistent with an original recall order. The findings are in line with the strategy disruption hypothesis, indicating that retrieval strategies may be disrupted in the presence of inconsistent part-list cues but not in the presence of consistent part-list cues.

Other research (Watkins, Schwartz, & Lane, 1984; Drinkwater, Dagnall, & Parker, 2006) extended the finding of reduced part-list cuing impairment to visuospatial material and demonstrated that part-list cuing may not affect reconstruction of the spatial locations of pieces on a chess board. Participants in these studies were shown a chess board with 24 pieces of a partly played game and were then asked to reconstruct the chess board in the presence of half of the pieces in their proper positions as retrieval cues or in the absence of any pieces. Part-list cuing did not influence recall performance, which according to Drinkwater et al. (2006) may indicate that the retrieval of chess pieces might rely on different memorial processes that are less susceptible to part-list cuing than retrieval of verbal stimuli. Two more recent studies revisited part-list cuing with visuospatial material and reconstruction tasks, using snap circuit objects as stimuli (Cole et al., 2013; Kelley et al., 2016). They tested reconstruction performance by providing either a blank board or some circuit pieces in their appropriate locations and reported enhanced reconstruction performance in the cued condition in comparison to the uncued condition. The findings may suggest that the connections of the spatial stimuli may enhance the formation of inter-item associations and retrieval plans, so that congruent part-list cues at test facilitate reconstruction of the remaining items (for evidence in support of this view, see Kelley et al., 2016).

Future work on part-list cuing may examine the effects of part-list cuing with consistent and inconsistent cues and with recall and serial reconstruction tasks in further detail, and compare the effects both when study and test match and when the two contexts differ. Such findings will provide new insights into the mechanisms mediating part-list cuing in serial reconstruction tasks and into how these mechanisms differ from those mediating part-list cuing in recall, thus eventually leading to a more general theory of part-list cuing. The multi-mechanisms account of part-list cuing provided in the present study may help to guide such future work.

4.7 Summary of the Effects of Retrieval Cues with Applied Perspectives

The current finding of detrimental *and* beneficial effects of part-list cuing may lead to a rapprochement in the apparent conflict between Tulving's and Slamecka's findings, which was outlined at the beginning of this thesis. While memory research first emphasized and demonstrated positive aspects of cues (Tulving & Osler, 1968; Tulving & Pearlstone, 1966; Tulving & Psotka, 1971), Slamecka's (1968) finding that retrieval cues in the form of part-list cues might rather hinder recall of the remaining target items led to a new way of thinking about cuing. For more than five decades, PLC research has focused almost entirely on negative effects, in stark contrast to Tulving's findings and our everyday perceptions and experiences that suggest a benefit and positive effect of cues. The current findings now show that even this special type of cues - part-list cues - may not only have negative effects, but also positive effects, and thus draw attention back to the benefit of cues. In accordance with more recent studies (Bäuml & Samenieh, 2012; Bäuml & Schlichting, 2014; Goernert & Larson, 1994), the present thesis demonstrated that part-list cuing may improve recall after listwise directed forgetting and a longer retention interval by reinstating the original study context which serves as an additional retrieval cue for the remaining items.

The demonstration of positive effects of part-list cues when access to study context is impaired is of high relevance for models of human memory but also for the transfer to everyday situations. In real life settings, there is often a considerable time period between encoding and retrieval and, most of the time, it is very likely that the original study context has changed. For example, remembering may occur in a different location or in the presence of different persons than during encoding. Additionally, the internal state of a person like his or her mood may probably not remain unchanged, ultimately creating a mismatch between the contexts of encoding and retrieval. In these situations, the findings of the present thesis suggest that part-list cuing may reduce the mismatch between the context at encoding and the context at test and improve target recall, and thus may be much more useful in everyday life than was previously assumed due to the negative effects in numerous laboratory studies.

This perspective also provides implications for different fields of application, such as educational practice as well as relieving memory deficits in health care. In educational contexts, for both teachers and students, it seems quite relevant to be aware of how cues may improve recall under some conditions but may impair recall in others in order to adjust learning strategies and test procedures, especially since a laboratory study on metacognition and cuing (Rhodes & Castel, 2008) has shown that participants were unable to anticipate the effects of cues. In general, since retrieval in educational settings usually takes place after a prolonged retention interval and a different context than during learning, the present findings suggest that providing a subset of the studied information as retrieval cues, for instance as an adjunct to audit questions, may support the retrieval process. However, students appear to benefit from part-list cuing only at a certain age (John & Aslan, 2018), so that teachers of younger age groups should be aware that cuing might not improve remembering when designing and assessing tests. Additionally, the present findings also indicate that it can be more helpful to present cues only at the beginning of a test and then remove them again, especially if students have developed serial retrieval plans during repeated encoding - as seems likely, in particular, for important examinations. The provision of cues at the beginning may help to reinstate the study context, but may, after removal, not impede the developed retrieval strategy. Future research is needed that prooves the illustrated implications in more detail in real life settings in order to contribute to the improvement of educational practice.

Environmental support in the form of providing external cues plays also an extremly important role in clinical settings, such as rehabilitation programmes after the loss of memory as a consequence of an accident or stroke, or in treating memory deficits in older ages or specific diseases like Alzheimer or Parkinson's Disease (Craik & Anderson, 1999; Wilson, 1987). For instance, in retrograde amnesia, often a considerable amount of autobiographical memories, especially more recent memories, are disrupted (see Brown, 2002; Ribot, 1882). When there has not been a permanent brain damage, the provision of external cues like the name of persons or locations, photographs, or special songs may help to recover a majority of the memories. Memory deficits in older ages are often explained by a reduction in processing ressources (Craik, 1986). The age-related deficits in self-initiated mental operations may be then compensated by environmental support, such as retrieval cues. In accordance with this account, persons in older ages are more impaired in memory task that require self-initiated retrieval processes and thus internal generation of retrieval cues than memory tasks that involve more external support in form of providing retrieval cues, such as cued recall or recognition tasks (Light & La Voie, 1993; Marsh et al., 2004). The same picture arises also for patients who suffer from Parkinson's Disease (Ivory, Knight, Longmore, & Caradoc-Davies, 1999). However, to date, it must remain unclear whether part-list cuing may also support retrieval in clinical settings because more recent studies (John & Aslan, 2018; Aslan, Schlichting, John, & Bäuml, 2015) suppose that there is a relationship between working memory capacity and beneficial effects of part-list cuing due to context reactivation processes. Since decrements in working memory capacity are assumed to occur in old age as well as specific diseases like Alzheimer and Parkinson's Disease it is questionable whether the patients' recall performance may benefit from the provision of a subset of the information required. Amnesic patients who usually have intact working memory may well benefit from part-list cuing, but it remains to be verified by future studies.

Despite the obvious fields of application in everyday life, part-list cuing research has focused almost exclusively on basic laboratory studies. Thus, mostly, only simple word lists with either unrelated words as in the present experiments or words from different semantic categories were employed and there are hardly any studies that have employed ecologically more valid material such as coherent texts, vocabulary, or the like with which we are usually confronted in our daily lives. So far, two studies (Bäuml & Schlichting, 2014; Fritz & Morris, 2013) have investigated the effects of cues on remembering coherent prose texts and found negative effects of cues after a short retention interval, analogous to the results for simple word lists. Analogously to the present results, even beneficial effects were reported after a prolonged retention interval (Bäuml & Schlichting, 2014). A further study (Bovee et al., 2009) used grocery lists that were tested immediately after memorizing, and also found typical negative effects of part-list cuing when access to the original study context was maintained. Even though the (very few) findings with more complex material seem to suggest that the results of basic research on part-list cuing can be transferred to everyday issues and that part-list cues may influence remembering in our daily lives in a very similar way, certainly many more studies are needed to investigate the conclusions regarding the effects of part-list cues in different application contexts in more detail.

4.8 Final Conclusions

Part-list cuing has many faces. The present thesis showed that part-list cuing can impair, improve, or not affect target recall. Two factors - the encoding situation and the contextual overlap between study and test - are considered to play a critical role for the effects of part-list cuing. Depending on the combination of these two factors, different mechanisms operate and influence memory performance quite differently. The reported series of experiments demonstrated that part-list cuing impaired recall when, at test, access to study context is maintained, but that this detrimental effect can turn into a neutral or even beneficial effect when, at test, access to study context is impaired.

On the basis of these findings, a multi-mechanisms account of part-list cuing is suggested, which provides a rationale for how part-list cuing affects target recall in different experimental conditions. Since Slamecka's (1968) original finding the term 'part-list cuing' has typically been associated with recall impairment, making this form of cuing appear an ineligible method to improve people's recall performance. The present findings reveal part-list cuing in a different light, indicating that it can also induce recall improvement. The multi-mechanisms account provides a useful framework to describe the present results and may help to unravel the many faces of part-list cuing.

The findings are also of practical relevance, for instance, with regard to educational settings or healthcare. They suggest that part-list cuing can be beneficial in these settings and, under certain conditions, provide an effective way to support students' recall or enhance the recall of patients or older persons with memory problems. With these theoretical and applied perspectives, the present thesis may motivate and guide future research on part-list cuing.

Such future research may include experimental situations in which the selection of part-list cues is not random. At the moment, it is still unclear whether the present results and the proposed account may generalize to situations in which part-list cues are not randomly selected. Future work is required to complement the effects and mechanisms mediating part-list cuing in these experimental situations, thus eventually leading to a more general theory of part-list cuing.

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