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Behavioral Studies of Memory: Conditional Discrimination Techniques

Lars Strandbakken

Faculty of Health Sciences
Department of Behavioral Science

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Contents

Abstract

A presentation of various conceptual problems and challenges in the field of memory research is given in Article 1. After giving examples of approaches to the phenomenon by the disciplines of behavior analysis and cognitive psychology, more fundamental differences between the disciplines are discussed. It is promoted that behavior analysis has much to contribute with in the study of memory, both in the experimental field, and in applied settings in which treatment of different forms of memory-deficits is relevant. A special focus is pointed to treatment of patients with dementia, of which an important feature is decline in behavioral functions related to memory. Different matching-to-sample procedures have been promoted as promising in this treatment. In Article 2, a matching-to-sample procedure is conducted to establish name-face relations of three caregiver staff in a woman with unspecified dementia. Effects of a morphing procedure on the efficacy of the establishments were studied. This involves that two of the stimuli used in the experiment were put together as one stimulus, wherein one of the elements in the morphed stimulus functioned as a fading prompt. The stimuli used consisted of a picture of the caregiver's face, the caregiver's written name, and the caregiver's spoken name. The results indicate that morphing can be a quite beneficial technique in conditional discrimination, and that matching-to-sample procedures can function as appropriate and effective tools to train skills in patients with dementia. The findings are discussed, and guidelines for future research are suggested.

Keywords: Behavior analysis, memory, matching-to-sample, dementia, morphing, radical behaviorism

Behavior Analysis and Memory

Lars Strandbakken

Oslo and Akershus University College

Abstract

In order to introduce a behavior analytic approach to memory, some challenges and criticisms of the leading approaches in the field are presented. There are several aspects of the field that are problematic from a behavioral analytical standpoint as well as other standpoints. This is mainly because of the extensive use of hypothetical constructs that are conducted to account for memory. The present paper gives examples of approaches to memory, both from the standpoint of cognitive psychology and of behavior analysis. A discussion emphasizes the fundamental differences between the two disciplines, and promotes that behavior analysis has much to contribute with in the study of memory. To account for the complex behaviors related to memory, interpretations are a necessity. A solid base of experimental analysis of environment-behavior relations puts behavior analysis in a firm position to make such interpretations. A behavior analytic approach to memory has proven beneficial in both experimental and applied settings. Conditional discrimination procedures are much used because of its compatibility with both settings. Recently, conditional discrimination procedures have been conducted with participants suffering from dementia. Some findings are presented in this paper, and it is suggested that behavior analytic methodology has much to offer in favor of people with dementia and other diagnoses related to memory deficit. The methodology of behavior analysis makes it strong in accounting for causal relationships between behavior and environment, and makes the discipline suitable for experimental, clinical and applied settings.

Key terms: memory, remembering, radical behaviorism, hypothetical constructs, interpretation, storage and retrieval, dementia

Disciplines other than behavior analysis have studied memory in a large degree. What actually defines memory is a topic of discussion, but a wide range of researchers turn to accounts based on the work of Atkinson and Shiffrin (1968) and Baddeley and Hitch (1974). Like Mahadevan, Malone, and Bailey (2002) promoted, a widespread belief evolving in the 50's and 60's that radical behaviorism could not account for complex behavior phenomena gave way for other approaches. Many psychological textbooks have mistakenly referred to this period as the cognitive revolution (for a detailed discussion, see Hobbs and Chiesa, 2011). To harness the complexity associated with memory, a large part of the research done in these matters lead to the creation of hypothetical constructs. As Branch (1977) described, a construct is something said to have physical status, but is unobservable due to limitations of technology. Experimental disciplines of psychology have a long tradition of hypothesizing and conducting complex explanations to account for complex phenomena. The metaphors applied when it comes to the study of memory are many (Roediger, 1979, 2008). Roediger (1979) pointed out that, almost without exception, all the approaches to explain memory till then consisted of some hypothetical construct. These constructs were based on different kinds of metaphors, in large degree referring to different types of information storage common to the time of the construct's creation. Despite the numerous attempts to structuralize the phenomenon of memory, all the constructs seemed to build on one overall construct in which memory was approached as an open space in which memories are stored like objects in a room. A person's retrieval of a memory was compared to the action of searching an open space for a specific object.

There are several aspects of the memory research field that are problematic, according to many researchers within the discipline of behavior analysis (Branch, 1977; Fryling & Hayes, 2010; Marr, 1983; Palmer, 1991; Wixted & Gaitan, 2002), and outside of the discipline (Nilsson, 1979; Roediger, 2008; Tulving, 1979; Watkins, 1990; Wright & Watkins,

1987). Tulving (1979) stated that memory research has not yielded satisfactory knowledge, despite the high interest in the phenomena by researchers through the times. The author pointed to a general lack of agreement and consensus among the researchers of the field on what constitutes important research questions and valid findings.

The term memory will itself be topic of discussion below. However, despite that a behavior analyst would claim that the term is little useful, the term is used throughout the text of practical reasons. The term "cognitive psychology" is frequently used throughout the text, and refers to the main part of psychology in which the main areas of interest concern topics as learning, memory and mediating processes. This seems to be an accepted classification of a large part of psychology, because of the common interest in accounting for behavior by studying and explaining mental processes (Costall, 2006). The goal of this paper is to present a behavior analytic approach to memory and to promote benefits of using the discipline's methodology in both experimental and clinical work. In order to do such, differences between cognitive psychology and behavior analysis must be pointed out. The differences between these two disciplines of psychology are not easy or superficial. Hence, a discussion of more foundational aspects of the disciplines is initiated. Examples of both cognitive and behavioral approaches to memory are given. In addition, matching-to-sample (MTS) procedures are presented as an effective tool for experimental analyses of behavior related to memory. Further, MTS-procedures are promoted as beneficial in both assessing and enhancing remembering functions in patients suffering from memory deficit and dementia.

Criticism and Challenges of Memory Research

Challenges and problems will arise in a science consisting of lots on lots of hypothetical explanatory models, and it is often difficult to reject such models (Roediger, 2008; Tulving, 1979, 2002). Watkins (1990) added to this point that one of the reasons

models are seldom rejected is that researchers in large degree are interested in their own constructs before others. Instead of rejection, Tulving (1979) wrote, unsatisfactory theories are changed in manner to fit the data to which they represent until they collapse under their own weight. This makes a hinder in any science, since it impedes efficacy. Nilsson (1979) shared this view, and wrote that the research field of memory at the time had become too vast, with countless theories trying to explain the processes of memory. Nilsson expressed the need for a general theory to explain memory, at the same time as he acknowledged the great challenge of deriving such a theory from such a jungle of theories. As Baddeley (1978) suggested, both Nilsson (1979) and Tulving (1979) acknowledged the promising possibility to analyze the complex phenomenon into smaller and simpler underlying components to understand the bigger whole. However, they addressed a behavioral analysis as unsuitable to account for such complex phenomena, mainly because the behavioral approach was to simple, and would fall short in accounting for complex psychological processes. Morris (1996) noted that different researchers use different constructs and measurement methods to approach their area of interest. However, similarity between the measurement methods and a general absence of a unitary conceptual framework leads to problems when one researcher measures attention and another measures memory with the same measurement tool. The methodological overlap between the areas of attention, memory and executive functions is among the least well-defined and operationalized constructs in the field of psychology; without comprehensive validation of constructs, the confusion will grow (Morris, 1996).

Cognitive theories, models and constructs provide both basis and aim in large parts of contemporary psychology (Chiesa, 1994; C. Lee, 1992). Cognitive theories are mainly based on hypothesizing causes of behavior, and explanatory models are constructed to provide possible explanations. Such explanatory models often consist of hypothetical constructs, which in turn are based on unobserved variables (C. Lee, 1992). A pitfall of basing science on

hypothetical theories and models, is that the theories and models themselves might become the subject matter instead of the observations they are supposed to explain (Sidman, 1994). The number of different hypothetical constructs to account for memory has increased, some more accepted than others (Roediger, 2008; Watkins, 1990; Wixted, 1998). Watkins (1990) offered a sharp critique against the field of memory research. Among the most important points that were made, Watkins stated that mediationism is a true distractor of any science and subject matter, and that the field of memory research is disturbed by such an approach. The theorizing in the field, as Watkins promoted, is going nowhere. Despite the wide selection of theories and the research done to meet and complement them, approximately all of these build on an equal basic theory. That theory emphasizes encoding, retention and retrieval as critical processes to fulfill the function of memory (Watkins, 1990), quite similar to Roediger´s (1979) notion above. These three stages have a central position in psychology as a consequence of mediationism, to which Watkins (1990) referred as the notion that some mechanism of memory bridges past events and present behavior. Later, Watkins (1996) stated that no experimental technique with the goal of exploring the putative physiological substrate of memory processes can yield anything more than hypotheses to psychology.

Branch (1977) commented that a researcher is less likely to make new non-intuitive formulations from data, given that a hypothetical construct was postulated in advance of an experiment. This is related to the fact that explanations are easier to make by adding new properties to an existing hypothetical construct than achieving experimental control by functional analysis. Further, Branch claimed that the functional approach to behavior had done much better than the structural ones, regarding experimental work and application in daily life settings.

Roediger (2008) recognized the problems resulting from the extensive amount of memory theories, and called for a unitary approach to the memory phenomenon. However, he

disagreed with the criticizers claiming that memory research has gone nowhere. In contrast, Roediger stated that the study of memory has yielded a huge amount of knowledge and a robust and increasingly detailed scientific base. By this, the author referred to findings on the topics of repetition, study time, distribution and spacing effects, and forgetting amongst others. The author presented some laws of remembering proposed from early researchers of complex behavior, laws that have vanished as a result of empirical findings. Roediger referred to "law" as an established functional relation, one that endures manipulation of different variables. Such a law is needed in the study of remembering, and should be the aim of experimenters in the field. It is of great importance that researchers continue to manipulate variables that have been found to be controlling in some setting, but possibly not in similar or different settings. This point was also emphasized by Capaldi and Neath (1995). They pointed to several challenges in the memory research field, particularly related to the conditional differences between training and tests within experiments, and how this affected the results. It was argued that the context in which learning occurred was crucial to whether a participant would respond similarly in a similar condition at a later time.

As mentioned, memory has been explained and accounted for by a vast number of constructs and given many names. To state an example, Tulving (2007) listed up all the different names he had found to feature types of memory, and entitled his article "Are there 256 kinds of memory?".

Examples of Cognitive Approaches to Memory

Atkinson and Shiffrin (1968) provided a model to account for the processes related to memory. The model consisted of a sensory register, a short-term store (STS) and a long-term store (LTS). According to the authors, any stimulus presented to a participant is first registered in the sensory register. From there, the information is encoded and transferred to

STS or LTS. In both the sensory register and STS, the information is said to decay. In LTS, however, the information was said to be stored in a more permanent manner. Atkinson and Shiffrin (1971) claimed that the STS metaphor to approach memory was of a rather pivotal kind, since the processes in STS was said to be under the immediate control of the participant, and at the same time controlled the information flow in the memory system. The authors provided an example; various sensory systems accept and process environmental information before it enters into STS. The participant controls the amount of time in which the information stays in STS. While staying in STS, the information may be copied into LTS. After being copied into LTS, the information is probably permanently stored, though the participant might not manage to retrieve the information at later times. As information enters into STS after being processed by visual, auditory, or other kinds of specific modality, related information from LTS also enters STS, independent of as which kind of modality it was processed. STS was also said to have the ability of a working memory, making decisions and solving problems. While retrieval from STS is fast and accurate, retrieval from LTS is far more complicated because of all the information stored there. To explain the retrieval process, Atkinson and Shiffrin (1971) used a library metaphor: Just as a person searches for a book in a library, one search for access to a small subset of the information needed in LTS. First when the book is found, it can be scanned for information; likewise, when a subset that is likely to contain the desired information is found, it can be retrieved into STS and examined. If the participant does not find the right information, a new search is done. When the right information is found, the search is terminated.

Baddeley and Hitch (1974) presented an alternative account for the understanding of memory based on empirical findings that hardly fit the STS-LTS model of Atkinson and Shiffrin (1971). Instead, Baddeley and Hitch (1974) assigned working memory as a more critical component, assuming that a central processor controlled two subsystems; of

respectively auditory (phonemic) and visual short-term storage. This account led to the construction of a much-sited model of working memory consisting of the central executive and it's to slave systems; the phonological loop and the visuospatial sketchpad. As this model encountered some challenges from the research field, Baddeley (2000) introduced the episodic buffer, a new component of the model to account for issues regarding long-term memory, conscious awareness and interaction between the visuospatial sketchpad and the phonological loop (amongst others). According to Baddeley (2003) and Baddeley and Hitch (1974), the model of Atkinson and Shiffrin (1968, 1971) fell short because of limiting aspects regarding learning processes; if STS involved working memory, how could subjects suffering from impaired STS still learn?

Cowan (2008) proposed an alternative model to account for memory, wherein subsets of information stored in long-term memory (LTM) combined with attention-control processes together derives short-term memory (STM). In this model, STM and working-memory is part of the "overall" LTM, and as novel (never before stored) information is processed, this information is managed in an attention-focused part of LTM along with substrates of information from LTM. Cowan´s model proposes more of a unitary-store approach to memory than do Atkinson and Shiffrin (1971) and Baddeley and Hitch (1974).

A contribution by Jonides et al. (2008) presented studies done in the fields of psychology and neuroscience, and after reviewing a good deal of studies, the authors proposed a model based on the findings from the reviewed literature. This model consists of hypothetical elements as well as neuropsychological ones. According to Jonides et al. (2008), findings from the neuropsychological literature strongly suggest that different areas of the brain are critical in acts of memory-processes like encoding and short and long term stores (medial temporal structures), focus of attention (parietal and frontal lobe), retrieval (frontal structures) and more. From the literature of psychological theorizing, Jonides et al. (2008)

concluded that STM and LTM are not separable systems. Further, the authors stated that active representations vary in memory, and that long-term memorized representations is of a dormant kind, dependent of recent perception and retrieval of those representations. Focus of attention is a critical component in different acts, for example retrieving from LTM, encoding from the environment and maintenance. Forgetting is caused by the leave of information from the focus of attention and by the interference of other information entering the attention. In addition forgetting might be caused by decay, a decline of the representation over time (Jonides et al., 2008). As some promote a unitary-store approach to memory (Cowan, 2008; Jonides et al., 2008), a multi-store account is promoted as better suited for such complex phenomena by others (Baddeley, 2003; Repovs & Baddeley, 2006).

A Behavior Analytic Approach to Memory

Skinner (1947, 1953) made it clear that, in order to use scientific methods to account for behavior, we must assume that behavior is lawful and completely determined. To achieve an understanding of behavior, the goal of any behavioral experiment must be prediction and control of behavior, and not confirmation or disconfirmation of hypotheses (Skinner, 1950, 1953). An important characteristic about behavior analytic approaches to any behavioral phenomena, is that one seeks to demonstrate functional relationships between organism's behavior and the environment in which the organism operates (Mahadevan et al., 2002; Palmer, 1991). Therefore, the term memory is problematic itself, because of its reference to something unobservable (Branch, 1977; Palmer, 1991; Watkins, 1990). Palmer (1991) stated that the term "usurps the role of explanation and impedes the search for controlling variables for current behavior" (p. 261). Roediger (2008) agreed that memory is probably an unfortunate term, standing as a label for too many different constructs and metaphors. The

consequence is, as pointed out by the author, that psychology suffers from a lack of uniform approach to the phenomenon.

Mahadevan et al. (2002) wrote that an important distinction between a behavior analytic and a cognitive approach to memory is that the latter emphasizes ordinary-language categories. Memory is such a category (along with e.g. attention, motivation, perception and many others). A problem is likely to arise when expressions of everyday language is taken into explanations to account for the unobserved unknown (Marr, 1983). Marr (1983) compared viewpoints from cognitive and behavior analytic approaches to complex phenomena and stated that the different disciplines do have similarities in their interpretations. However, the critical difference appears when experimenters of the former search for and create an internal agent or mediator to account for unobservable processes causing the target behavior. Such an approach to account for behavior has been rejected in the field of behavior analysis (Skinner, 1953).

As use of the term memory offers some unnecessary challenges, as mentioned above, many authors instead use the term remembering because of its reference to a behavioral activity (e.g. Marr, 1984; Palmer, 1991; White, 2013). Palmer (1991) provided an account of how behavior analytic principles can be conducted to understand the behavior of remembering. Like the author stated, a behavior analyst has no tools to study memory. He can only study behavior and the variables controlling it. Despite the aim of prediction and control in behavior analytic research, interpretation is by all means necessary when it comes to describing complex behaviors, since the subject matter is unobserved. It is relevant to mention the difference between unobserved and unobservable, of which the latter term refers to something that is not possible to observe, and the former refers to something not yet possible to measure because of limitations due to technology. However, it was claimed that the strong principles on which behavior analysis is standing, build a good foundation on which one can

make valid interpretations (Donahoe & Palmer, 1994; Palmer, 1991). This point is of importance and distinguishes behavior analysis from cognitive psychology. As Donahoe (2004) stated, interpretations to account for complex behavior in the behavior analytic tradition are based on experimental analyses of environment-behavior relations. In cognitive psychology, interpretations are made that are based on the complex behavior itself. Palmer (1991) stressed that an interpretational appeal is not the same as opening up for mentalistic explanations or hypothesizing novel principles (mentalism is emphasized below). As the subject matter in behavior analysis is a relation between environment and the behavior of an organism, covert behavior is not different from overt behavior, other than that it is unobserved.

Donahoe and Palmer (1994) distinguish between reminding and remembering. The former refers to instances where environmental stimuli elicit specific thoughts, feelings or other covert behavior. In this case the response emitted was under control of the eliciting stimulus. The latter involves more initiative from the individual in focus, as referred to above. For example, when a person looks at an old picture of his school class, he might have problems coming up with the names of some of the old classmates on the picture. The person might run through the alphabet to come up with the correct name, and suddenly he spells it out. In cases like these, the picture was not a sufficient stimulus to elicit the response. Instead, the picture elicited remembering behavior that in the end occasioned the classmate's name. Such behavior can be referred to as precurrent behavior (Palmer, 1991). Palmer (1991) wrote that an individual must engage in precurrent behavior if the target response is part of the repertoire without being directly controlled by the primary discriminative stimulus. In the example, the individual provided himself with supplementary stimuli until the supplementary stimuli and the picture stimulus together occasioned the target response. The author provided another example: when solving a complicated mathematical problem "in the head", the

individual actually split the problem into smaller solvable problems, so that a chain of operants, in which each of the operants serves as a controlling variable for the subsequent ones, leads to the target response (for a description of an operant, see next section). Cooper, Heron, and Heward (2007) pointed out that the environment in behavior analysis includes stimuli outside of the body (surroundings, sounds, smells etc.) and inside the body (feelings, thoughts, pain etc.). When an individual emit precurrent behavior, the individual's present environment is altered in fashion to produce stimuli that together with other discriminative stimuli evoke target behavior.

Baum (2005) stated that remembering is no different than other behaviors, and that the invention of complexes to describe any behaviors is unnecessary. Stimulus control of behavior is evident when a stimulus affects behavior in any way, and a contingency analysis of antecedent, behavior and consequence is the preferable analysis to study relationships between behaving subject and controlling variables (McIlvane, Dube, & Callahan, 1996). Baum (2005) and Donahoe and Palmer (1994) provided examples of the problems of storage and retrieval in that we never speak of dogs retrieving a salivary response when hearing a tone. "Retrieving" implies that some willful agent performs an activity of retrieval to mediate a response, and excludes the interaction between the environment and the organism´s behavior. In addition, a storage metaphor is often conducted when the time interval between controlling stimulus and response emission is larger than some value, a memory is stored and retrieved at a later time. However, when the time interval is shorter than some value, the response emitted is said to be something other than retrieved. The point made is that there is no reason to distinguish between the former and the latter. In acts of remembering, the main clue is that there exist a temporal distance between the behavior of interest and the variables controlling it (White, 2013).

Mentalism refers to instances in which behavior is accounted for by appealing to inner causes. The field of psychology is rich on mentalistic approaches and explanations. A mentalistic explanation, however, explains nothing (Moore, 2003a; Overskeid, 2008; Skinner, 1974). Category-mistakes refer to another aspect said to concern the shortcomings of psychology (Holth, 2001). A category-mistake is made when a member of a logical category is conceived of as a member of a sub-category. One example can be the verbal statement: ”look at all the beautiful guitars, drums and instruments”. In this case, guitars and drums are members of a category subordinate to instruments, yet they are spoken of as members of the same category. As Ryle (2009) put it, a category-mistake assign facts of mental life to the belonging of specific types or categories, when they in reality belong to others. The author pointed to a view in psychology compatible with the dualism of Descartes, the distinction between mental and physical dimensions, of which both acted as causal agents. Dualistic approaches are common in contemporary psychology (Holth, 2001; Moore, 2003a).

Variation, Selection and Retention

Donahoe (2003) emphasized selectionism as the general approach to account for complex phenomena. It was made clear that the three steps of selection; namely variation, selection and retention, are sufficient to understand how complex phenomena come about. As Donahoe wrote, variation serves as the source of novelty emerging through repeated cycles of the three-step process. The act of selection can only occur on pre-existing entities. Retention refers to the endurance of certain selected variations that in turn provides a source for future variations to be selected. Whether complexity is to evolve or not depends on the processes of variation, selection and retention. The three steps are inter-dependent, and as the environment operates in the selection of species (also referred to as phylogenic selection), selection of behavior by reinforcement (often referred to as ontogenic or operant selection) is acted upon

the organism by variables in the environment. During selection, the environment favors some characteristics before others. In the case of behavioral selection, an organism's behavior is determined by the present environment's action on the products of past selections (Donahoe & Palmer, 1994). This means that what is selected is a relation between behavior and environment. Any change in stimulus conditions in an organism's environment, that alters the probability that a similar response will be emitted again in the future, is referred to as reinforcement (increase or maintenance in probability) or punishment (decrease in probability). An operant refers to a class of topographically similar responses controlled by the similar environmental consequences, a class of responses (Catania, 2007).

On a neural level, the unit of selection is different connections between receptors and muscles. Like Donahoe and Palmer (1994) promoted, the pitfall of confusing "a memory" with a single response is avoided by such an account. Despite similar topographies, different responses can be under the control of multiple environment-behavior relations. For example, the responses of shouting "water" when the house is on fire or shouting "water" when one is aching to take a dive in the heat, and suddenly spots a lake, might be almost identical in topography. However, they are under the control of different stimuli, ergo different environment-behavior relations have been selected in the past. Further, a neural account replaces "the memory" with a pattern of activation in a neural network. When this exact pattern is not present, "the memory" does not exist. Environmental conditions are critical to which degree different neural network patterns are activated or changed. Jonides et al. (2008) presented a good deal of neuropsychological findings that assigned different areas of the brain as critical to perform different types of memory tasks, as mentioned above. Fryling and Hayes (2010), however, stated that such biological events have never been observed to store, recall or remember the past. Thus, the environment is crucial in any complete analysis of behavior.

Behavior Analysis and Cognitive Psychology

As Moore (2003b) put it, most supporters of behavior analysis are aware of the differences between their field and cognitive psychology. This is probably also true from the cognitive scientist's point of view. Subject matter and scientific aims differ in a quite thorough way, although the commitment to scientific method is a common aspect of both disciplines (Chiesa, 1994). According to Chiesa (1994), mainstream experimental psychology is a discipline in which it seems like the only plausible methodology is the hypothetico-deductive one. As Chiesa noted, sciences of biology, chemistry and physics have successfully progressed by the conduct of hypothetico-deductive method. Psychology, however, lacks precise measurement techniques and a solid conceptual system, and thus suffers from a database of great diversity. In psychology, then, it is difficult to compare empirical outcomes with theoretical elements. Hypothetical deduction is much about confirming or disconfirming hypotheses, and in a science in which hypothetical constructs are an important element of describing complex phenomena; challenges arise. Hypothetical deduction is one out of two schools concerning the effective systematization of data, and the counteract to hypothetical deduction is induction. The method of induction is conducted by radical behaviorists and means that research is empirically driven; based on data, not hypotheses. In addition, induction involves reasoning from observed instances into general laws (Chiesa, 1994; Sidman, 1960).

An important distinction between hypothetical deduction and induction concerns how theory is explained. With the inductive understanding of theory, researchers within behavior analysis are much concerned with establishing a theory of behavior. That said, it is the nature of theory that is the subject of debate between the two disciplines, and not whether theory is necessary or not (Burgos, 2007). Skinner (1947) wrote that theory is crucial to the scientific understanding of behavior. In addition, he stated that theories "are statements about

organizations of facts…they have a generality which transcends particular facts and gives them a wider usefulness" (p. 28). At the same time as promoting an inductive approach to theory, the author recognized that experimental psychology was subject to a theoretical chaos. However, the essential goal of experimental psychology is a satisfactory theory of behavior. Supplementing this, Sidman wrote; "It is the job of science to find orderly relations among phenomena, not differences" (1960, p. 15). By this, the author referred to the importance of generating findings of generality. Only by replication of instances of experimental control over behavior by manipulating independent variables, are researchers able to establish a theory of behavior. In addition, the author promoted the importance of integrating findings from different areas of research. With a consensus on subject matter and methodology within a science, such integration is more likely to find place.

Like Donahoe and Palmer (1994) wrote, hypothetical theories and explanatory models based on inferred processes are in fact explanatory fictions. They make no existential claims, but are made to serve as fruitful guidelines to future research. C. Lee (1992) added that such models are unscientific, but despite their lack of ability to explain behavior, they can provide useful metaphors to describe behavior. In the end, the use of hypothetical constructs increases the likeliness that the researcher will be distracted from focusing on actual behavior. Hence, such hypotheses might lead to reasoning that in the end has no relation to the data from which it is derived (Sidman, 1960). When control of an organism's behavior is achieved, any hypothetical theory to explain that behavior is worthless (Skinner, 1956).

As pointed out in the beginning of this section, there are some fundamental distinctions between the fields of behavior analysis and cognitive psychology. The methodologies applied involve completely different uses of theory, that in turn lead to different requirements of what is to be regarded as a satisfactory science. In behavior analytic experiments, prediction and control of behavior is the goal. In cognitive sciences, a

correlation between hypothesis and results is often satisfactory. This distinction has long been evident in psychology (Cronbach, 1957). However, correlational studies are often synonymous with unscientific studies (Shadish, Cook, & Campbell, 2002).

According to some, the discipline of cognitive psychology lacks a subject matter and unity (Chiesa, 1994; V. Lee, 1988; Skinner, 1987). V. Lee (1988) referred to this topic as a fundamental problem in psychology, one that has endured for a century despite many a psychologist stressing the importance of harnessing this great diversity of subject matters. A split between behavior-environment relations and cognitive processes, and branches of these, constitute the main topic of disagreement on what should be the subject matter of psychology.

Radical behaviorism involves some criticism of the mainstream traditions in cognitive psychology, in addition to the lack of subject matter. For example, some state that cognitive psychology consists in large degree of understandings based on category mistakes (Holth, 2001; Ryle, 2009) and explanatory fictions (Donahoe & Palmer, 1994). In addition it is stated that cognitive psychology has a mechanistic approach to behavior (Hayes & Brownstein, 1986; Moore, 2003b) and has much in common with “folk-psychology” (Moore, 2001; O'Donahue, Callaghan, & Ruckstuhl, 1998). The two latter criticisms are based on the fact that most of the cognitive accounts for behavior structuralize human behavior by using different metaphors. Quite often, in the same sense as computers consists of processors and memory, behavioral characteristics are given the abilities of storage and processing. Behavior is accounted for by designing a structure with different components, and this structure is used to explain behavior, without analyzing other variables than the behavior itself. This is an example of mechanism (Hayes & Brownstein, 1986). What is meant by “much in common with folk-psychology” is that cognitive psychology consists of a terminology that is largely based on everyday language, and hence consists of many concepts and beliefs that invite for mentalistic inferences (O'Donahue et al., 1998). Memory is an example of such concepts.

An obvious reason for the kind of critique listed above is because of the great tends to conduct hypothetical constructs by inferring inner processes as mediators of behavior. In addition the discipline consists of almost countless theories to account for the same matters, thus a great diversity of psychological understanding within the field is derived. Wessels (1981) stated that the aim of cognitive psychology is to explain behavior by specifying a conceptual system of universal, internal structures and processes, and that it is through these that the environment affects the subject. However, there are numerous suggestions of what is the actual subject matter of cognitive psychology (Holth, 2001; V. Lee, 1988; O'Donahue et al., 1998; Overskeid, 2008). It is important to mention that the field of behavior analysis and behaviorism is also an arena for discussions and disagreements on a wide range of topics (Marr, 2003).

In behavior analysis, an explanation refers directly to prediction and control (Hayes & Brownstein, 1986; Skinner, 1953). Put another way, "causal explanations are given in terms of interactive relations between person and environment, and both behavior and environment are broadly defined" (Chiesa, 1994, p. 99). Thus, the absence of control prevents any explanation of phenomena. To achieve control, behavior analytic studies conduct single subject designs in a large degree. As Sidman (1960) pointed out, a large group of subjects in an experiment, followed by statistical analysis, is not the way of producing data of generality. Mean and standard deviation are common to statistical analysis, but tells little about the actual measures of the individual subjects. Possibly, only one third of the subjects actually yielded mean values. A counterpart to statistical analysis, and an important characteristic of behavior analytic studies is the single-case design, in which the subjects serve as their own control (Lattal, 2013; Perone & Hursh, 2013). Single-case designs might be arranged in a variety of ways, and is advantageous in defending internal validity (Kazdin, 2011; Perone & Hursh, 2013). As Perone and Hursh (2013) wrote, internal validity is prerequisite to extern validity,

which concerns the generality of findings. Generality of data is of great importance, and refers to the consistency of findings through direct and systematic replications. To achieve generality of findings, the use of single-case designs prove a good foundation. An experimental single-case design is most often conducted on a limited number of participants, and leaves open the possibility that effects seen might be restricted to the participant in focus. If an effect is observed, the researcher cannot conclude that the effect is of generality across persons, unless earlier studies have yielded the same effects. It is first when replications of findings are made across different dimensions, like species, settings, target groups or other variables, that generality is to speak of as an actuality (Branch & Pennypacker, 2013; Sidman, 1960).

There are consensus among researchers from a behavior analytic standpoint that the tradition has a lot to offer for psychology as a whole, concerning philosophy and methodology. However, serious challenges are met when it comes to acceptance from psychologists of other disciplines. As Marr (1984) wrote, two important reasons for this is that behavior analysis is conceptually difficult, in addition the discipline is contradictory to parts of the earlier established psychological philosophy.

As Dougher (1995) pointed out, a discussion of whether the analysis of behavior or the cognitive approach to behavior is the better one, will be in vain. The author noted that different units of analysis, objectives, views of causation and criteria for explanation distinguish these disciplines of psychology. The fact that a cognitivist conceive of inner processes as subject matter and of inner mediators as determinants, and is satisfied with an explanation based on a result that correlated with one's prediction, makes the cognitive paradigm so fundamentally different from the behavior analytic one that it would fall short to contest them in any way.

A Functional Approach to "Memory" in Clinical Settings

Many of the differences between the two disciplines emphasized exist also in the realm of clinical treatment. Overskeid (2008) claimed that the functional approach of behavior analysis to important problems regarding human welfare is more accepted today, than for only a decade ago. Different disciplines (e.g. neuropsychology, social psychology) have opened up more for an approach that involves the environment in their experimental analyses, and in clinical settings. Fryling (2013), however, noted the distinction from mainstream focuses to applied as well as experimental behavior analytic work, namely the rejection of mentalistic explanations, and added that behavior analysts is assumingly the only professionals in the world of health and care workers that take such a stand. Hopefully, Overskeid's (2008) claims apply to the researchers of memory as well as other important fields.

Regarding how to treat and understand types of memory deficit, there are disagreements. Carlesimo and Oscar-Berman (1992) wrote: "…linguistic, attentional and visuoperceptual deficits, as well as impairments in abstract reasoning, can prevent the normal processing of information, thereby interfering with efficient encoding and retrieval processes" (p. 120). This was written in the context of how a theoretical account of memory disorders in people with Alzheimer's disease was to be approached. Germano and Kinsella (2005) promoted benefits of applying the working memory model in the neuropsychological analysis of deficits in people with early Alzheimer's disease, and noted that an advantage with the working memory model is that it can be tested empirically. The authors noted a growing support for the view that deficits in acquisition of new information is common to Alzheimer's patients on an early stage, though there are disagreements on how the processes of retention and retrieval are affected.

Germano and Kinsella (2005) also stated the importance of identifying Alzheimer's patients' deficits and intact cognitive abilities, to increase the basis on which remediation can be done. Sidman (2013) supported this point, but provided other techniques to assess Alzheimer's patients functioning than mentalistic approaches. Instead of different recall tests which is common to assess function of so-called STM and the like (Capaldi & Neath, 1995; Germano & Kinsella, 2005; Roediger, 2008), Sidman (2013) proposed to present a task in a variety of ways regarding the same information. In an example, Sidman presents a father who cannot come up with his daughter's name. To assess to which degree he remembers her, a picture of her is shown, and he is asked "who is this". If he cannot answer this question, a new task can be presented, by showing him several pictures and ask him to point at "daughter's name". Or how about selecting his daughter's spoken name from several others, or selecting her written name from several others? As Sidman stated, by arranging such matching-to-sample (MTS) tasks, one is testing for equivalence relations. By uncovering fractured or intact stimulus and response classes, the base on which effective treatment can be made is more solid. A stimulus equivalence class involves at least three members that equally control a response. In Sidman's example, an intact equivalence class could consist of stimuli such as daughter's face, different photos of the daughter, her written name, her spoken name, special objects associated with the daughter and so on. However, to be part of the same class, all these stimuli must exert control over the same operant, and be equally substitutable for each other. In addition, to fulfill the requirements of an equivalence relation, each relation in the class must have the properties of reflexivity, symmetry and transitivity (Green & Saunders, 1998; Sidman, 1994).

MTS procedures are one possibility of arranging for conditional discrimination, and common in research regarding stimulus equivalence. An MTS procedure is conducted by exposing a participant of a sample stimulus. After either a response or the lapse of a temporal

interval, a number of comparisons are presented to the participant. One of these are defined as correct, either identical to the sample stimulus (identity MTS) or not (arbitrary MTS). The sample and comparison stimuli might be visible to the participant at the same time, (simultaneous discrimination) or the sample stimulus may disappear for *n* seconds before comparison stimuli appear (successive discrimination). The latter constitutes a delayed matching-to sample procedure (Arntzen, 2006; Cumming & Berryman, 1965).

Conditional discrimination has been used in a variety of clinical and applied settings, for example in establishing reading skills (Sidman, 1971), mathematics and geography skills Hall, DeBernadis, and Reiss (2006) and intraverbals (Peréz-González, Herszlikowicz, & Williams, 2008).

It has been proposed that MTS procedures can be used to study remembering, by arranging delayed matching-to-sample (DMTS) tasks (Arntzen, 2006; Steingrimsdottir & Arntzen, 2011b). Dementia is a diagnosis carried by a rapidly increasing population (Buchanan, Christensen, & Houlihan, 2011), and many of the problems encountered with these diagnoses are due to deficits in so-called memory. Hence, the importance of finding efficacious treatments for this group is obvious. Buchanan et al. (2011) called for behavioral interventions with the aim of rehabilitation of people with dementia, and referred to a growing body of research in favor of this aim. Conditional discrimination procedures seem apt to contribute to this target group. It is proposed that MTS procedures are useful in training functional skills, both for maintenance of established skills and in acquiring new ones (Steingrimsdottir & Arntzen, 2011a). In addition to treatment techniques, investigators state that MTS procedures are applicable in assessing state and progression of dementia and medical effects (Fowler, Saling, Conway, Semple, & Louis, 1997; Gallagher & Keenan, 2009; Steingrimsdottir & Arntzen, 2011a). Gallagher and Keenan (2009) found a high correlation between scores from stimulus equivalence tests and scores from The Mini Mental Status

Examination (MMSE), which is a common shorthand assessment for cognitive functions in the elderly. However, results from equivalence tests indicated more sensitivity to higher functioning patients than the MMSE. Thus, MTS, was suggested as a diagnostic tool for assessing higher cognitive functioning.

Like in any instance of behavior analytic work, a functional approach to behavior is advocated. In the second part of the present thesis, studies are presented that point in a promising way for behavioral treatment of people with dementia. MTS procedures have been conducted in different ways, both in basic and applied research and is highlighted here because of its applicability when it comes to training skills related to remembering as well as other functional skills. The results from the experiment in Part 2 of this thesis support this statement. Conditional discrimination procedures, then, seem beneficial in both exploring remembering and in treatment of people suffering from fractured ability to remember. As pointed out by Steingrimsdottir and Arntzen (2011a), conditional discrimination procedures with people with dementia are still on an early stage, but the findings are promising, and the possibilities for application and study are many.

Summary and Conclusion

As Dougher (1995) promoted, any effort to contest cognitive psychology and behavior analysis would be a vain struggle. However, the two disciplines could make use of each other. Behavior analysis provides a functional account of behavior, in both experimental and applied work, and the beneficial gains from this is that findings are completely based on observations of behavior-environment relations. In addition, by a functional rather than a mechanistic approach to behavior, the possibilities to discover unforeseen relations and effects are better.

As cognitive researchers talk of different levels of encoding, behavior analysts speak of selection of relations between environment and behavior. The latter invites for a more

economic way of describing observations, as well as no postulates about unobservable or non-existing entities are made. Further, instead of claiming that a person retrieves memories from storage, a behavior analyst would claim that the person's behavior is under control of specific or multiple stimuli in the environment. In instances of remembering, the person emits precurrent behavior to produce sufficient discriminative stimuli for occasioning the target response.

The aim of this paper was to present a behavior analytic approach to memory and the benefits of this account. The highlighting of the two disciplines and the foundational differences between them is not novel in any way, but it is as relevant today as it was in the times of the so-called cognitive revolution and before to make them objects for analysis and debate.

Behavior analytic procedures in different forms of MTS have shown to be of beneficial value in clinical settings. Recently, behavior analytic research has pointed in a promising direction for treatments of dementia, a diagnosis especially associated with memory deficit. The findings suggest that by using different MTS procedures, one can maintain levels of functioning in patients with dementia, as well as assessing medical effects and progression of the disease. The findings from the experiment in Part 2 of this thesis strongly suggest that DMTS can be used to train names on persons close to the patient.

Behavior analysis is based on principles derived from an extensive amount of experimental and applied research, and thus consists of a solid technology of procedures applicable across a wide range of settings and target groups.

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Effects of Morphing on Conditional Discrimination Training in a Patient with Dementia

Lars Strandbakken

Oslo and Akershus University College

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Abstract

A delayed matching-to-sample procedure was conducted to train names of health care staff in a participant with unspecified dementia. After baseline assessments of the participant's skills in naming three of her healthcare staff and two sessions of conditional discrimination training, a morphing procedure was initiated to increase the effectiveness of the conditional discrimination training. The participant was exposed to training of three 3-member classes, consisting of dictated name, picture and written name of caregiver. The two latter stimuli were morphed (put together in one stimulus) and arranged in a morphing hierarchy with the goal of removing the written name completely from the morphed stimulus. As the participant mastered initial steps of morphing, she moved one step up in the hierarchy. The results indicate that the morphing procedure had a substantial impact on the participant's responding, and thus, that morphing techniques might be beneficial in applied settings in which conditional discrimination are used. The participant's correct responding increased significantly throughout the experiment, and she mastered the last step of morphing in which the written name was totally absent. However, when exposed to tests for equivalence and symmetry, she responded in accordance to chance. In a follow-up training session she responded 77,7% correct. Directions for further research are suggested.

Keywords: conditional discrimination, morphing, dementia, delayed matching-to-sample, picture–name relation

People with dementia experience a wide range of difficulties, and many of these problems are due to memory deficit. Social isolation, communication difficulties, a general loss of control of one's life situation is common (Buchanan, Christensen, & Houlihan, 2011; Judd, Harrison, & Weatherhead, 2011; Turner & Mathews, 2013). Interventions with the goal of helping with memory difficulties might reduce the incidence of such symptoms (Clare & Woods, 2004). Therefore, scientific contributions to explore new methods for rehabilitation or maintenance of important self-care behavior (including skills related to memory) should be worth the while for the patient, the patient's family and the society as a whole. Sidman (2013) clarified his view on the importance of a quantitative methodological approach to remembering and forgetting, and underlined the beneficial possibilities for the understanding and treatment of Alzheimer's disease.

Patients diagnosed with dementia are increasing in number, and with the rapidly aging population, Buchanan et al. (2011) predicted a doubling of the group during the next 20 years. Despite this, the authors point at a lack of both pharmacological and behavioral treatments available. Further, the authors stressed the importance of behavioral intervention with the goals of rehabilitation, and not limited to the stabilization of the disease's progression which is often the case concerning the patient group. Supporting this view, Turner and Mathews (2013) pointed out the lack of research focusing on increasing the capacity of patients to interact with their environments, despite the good deal of research done focusing on the *need* to increase patients' engagement with their environment. In addition, Trahan, Kahng, Fisher, and Hausmann (2011) reported a lack of behavior analytic research concerning people with dementia with some exceptions. However, Buchanan et al. (2011) referred to a growing body of empirical support for interventions focusing on improving and maintaining skills like verbal communication, self-care and short-term memory.

Buchanan et al. (2011) suggested that future treatment of patients with dementia should consist of rehabilitation that targets the following areas: "memory enhancement, altering social contingencies and communication styles, improving self-care skills, the arrangement of physical environments to maintain and improve functioning, and increasing physical fitness/physical activity" (p. 11). Livingston, Johnston, Katona, Paton, and Lyketsos (2005) concluded with their meta analysis that behavioral management techniques on individual patients are generally the most effective approach for reducing neuropsychiatric symptoms over time, in patients with dementia. However, since a great part of the studies they examined was in some degree poorly conducted, they promote the need for more experimental studies on the field.

The degree of relevance between behaviorally oriented rehabilitation and the research field of conditional discrimination appears to be high. A behavior analytic approach seems to yield important contributions in the form of matching to sample (MTS) protocols to promote derived relations as well as training what is commonly called short-term memory (Arntzen, 2006; Steingrimsdottir & Arntzen, 2011c). MTS procedures consist of arbitrary or identity matching. In identity MTS the experimenter-defined correct comparison stimulus is identical to the sample stimuls. Identity between sample and comparison stimuli is absent during arbitrary MTS (Green & Saunders, 1998). A great deal of research has been done on delayed matching to sample (DMTS), and involves inserting a delay of *n* seconds between sample stimulus offset and comparison stimulus onset (Arntzen, 2006; Cumming & Berryman, 1965).

By using DMTS procedures, Steingrimsdottir and Arntzen (2011a) stated that patients diagnosed with dementia can train and maintain functional skills related to tasks of memory. The latter can be done by gradually increasing the delay between a sample stimulus and the comparison stimuli. Steingrimsdottir and Arntzen (2011a) also claimed that MTS protocols can provide as a helpful tool to assess current state and progression of dementia and related

diseases. This statement supports findings from Fowler, Saling, Conway, Semple, and Louis (1997), indicating MTS as an effective tool in assessing dementia at early stages. Gallagher and Keenan (2009) reported a high correlation between scores from the Mini Mental Status Examination (MMSE) and results from a stimulus equivalence test. This indicates that conditional discrimination procedures might contribute as a tool for assessing levels of function in patients with dementia and other related diagnoses. MMSE (Folstein, Folstein, & McHugh, 1975) is the assessment tool most commonly used for these purposes. It is easy to administer and quick to perform. However, it has received some critics; Tombaugh and McIntyre (1992) concludes in their review that the MMSE fails when it comes to assess dementia in an early stage. In addition, the authors claim that the tool is insensitive to progressive changes in severe Alzheimer's disease.

There are currently no possibilities of reversing the progression of dementia, but it has been shown that behavioral interventions have temporarily improved ability to remember, for example by "spaced retrieval" and tasks related to "errorless learning" (Buchanan et al., 2011). Spaced retrieval consists of exposing the subject for a remembering task and then increase gradually the time-interval during which the information has to be remembered. This is related to delay-titration in DMTS research (Cumming & Berryman, 1965). Errorless learning consists of different techniques solely based on stimulus control shaping, for example as presented by Cooper, Heron, and Heward (2007).

Morphing involves gradually changing one stimulus into another by manipulating elements in the stimulus. It has been conducted in different ways, for example as done by Arntzen, Narley, and Steingrimsdottir (2013) and Fields and Moss (2008). Lattal (2013) presents differential reinforcement of successive approximations; this procedure is highly compatible with a morphing technique. The same applies to stimulus control shaping (McIlvane, 2013; McIlvane & Dube, 1992) and prompt-fading (Smith, 2001). It seems

reasonable to assume that similar procedures would contribute to conditional discrimination tasks as well.

Steingrimsdottir and Arntzen (2011c) used conditional discrimination to study remembering in a patient with Alzheimer's disease, which is the most common type of dementia, according to Judd et al. (2011). The subject in Steingrimsdottir and Arntzen (2011c) went through arbitrary and identity MTS, and responded correctly on the identity matching. In later conditions the subject were exposed to DMTS, where she responded correctly on 0s, 3s, 6s and 9s delays. The subject showed a Mini Mental Status Examination (MMSE) score of 20 out of 30 points. In addition, the authors suggested that DMTS procedures might be used to examine effects of drugs on patients with Alzheimer's disease. They also pointed to indications that conditional discrimination might work well in evaluation of complex behavior like concept formation in patients diagnosed with dementia.

In another study from the same authors (Steingrimsdottir & Arntzen, 2011b), the effects of a delay and of varying the number of comparison stimuli was explored in a patient with Alzheimer's. The participant scored 10 on the MMSE. The results show quite clear indications that decreasing number of comparison stimuli from three to two yielded more correct responses, and inserting a 0s delay between sample and comparison stimulus lead to more incorrect responding.

In Arntzen, Steingrimsdottir, and Brogård Antonsen (2013), the participant, a patient with Alzheimer's disease was exposed to different delays. She responded in accordance with identity MTS with a 10 s delay and with three stimulus classes. However she did not master a 12 s delay. In a second experiment she was exposed to a titrating DMTS procedure to explore to which degree the delay could be increased further than 10 s along with responding in accordance with identity MTS. The results shows that the titrating delay reached 12,25 s, but without any stable responding at any titration step.

According to Steingrimsdottir and Arntzen (2011a), there are few studies conducted exploring stimulus equivalence and patients diagnosed with dementia. There are findings, however, showing that elderly people are less likely to respond in accordance to stimulus equivalence, compared to younger people (Pérez-González & Moreno-Sierra, 1999; Saunders, Chaney, & Marquis, 2005; Wilson & Milan, 1995).

The findings of Steingrimsdottir and Arntzen (2011c) indicate that conditional discrimination procedures are applicable and probably useful for the purpose of training names. The results from Cowley, Green, and Braunling-McMorrow (1992) supports this indication. Cowley et al. (1992) employed conditional discrimination procedures to train names of staff with three adult males with acquired brain injury. Sidman (1971) managed to establish reading comprehension in a 17 year old boy with severe mental retardation, by using conditional discrimination training. This involved that the boy taught to name and match pictures and words, and he selected correct pictures and words when the experimenter dictated them. Sidman and Cresson (1973) managed to produce similar results with two boys with Down's syndrome. In the latter study, the authors promoted the benefits of MTS procedures, in which a computer is sufficient to expose the participant to training trials.

Plaza, López-Crespo, Antúnez, Fuentes, and Estévez (2012) showed that the use of a delayed matching to sample procedure might function as an effective tool in training face recognition with Alzheimer's patients. The authors stressed the importance of future research on areas of maintenance skills in patients with memory disorders, and suggest matching to sample procedures to train or establish names of family members, functions of different items found in the bathroom and how to use them (which is often skills that decline in patients with dementia), and the like.

The purpose of the present study was (a) to establish name – face relations of three caregivers in a patient with dementia by using a MTS procedure, and (b) to explore if the use of morphing could work as an effective tool to establish conditional discriminations.

Method

Participant

The participant, Anna, was a 61 years old woman diagnosed with unspecified dementia and organic personality disorder. These diagnoses were a result of an infection in the brain by the virus Herpes Simplex Encephalitis. At the time of the experiment she scored 17 out of 30 on the Norwegian revised Mini Mental Status Examination test (MMSE-NR), which indicates moderate cognitive impairment. In a neuropsychological examination, it is reported that she had serious memory difficulties and minor impairment in working memory. She lived at a residential care facility consisting of 6 residents including Anna. Health care staff was available through day and evening shifts, and Anna received help at a scheduled basis throughout the day. During night one staff was at the facility, resting. Two days a week, Anna went to an activity center where she performed different suitable tasks and socializing. According to Anna's staff she mastered activities of daily living (ADL) such as performing personal hygiene and washing the dishes. However, she had difficulties starting activities and ending ongoing activities. Therefore, much of the help Anna received from the staff was different forms of verbal prompts for starting or ending an activity (e.g. brushing teeth, vacuum cleaning). With activities like this, where it is not necessarily any obvious stimuli telling when one is finished, she could just go on. She was always with staff when doing activities outside of her apartment; this was to ensure she would find her way back home. Anna was familiar with computers and used one every day, mainly for playing solitaire.

Apparatus and Setting

The touch screen used in the experiment was an LG T1710B. An HP Elitebook 8760w, Intel Core i7-2820QM was used to run the procedure. The software used to morph the stimuli was FantaMorph Deluxe 5 (version 5.4.1) and is publically available. Match-To-Sample, made by Cognitive Science Partner in collaboration with professor Erik Arntzen, was the program used during the experiment. There was also made use of a portable stereo speaker of the type Music Angel Friendz, model JH-MD04E2.

All experimental sessions were conducted in a small and unused room at the care facility. The room measured 176 x 276 cm, and was placed in the same corridor as Anna's apartment, about 10 meters from her door. There were no windows in the room, which was not considered problematic since the sessions where rather short. The originally white walls in the room were worn, and so was the dark floor. A lamp in the roof lit up the room. The furniture in the room consisted of a wooden desk (80 x 145 cm), an office chair and a wooden chair. The desk was placed in the left corner of the room, and the participant would sit on the office chair on the left half of the desk during the experimental sessions. The touch screen was placed in front of her and the speaker was placed out of view behind the touch screen. A partition installed on the middle of the desk blocked the participants view to the right side of the desk. The experimenters' computer was set at the right end of the desk, almost shut with the screen pointing away from the participant. The wooden chair was placed on the short right side of the desk. The door to the room was behind the participant during experimentation, and was closed up but not completely during each session, mainly for the experimenter to hear if Anna would call for assistance of some sort. Since there were no windows in the room, it was also considered ethical to not shut the door entirely.

Procedure

In each of the conditions the computer was set to present a sample stimulus on the screen. Then three comparison stimuli appeared in three random corners of the screen. After the participants touch to one of the comparisons, the stimuli disappeared, and a programmed consequence, a text promoting whether the response was correct or incorrect, was shown on the middle of the screen.

Stimuli

The aim of the experiment was to establish three 3-member classes; (a) dictated name, (b) written name, and (c) picture of caregiver's face taken from front. The pictures were edited so that they showed the caregivers face from neck to top on a white background (See figure 1).

When an auditory sample stimulus was presented, three comparison stimuli appeared in three of four corners on the screen, and a speaker symbol was shown in the middle of the screen. When a comparison stimulus was selected, the screen turned all white, and a programmed consequence appeared, telling whether the participant made a correct or incorrect response. The programmed consequences to correct responses consisted of single words such as "correct", "super", "good", "fantastic" and the like. These appeared on a random schedule. If Anna made an incorrect response, the consequence "try again" appeared on the screen. The number of correct responses so far in the session was shown in the lower right corner during the programmed consequences of correct responses. The programmed consequence lasted for 1500ms. An inter-trial interval (ITI), 500ms, would pass before the next trial was presented.

The touch-area, the area including the stimulus and some space on each side of it, was equal in all stimuli; 5,1 x 5,1 cm. However, the size of the picture stimuli varied somewhat,

because of different styles of hair and face shapes. All the images were 5,1 cm high, and the narrowest picture was 4,5 cm broad. The width of the three text stimuli (written name) varied from 4, 4 to 2,6 cm. Two of the stimuli were 1,2 cm high, the third one measured 1,1 cm. The size of the speaker symbol was 5,1 x 4,6 cm. The diagonal length between two comparison stimuli measured 35 cm, and the vertical distance between stimuli was 22,5 cm. Horizontally, the length between stimuli was 28 cm. All measurements were made with the centers of the stimuli as starting and ending points.

Anna was exposed to programmed instructions at start of each training session. The short introductory text informed Anna that when she was ready, a sound would be played, and three pictures would appear on the screen. Anna was further instructed to touch the picture that she thought was the right one. The last part of the instruction told the reader to “try as good as you can to concentrate” and “get as many correct as you can”. Anna was instructed to call for the experimenter if she had any questions or if something was unclear, and to touch the “Start-button” when she was ready. Before exposing Anna to the touch screen and the instructions, the experimenter told her that the instructions on the screen would give her all the information she needed, and that she could just give a sign if she had any questions.

Baseline

The participant was exposed to two different tasks. In the first one, a sorting task, the participant was given nine cards containing the following stimuli; three written names, three pictures of caregivers taken from front and three pictures of caregivers taken from aside (nose pointing left). She was instructed to sort them the way she thought was right.

The second task was performed to find out if an auditory stimulus could work as sample during training. The experimenter put three cards on the table, showing the caregivers pictures taken from front, and asked the participant to point at the picture related to the name

pronounced (i.e. “can you point at Suzy”). The position of the three cards on the table was changed between each task, and the order of tasks was varied in blocks of three. This means that the experimenter would ask for three names in one order, then ask for the three names again in a different order. There were presented seven blocks of three tasks, thus the participant was asked to point at a picture 21 times. This session was recorded and inter observer agreement (IOA) was calculated, between two experimenters, to a 100% agreement on whether the participants responses were correct or incorrect.

Training and test

Anna was exposed to conditional discrimination with three colors during pre-training. The purpose of the pre-training was to give Anna experience with the use of the touch screen. The pre-training session consisted of three blocks of 18 trials. The mastery criterion was set to 100 %. Hence she would have to respond at least 17 correct, two blocks in a row to move on to the training phase.

In the first training phase, a one-to-many (OTM) training structure with the following stimuli was used; (A) dictated name (sample), (B) written name (comparison) and (C) picture (comparison). During the second training phase there was conducted a morphing procedure. This means that computer software was conducted to put the two sample stimuli together as one stimulus in each stimulus class. Hence, there was now one relation, AC′ (dictated name–morphed stimulus) in each class to which Anna was exposed. A schematic morphing step hierarchy was made (see Table 1). Each morphing step consisted of a change in visibility percentage of text and picture, and was made to gradually establish the picture as the controlling stimulus for Anna’s responses.

After completing the conditional discrimination-training phase, Anna was introduced to test conditions. This means that Anna was exposed to trials with picture as sample and

written name as comparison and vice versa. To make test conditions as similar to training conditions as possible with the software, the sample onset was set to 1,5 seconds, which is about the same amount of time the computer used to present each of the dictated names during the training phase. Without an observing response, the comparisons were presented immediately at the sample offset. The first test consisted of DMTS with a 0s delay. In the next test, the participant was exposed to SMTS with no observing response. This involved that sample and comparison stimuli appeared at the screen simultaneously.

A one-to-many (OTM) training structure was conducted in all phases. There were no fading of programmed consequences between training and test phase. 45 days after the last training session in the training phase, Anna was exposed to a similar training session.

Criteria

Mastery criterion was set to 90%. If the participant mastered one level of morphing (two blocks of 18 trials, least 17 out of 18 correct per block) she would move to the next step of morphing (see Table 1). If she did not respond in accordance with the mastery criterion or wanted to quit a session before she finished, she would move back one step.

After 52 sessions a new criterion was implemented and involved that the participant would no longer move back a step if she did not master a session. In addition, there was introduced a new step, 6.2 (6%). When the participant reached this step, she would train for 10 sessions independent of the mastery criterion. This was decided to see if it would yield stable responding before the participant moved on in the procedure. There were made 5 additional steps, of which the sight of name text decreased from 5 to 1 percent between step 6.2 (6%) and step 7 (0%). Thus, the participant would remain on the same step if she did not master it, and she would move to the next step if she responded in accordance with the mastery criterion.

Experimental phases and design

There were three experimental phases (see Figure 2). During the first experimental phase, Anna was exposed to DMTS with a 0s delay and concurrent presentation of the trial types AB (dictated name–written name) and AC (dictated name–picture). Secondly, after the implementation of the morphed stimuli, Anna was exposed to AC′ (dictated name–morphed stimulus) trials only, with the gradual decrease of text visibility, and the increasing sight of the caregiver's picture (see Table 1). During tests, Anna was exposed to the relations CB and BC in a random order.

In the present study, an AB-design with a follow-up was conducted.

Results

Anna responded correctly in the sorting task by pairing the pictures taken from front and taken from aside together correctly. However, the name cards remained in a stack for themselves, and the participant repeated that she just was no good with names. The fact that she sorted the pictures correctly, excluded the possibilities of training picture-picture relations (with these stimuli). Instead, we had to introduce another stimulus. When exposed to the second baseline task, in which Anna was instructed by experimenter to point at pictures given a name, Anna responded in accordance with chance level, 8 out of 21 correct.

During pre-training, Anna responded 100% correct in the second and third blocks. Her response on the first trial in the first block was incorrect. Thus, she mastered the pre-training after three blocks of 18 trials.

The first conditional discrimination training was run for 406 trials, divided into two sessions, before the second training phase with morphing was started. After these two sessions the results strongly indicate that the AB relations were already established (see

Figure 3). The results of Anna's responding to the AC relations show a chance level responding. Hence, the mastery criterion was not reached.

The results from the second conditional discrimination training with morphing show that Anna's correct responses to the AC´ relations have improved significantly. Figure 4 shows Anna's progression in morphing steps from session 1 to 52. From session 21 to 52, Anna mastered Step 5 twelve times and Step 6 four times. Thus, she reached Step 7 four times during these sessions, but without mastering it. Therefore, a change in criteria was about to be made.

The new steps as showed in Table 1 were introduced, as were the new criteria. Figure 5 shows Anna's responding per training block through steps 6.2 (6% visible text) till mastery of 6.7, excluding the ten response-independent sessions on step 6.2. The graph shows that she mastered steps 6.2 to 6.5 after one and two sessions. She used a considerably larger amount of sessions, 25, before she mastered step 6.6. Figure 5 shows a high degree of variability in Anna's correct responses, both during steps 6.6, ranging from 7 to 18 correct per block, and 6.7, ranging from 10 to 17 correct per block. Step 6.7 was mastered after 10 sessions, and step 7 after 6 sessions, and with somehow lower degree of variability. Step 7 was mastered with 94,4% correct responses.

After mastering the conditional discrimination training, Anna was exposed to a DMTS test. She responded 11 out of 36 correct which is beneath chance level. When exposed to the same test but with SMTS, she responded 9 out of 36 correct.

At the 45th day after the last training session on Step 7, Anna was exposed to a session on the same step. She responded correctly on 14 out of 18 trials in both blocks, approximately 77.7%. A closer look on these results shows that Anna responded correctly on 83.3% of the A1–B1 trials, on 50% of A2–B2 trials, and on 100% of A3–B3 trials (see Figure 6). In sum,

Anna was exposed to 114 sessions (followup excluded) of conditional discrimination training with morphing over 109 days. Thus, the mean number of sessions per day was 1.

Discussion

The purpose of the study was twofold: to establish names of caregivers in a patient diagnosed with dementia by using MTS, and to explore the effects of using a morphing procedure in conditional discrimination training. The morphing procedure seems to have had a substantial impact on Anna's mastering of the morphing steps until mastery of the training phase. This is assumed as the results show a clear difference from the end of the first training phase and the end of the second. However, the degree to which Anna has learned the names of the three selected caregivers is unclear. The test results from both DMTS and SMTS tests indicate that this is not the case, despite her mastering of the conditional discrimination training. The reason for the low scores might also be due to extinction effects (discussed below). However, the follow-up training session 45 days subsequent to the mastery of the training phase shows that one of the three relations (A3–B3) was still established. Relation A1–B1 was somehow lower than mastery criterion, 83.3%. Relation A2–B2 was just above chance level. Anyway, the average score from the two follow-up blocks of training is the same as the average score from the 12 blocks of training while Anna was exposed to step 7 of morphing. Variability in the data is seen all the way from step 6.6, thus the follow-up score is in some degree representable for the training scores. The results from the present study indicate that morphing might function quite well as a tool for establishing conditional discriminations.

Like Steingrimsdottir and Arntzen (2011c) promoted, this study also indicates that MTS procedures might yield beneficial results in the treatment of people with dementia, by training so-called short term memory. Another important contribution with the present study

is that by exposing a patient for MTS tasks on an average of less than three minutes a day, one might make a change of improvement in the lives of patients struggling with dementia. Like mentioned in the first article of this thesis, the use of MTS procedures appear as a useful tool in the treatment of dementia and related diseases.

The results from this study is compatible with the findings from Gallagher and Keenan (2009), who reported that subjects scoring 27 or above on the MMSE in large degree also responded according to stimulus equivalence. At the time of the present study, Anna scored 17 on the MMSE, and the experimenter-defined equivalence classes were not established during training.

As noted before there was made a change in procedure after two sessions of conditional discrimination training. The reason was twofold; firstly, Anna showed rather obvious signs of discomfort during the training because she had so much incorrect responses, according to her own statements. She would sometimes appear frustrated after a session, and often expressed that she knew the faces on the screen but just couldn't name them. There were also instances where she left the experimental session before finishing. Secondly, the data revealed that she had responded correctly on approximately 100% of the AB trials (dictated name–written name), but correct responses on the AC trials (dictated name–picture) were somewhat lower than chance level. Baer, Wolf, and Risley (1968) outline effectiveness as one of the seven dimensions of applied behavior analysis. According to the authors, an intervention is not effective if it does not yield large enough effects. In the case of the first conditional discrimination training, two sessions gave quite clear indications of zero behavioral change. Thus a procedural change was considered appropriate.

A morphing procedure was considered appropriate in Anna's case, because of her discomfort making incorrect responses. Figure 4 shows that Anna did not fail a session until she had reached step 6 (11% sight of text) and had to go back a step. The data indicate,

however, that the morphing procedure could have been conducted in a more effective manner. Future studies should make use of smaller morphing steps, and probably generate desirable results faster. The changes in criteria and the new steps implemented after 52 trials is likely to have had an important impact on the results. The new morphing steps involved finer fading of prompt stimuli, thus a more errorless training process took place. In addition, the criterion of not moving back a step if a session was not mastered ruled out the fact that Anna was exposed to conditional discriminations that were already established. The reason for implementing these changes at the current point of the experiment was that Anna's responding formed a pattern in which the results did not seem to improve despite increasing amount of exposure to the training trials. At the point of the change, she had reached the 0% step (Step 7) five times, without mastering it (see Figure 4).

After the implementation of the new steps, it would have been interesting to expose Anna, when working on a consecutive step, to probes with comparisons from the 0% step, and see if this would yield faster mastering of the training phase. Due to software limitations, this could not be done. Therefore, future studies should take this into account to study whether a more gradual fading of prompt could produce faster mastering of criteria.

The conditional discrimination training was done in a fashion approximately equal to DMTS. The difference from a standard DMTS procedure was due to software limitations and consisted of the following. As the sample sound was presented, so were the comparison stimuli. This would not be the case in "true" DMTS, wherein presentation of comparison stimuli is withheld till sample is offset (Arntzen, 2006, 2012). Anyhow, the procedure used in the experiment could not be addressed as simultaneous matching-to-sample (SMTS) either, because the pronunciation of the auditory sample stimulus lasted circa 1.5 s, and then was absent till next trial. In a traditional SMTS procedure, an observing response to sample is followed by comparison presentation, while sample is still present (Arntzen, 2006, 2012). It

was not possible with the software to arrange for observing response to activate the sound sample, therefore an automatic presentation was arranged. Thus, one might say that the procedure had elements of both SMTS and DMTS. Whether this affected the results is possible, but more important, it might make it more difficult to compare this study to future ones. In that case it constitutes a threat to external validity.

Arntzen, Braathen, Lian, and Eilifsen (2011) studied whether a required response to sample stimulus affected establishment of derived relations and number of training trials to reach mastery criterion. Their results show that the participants in the two groups in which a response to sample was required mastered the conditional discrimination training faster than the two groups where a response was not required. Hence, a required response to sample might have had desirable effects in the present study. The absence of a requirement of response to sample, may have lead to less efficient training. This might be considered a weakness of the present study and will be an important aspect in future studies because the probability of yielding desirable results more effectively would be increased.

This study has taken into account that experimental sessions should be carried out at approximately the same time of day to ensure that the participant would be in "the same state" during each session, as addressed by Arntzen, Steingrimsdottir, et al. (2013). McIlvane, Dube, and Callahan (1996) pointed out that the current state of a participant not only provides a source for behavioral variability, but also for variability in stimulus control topographies (STC, emphasized below). In the present study, 76 % of the experimental sessions were performed between 3 and 5 p.m. Further, during the present study, the participant was exposed to experimental sessions 7 days a week (with some exceptions, like on days she did not wish to attend or was busy). With the goal of establishing the experimenters as reinforcers themselves for the participant's attending behavior, she was offered a game of cards (an activity she strongly desired) and a cup of coffee after she had participated in a session.

Generalization, as one of the seven dimensions of applied behavior analysis as stated by Baer et al. (1968), is crucial in interventions like the one in the present study. Anna's responses cannot be said to have generalized to test conditions, and according to her caregivers, she did not use their names in everyday settings after the experiment. A more comprehensive procedure to support a higher degree of generalization was desired by the experimenters, but Anna did not want to continue the experiment any further than necessary. Any participant in any experiment has the right to retire from it at any time, thus the current experiment has met some limitations. To facilitate generalization, similar studies in the future could make use of expanding classes with additional pictures of the caregivers, with different clothes and hairstyles, from different angles and distances, and so on. According to McIlvane and Dube (2003), generalization is determined by the nature of established stimulus classes during training.

Experimenting with different dimensions of the stimuli used in a similar procedure would be interesting and probably useful for MTS procedures in applied settings. The term stimulus control topography (SCT), mentioned by Ray (1969), and emphasized (and elaborated) more recently by McIlvane and Dube (1992, 2003), refer to the aspects of a stimulus that exerts control over behavior. Like McIlvane et al. (1996) suggest, the complexity of any environmental event gives way for competition amongst multiple controlling relations between environment and behavior. More comprehensive analyses of coherence or differences in SCT (between experimenter-defined relevant aspects and the actual controlling aspects of a stimulus) could prove fruitful for applied settings. By providing systematic procedural variations, future studies can contribute to SCT as well as train name-face relations and the like (McIlvane & Dube, 2003). The results from the present experiment show that the control exerted by the morphed stimuli changed along with the dimension of visibility of text and face, and after repeated sessions of training. However, a finer morphing

hierarchy with smaller steps could have been useful for a more thorough analysis of SCT coherence.

Sidman (2013) presented a range of possibilities in measuring the existence or absence of stimulus relations in people with Alzheimer's disease. It would have been of interest during the present study to do a more comprehensive assessment to see if some of the relations had generalized to similar conditions. For example, we could ask Anna "who is this" and show her the picture to which she responded in accordance with mastery criterion in the follow-up session. Like Sidman (2013) promoted, "it is important to emphasize that we want to… not only identify fractured stimulus and response classes but also reveal elements that are still intact so that we can build on those to do remediation"(p. 143).

The test conditions in the present study were to some degree different from the training conditions. This was mainly because the experimenters had difficulties arranging the software to present trials of symmetry with auditory sample stimuli. Hence, we had to rule out the auditory sample stimuli in the test, and instead use the written name and picture stimuli. (For excellent examples of how trials with auditory comparison stimuli might be arranged, see Dube, Green and Serna, 1993; Stewart and Lavelle, 2013). From the first training phase it was clear that Anna had established the relation dictated name–written name in all three classes. Therefore it was not unlikely that she would respond correct to written name–picture and vice versa after mastering the second training phase (dictated name–picture). However, the test results show beneath chance level of correct responding. In this case, adding written name – picture trial probes into the morphing phase could have helped establishing this relation and maybe strengthened the test results.

Another possibility could have been to run a many-to-one (MTO) procedure with dictated name and written name as samples and picture as comparison. As Saunders and Green (1999) points out, a OTM training procedure is more likely to yield positive outcomes

on a test than a MTO procedure because of the higher number of simple discriminations during training. This point, however, is not consistent with the findings from Arntzen and Hansen (2011) and Arntzen and Holth (1997, 2000). The findings from the three latter studies indicated minimal differences on outcomes as a result of using MTO or OTM training structure.

An aspect that might have been crucial in the case of this study is that the procedure made use of no fading of programmed consequences. This means that Anna was exposed to test conditions (0% programmed consequences) after completing the last step of training (100% programmed consequences). This constitutes a limitation with the present experiment. Future studies should emphasize fading of programmed consequences and study the effects this might have on the participants' test scores. This was desirable to perform in the present study, after first leaping from 100 to 0 % without success, however the participant did not wish to continue the experiment. Like mentioned above, the low scores might have been due to extinction effects as the screen just turned completely white after each trial.

Arntzen, Steingrimsdottir, et al. (2013) stated that conducting experiments with participants with dementia is time consuming. The time consumption itself is a threat to validity, and because of the progressive nature of dementia-diseases, experiments with this group of subjects should optimally be performed in shorter time periods. Further, the authors pointed out the challenge with these subjects because of their (often) low stamina in experimental situations compared to other populations. There were periods during the present experiment, wherein Anna was likely to hesitate or refuse to participate in experimental sessions. As two-three days was likely to pass before she would participate again, the experimenters put in a two-day brake after each session, during the final part of the experiment. This seemed to make it easier for her to participate.

This study indicates one step in the right direction of a rehabilitation-focused intervention of memory enhancement, as Buchanan et al. (2011) called for. In addition, the present study supports the above mentioned suggestions made by Plaza et al. (2012), and strengthens the view that MTS procedures might be functional when it comes to training names of people and important objects of daily life, and in training functional behaviors. As exemplified by Steingrimsdottir and Arntzen (2011a), one could train spoon, fork, and knife in relation to eating, and toothbrush, toothpaste and comb in relation to morning care routine. Under similar conditions one could train putting on sweater, making breakfast, where to find objects, etc. Hence, the need for further research to see if such interventions might succeed is obvious and strongly desired. The fact that Anna suffered from a rare type of dementia makes a threat to the external validity of this study, but the findings should be of value to anyone interested in finding efficient behavioral treatment for people suffering from neuropsychological diseases like dementia.

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Table 1

Step	% text sight	% face sight
1	78	22
2	56	44
3	44	56
4	33	67
5	22	78
6	11	89
6.2	6	94
6.3	5	95
6.4	4	96
6.5	3	97
6.6	2	98
6.7	1	99
7	0	100

Note. Step 6.2 to 6.7 was implemented after 52 sessions.

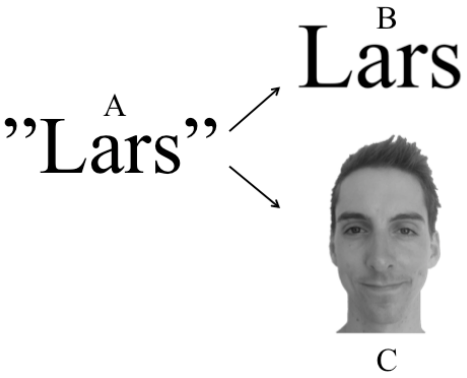

Figure 1. Example of a stimulus class the experimenters wanted to establish. The letter A indicates the dictated sample stimulus. B indicates the written name stimulus. C indicates the picture stimulus.

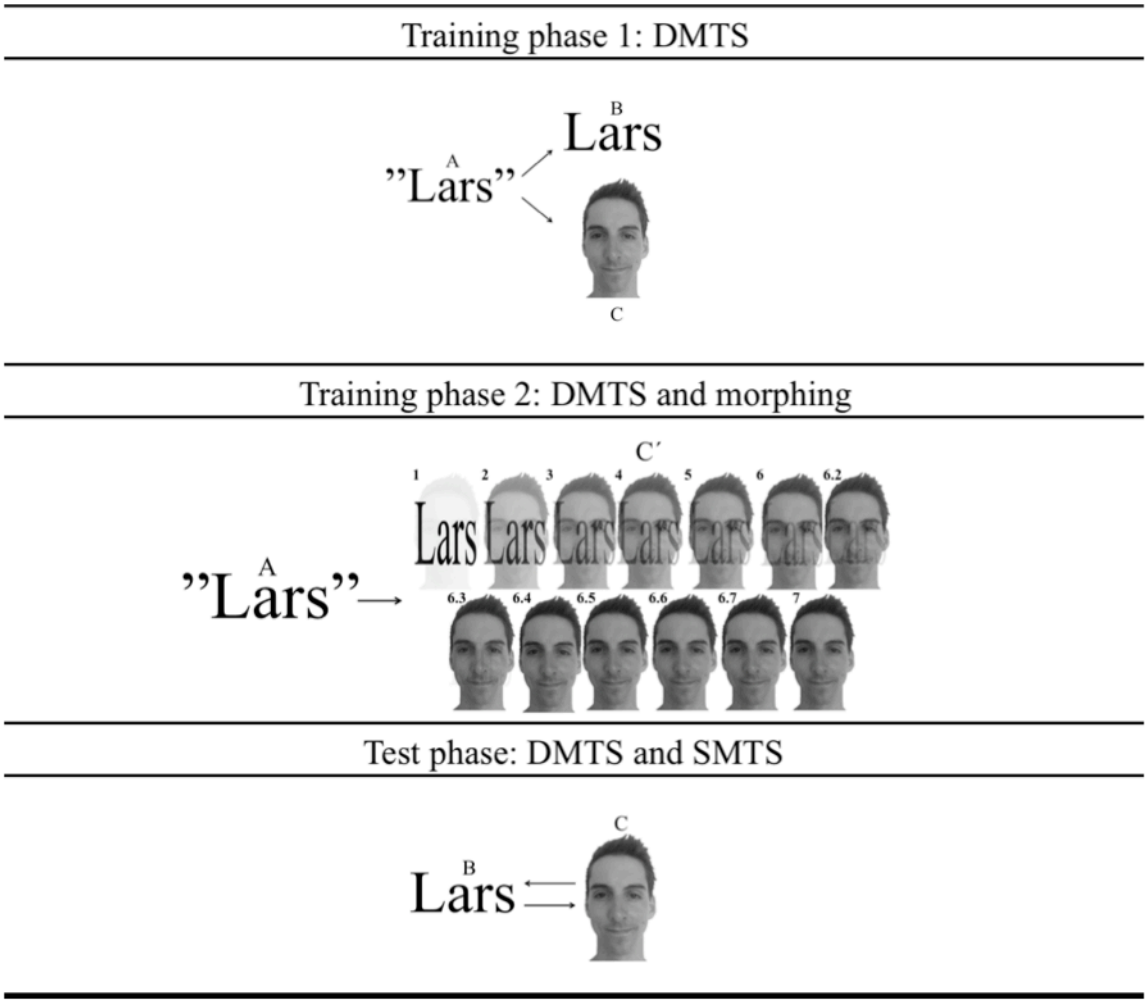

Figure 2. The figure shows the relations to which Anna was exposed, during the three phases. In addition the training structures in each of the phases is shown. The middle part of the figure shows examples of all the morphing steps during the second training phase. Each of the pictures is indicated on top left by step number of which it represents. The arrows shows the direction in which the relations were trained.

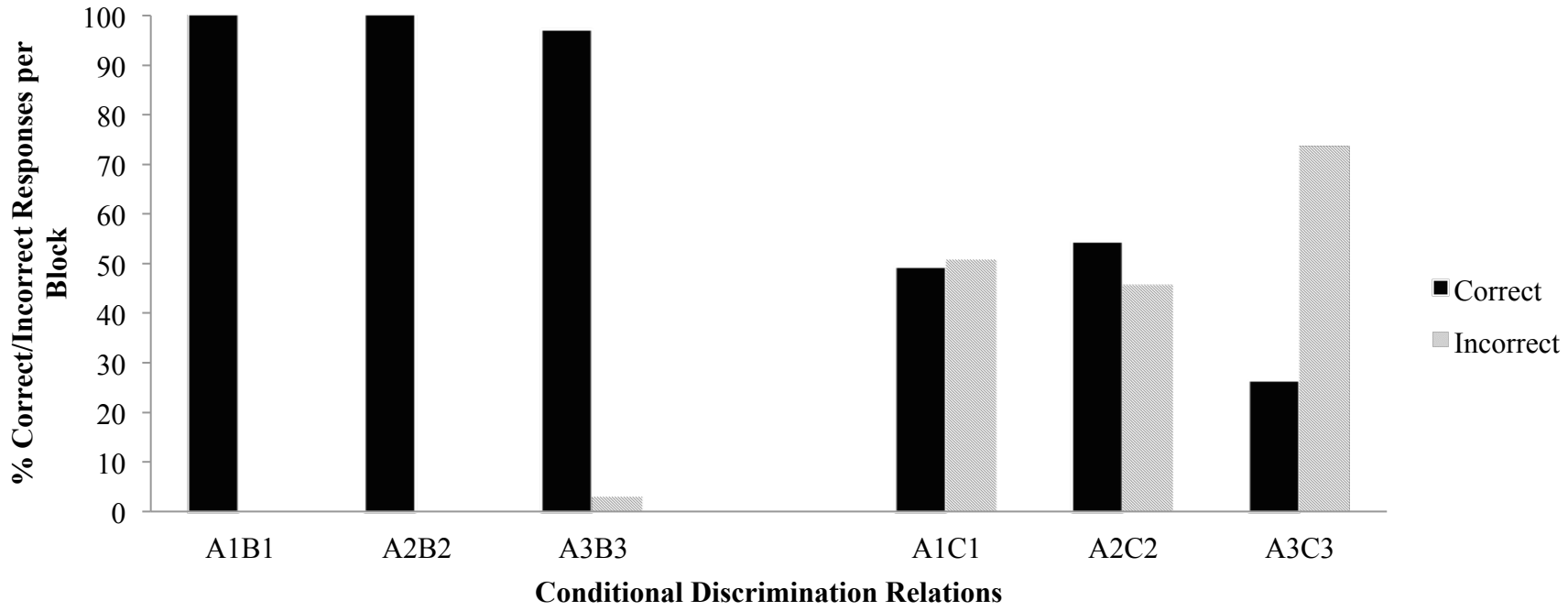

Figure 3. Shows the percentage of Anna's correct/incorrect responses in total from the first two training sessions in the experiment. The x-axis shows the different relations trained in the three classes. A1B1 indicates the relation "dictated name–written name" in one of the three classes. A1C1 indicates the relation "dictated name–picture" in one of the three classes.

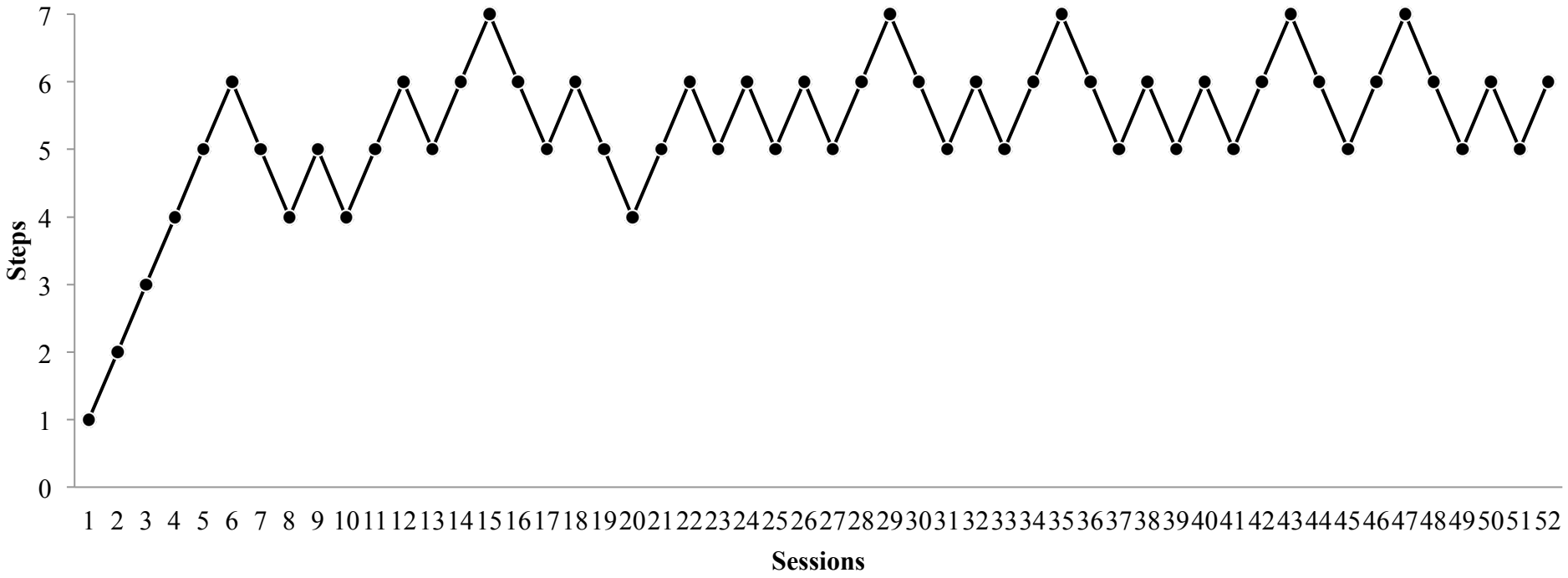

Figure 4. The figure shows Anna's step progression during the 52 first trials of training in the morphing phase. The steps are indicated on the y-axis, and the numbers on the x-axis indicates sessions. When Anna mastered a session, she would move one step up, and when she did not master a session, she would move one step down.

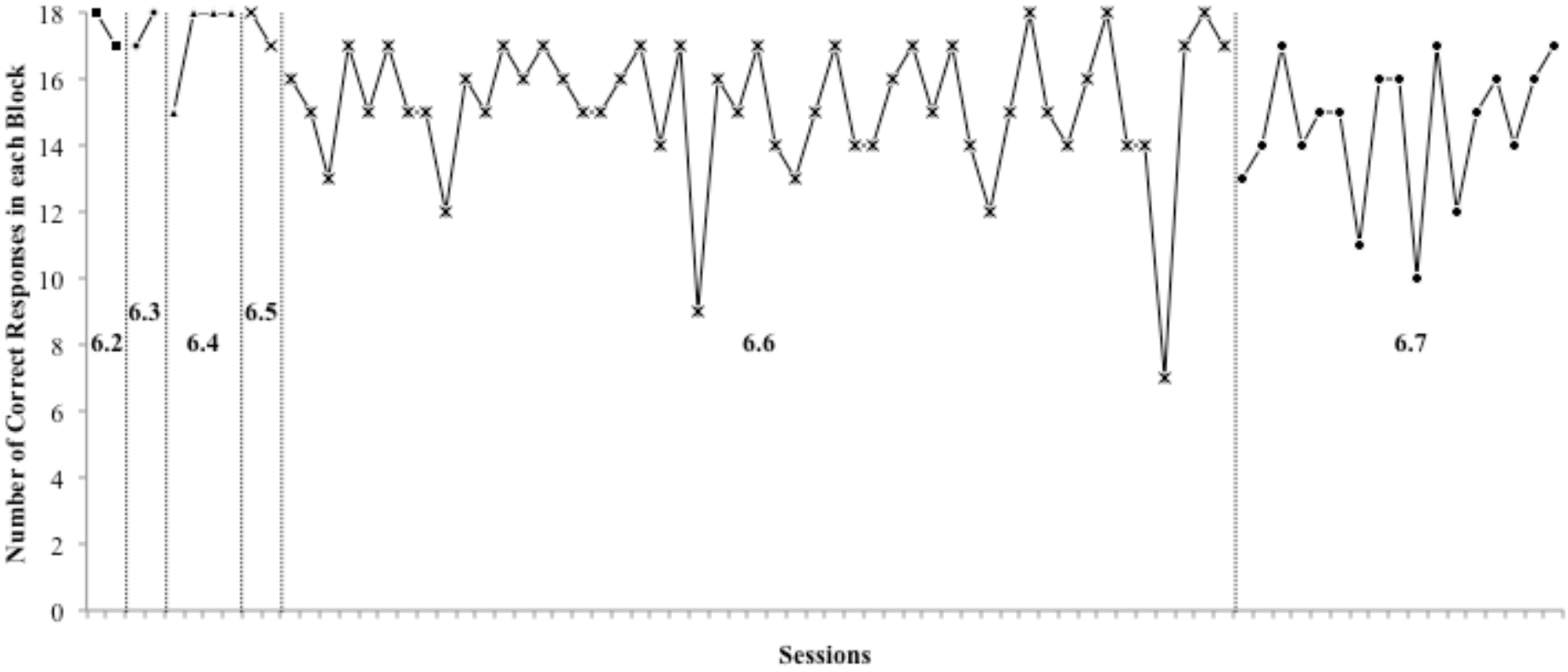

Figure 5. The figure shows Annas correct responses per block after the implementation of the steps 6.2 to 6.7. The vertical dashed lines are put on to indicate progression to a new step. In addition the step names tell us which step each of the lines represent.

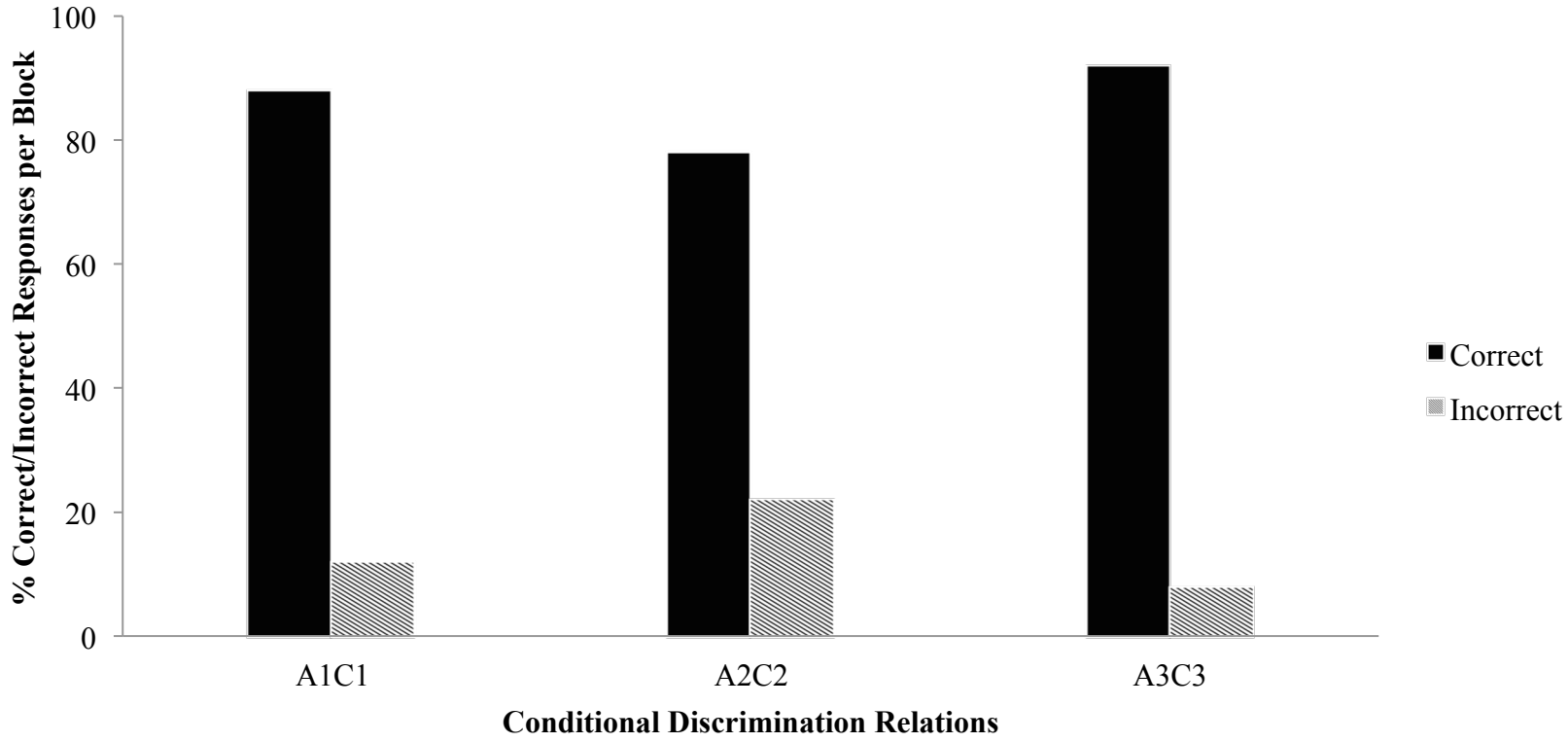

Figure 6. The figure shows total amount of correct/incorrect responses during step 7. This is mean scores from 6 experimental sessions, or 12 blocks of training.

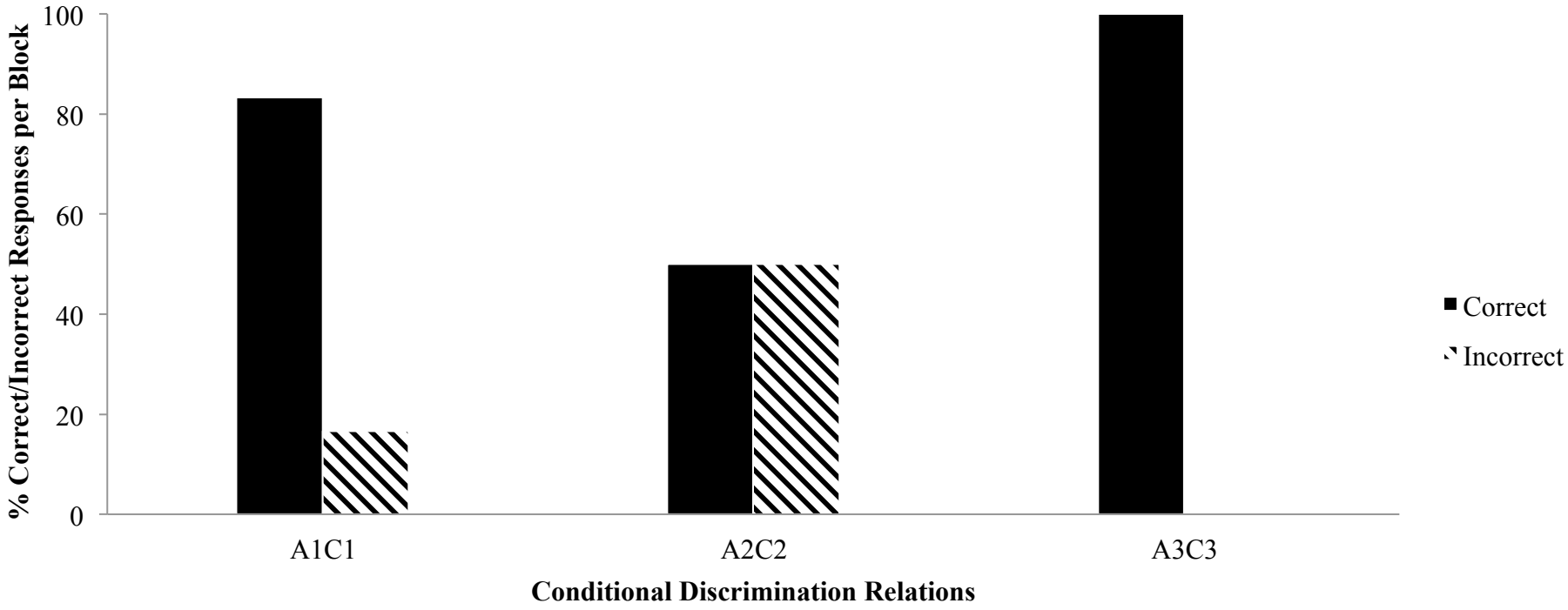

Figure 7. The figure shows percentage of Anna's correct/incorrect responses during the two blocks of the follow-up session.