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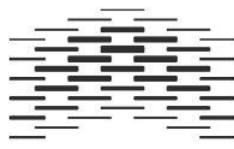
Feedback and Variability

Does feedback sign in the learning history affect variability?

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Abstract

The CEO study from IBM (Berman, 2010) concludes that creativity is the single most important leadership competency for the organizations of today. At the same time, we know that our educational system can be detrimental to children's naturally occurring creativity. This study conducts an inquiry into the possibility that feedback sign (positive vs negative feedback) can generate variation in behavior. Variability in behavior will not necessarily make individuals creative, but variability is considered an essential part of creativity. Simultaneously, feedback is acknowledged as an essential element of theories of learning and instruction. Former studies have concluded that reinforcement and extinction elicits variability. This study consists of an elementary computer experiment with a learning phase, where adult subjects receive either positive, negative or persistent negative feedback, followed by a phase where the subjects are free to choose without receiving any feedback. The tentative conclusion of this study is that individuals receiving positive feedback tend to repeat their answers, even in the learning phase so it takes significantly longer to learn, and on subsequent, similar tasks with no feedback. Individuals receiving negative feedback on wrong answers alter these answers relatively immediately, resulting in rapid learning. The subjects in the negative feedback group kept on varying their answers significantly more than the positive feedback group, on the succeeding similar tasks. The results of the persistent negative feedback group is similar to negative feedback, but there are differences that this study is unable to account for. A tentative conclusion of this study is; individuals use longer time learning when receiving only positive feedback on correct answers. The behaviors "learned" from the type of feedback in the feedback phase, varying or repeating, persists in subsequent similar tasks.

Abstract

Creative individuals are highly sought after in the job market today. The constantly changing societies, makes it necessary for organizations to always evolve and be able to make rapid changes when the surroundings demands it. Most organizations, and private individuals, have long since discovered the demand for constant development and adaption. But, the socializing procedures and educational system we all go through when growing up, often seems to kill creative skills instead of developing them. Earlier studies have shown that extinction and reinforcement of variation has an eliciting effect on variability. Variation in behavior is regarded as a part of, and necessary for creative behavior. Feedback is considered essential for learning. We all constantly receive feedback from our surroundings, and repeat or modify our behavior as a result. The main question of this study is whether positive or negative feedback will have an impact on individual's tendencies to repeat or vary their behavior. It is also important to remember, in these times when creativity seems to be the most important credential, that variability in behavior and creating and testing new types and products, comes at the expense of realizing the benefits of those already available.

Introduction

Every child is an artist. The problem is how to remain an artist once we grow up. – Pablo Picasso

The pace of change is quickening every day. Hardly anyone believes this pace is going to slow down any time soon, if ever. New technologies will continue to change our societies, sometimes in very unpredictable ways, into the future. We know that what we learn today might be useless tomorrow. Knowledge of truths is a fresh commodity, what you believe to be the truth today might prove to be false tomorrow. In 2010, IBM published *Capitalizing on Complexity*, the fourth edition of a series of global CEO studies. The introduction to this report states that;

We occupy a world that is connected on multiple dimensions, and at a deep level – a global system of systems. (...) It is this unprecedented level of interconnection and interdependency that underpins the most important findings contained in this report. Inside this revealing view into the agendas of global business and public sector leaders, three widely shared perspectives stand in relief.

1. The world's private and public sector leaders believe that a rapid escalation of “complexity” is the biggest challenge confronting them. They expect it to continue – indeed, to accelerate – in the coming years.
2. They are equally clear that their enterprises today are not equipped to cope effectively with this complexity in the global environment.
3. Finally, they identify “creativity” as the single most important leadership competency for enterprises seeking a path through this complexity. (Berman, 2010, p. 5)

Feedback and Variability

Several others have stated the need for variation and creativity in the organizations of today. In 2009 Sandaker wrote: “Modern, knowledge-based business encourage behavioral variation when meeting continuously changing demands in order to increase the probability that appropriate behavior comes about” (Sandaker, 2009, p. 278).

Sir Ken Robinson says, in his 2006 Ted talk “Do schools kill creativity?” that creativity is as important in education today as literacy, and that we should treat it with the same status. The ability to vary has always been important, every species on the planet today has varied, both in behavior and physically, in order to best adapt to the ever-changing environment. But, with the rapid pace of change today, which, as stated above, many believe will escalate in the future, we will most probably need to vary our behavior even more radically and more often than what has been needed in the past.

There seems to be no doubt therefore, that creativity is important for the continued development of our societies and organizations. We often divide people, like a workforce in an organization, into two groups, the creative and the non-creative (Robinson, 2011).

Robinson goes on stating that his starting point is that everyone has creative capacities, and that the challenge is to develop these capacities. He states that we need a culture of creativity and that this culture has to involve everybody, not just a select few.

In the field of behavior analysis modern evolutionary theory provides the framework within which to discuss and analyze behavior (Baum, 2005). Evolutionary theory entails three interdependent phases; variation, selection and retention. Selection by consequences is one of the fundamentals of Skinner’s behaviorism. According to Morgan and Lee (1996) behavior analysis has an impressive database when it comes to selection, but the empirical analysis of behavioral variability have been scarce.

From we are children we learn to behave conventional. Flora states “*Throughout childhood and into adulthood, for almost every behavior from language to lettering and drawing, conventional performance is differentially reinforced to novel or creative performance*” (Flora, 2004, p. 80, emphasis in original). Conventional behavior is extremely important to the survival of human existence, which is why we all learn to behave conventional more or less from birth. Still, some people manage to keep their creative side into adulthood, or become creative, often within a special field, when they are adults. What separate these individuals from the rest of us, who seems to lose all creative behavior when growing up?

When learning to behave correctly, read, write, do mathematics and all the other things we need to learn we are all dependent on feedback. When receiving positive reinforcement for a task well done, whether praise, money or a green R next to a correct math task, we get positive feedback. We get the understanding that the task was done correctly and we’ll continue to do the same, or similar, tasks in mostly the same way. If we receive punishment, verbal disapproval, a red mark besides a wrongly spelled word or an injury due to wrong use of tools we learn that this was the wrong way to do a task. We have received negative feedback, telling us that we need to change our behavior the next time we do the same or similar tasks. Feedback is considered essential for the learning process. Earlier studies has shown that without feedback learning is difficult, if not impossible.

The focus of this study is therefore to establish if positive or negative feedback in the learning history will affect future variation or repetition in behavior. Hence, the main question I ask in this experiment is; *will the use of positive or negative feedback in a learning session affect the future use of repetition or variability?*

Variability

It is a fact that variability is present in all physical phenomena (Denney & Neuringer, 1998).

It is also a fact that some individuals vary their behavior more than others, sometimes so much that it becomes problematic, as with individuals suffering from attention-deficit/hyperactivity disorder (ADHD). Other individuals are characterized by maladaptive repetitive behavior, e.g. individuals diagnosed with autism (Neuringer & Jensen, 2013). A great deal of research have shown several different ways to evoke variability in behavior, though not all the research have seemingly generated the same results.

Extinction elicits variation

According to Holth (2012) it is a consistent finding that extinction generates variability, especially when extinction alternates with reinforcement. “Consistent and extended extinction may not produce much behavior” (Holth, 2012, p. 245). Neuringer has also, in several articles acknowledged that suddenly withholding reinforcers, extinction of responding, increases variability.

The variations induced by extinction generally emerge from the class of responses established during original learning. For example, if lever pressing produced food pellets, a rat may vary the ways in which it presses when food is withheld, but much of the behavior will be directed toward the lever (Neuringer & Jensen, 2013, p. 524).

Iversen’s (2002) experiment gave a clear demonstration of how extinction alternating with continuous reinforcement schedules made rats vary their topographic behavior. When the rats operated and omnidirectional pole, which under continuous reinforcement schedules led to reinforcement, they automatically took snapshots of themselves, and thereby showing their topographic behavior at the time. These pictures show that the rats have about the same topographic behavior when operating the pole under continuous reinforcement. Whereas

under extinction their topographic behavior changes quite dramatically, as the rats tries to operate the pole in various ways that they hope will lead to reinforcement.

Reinforcement and variability

Barry Schwartz found that positive reinforcement taught pigeons (Schwartz, 1982a) and people (Schwartz, 1982b) not to use variation in their behavior. Schwartz's research showed that as soon as the pigeons or students hit a correct sequence that was reinforced, they repeated this sequence and rarely tried other patterns. E.g. Schwartz's (1982a) experiment with pigeons, that used a checkerboard-like light matrix. The pigeons had to move the light from the upper left corner to the bottom right corner, pressing either a right key or a left key. They were only permitted to press either key four times each. Whenever they pressed one of the keys a fifth time there was a time-out. The variability requirement was that the current sequence had to be different from the preceding trial. The results of this and other experiments was that the subjects received very little reinforcement when the procedure required sequence variability, because they either used the same sequence over and over or pressed one of the keys more than four times. Schwartz concluded that reinforcement produced stereotyped response patterns and therefore that reinforcement interferes with problem solving. Experiments conducted by among others Allen Neuringer on the other hand suggests that stereotypy behavior only occurs if that is the behavior that is being reinforced. Page and Neuringer (1985) suggested that it was the contingencies of Schwartz's experiments, only allowed to press each key four times each, that made it difficult to obtain reinforcement for the subjects. The fact that they received very little reinforcement, makes it difficult to conclude that reinforcement does not produce variability, the subject hardly received reinforcement for varying. We can conclude from these experiments that contingencies that do not require variability but only permits it, will not produce variability in behavior but rather produce repetitious response topographies (Holth, 2012).

Pryor, Haag and O'Reilly (1969) were of the first to show how reinforcement could elicit novel and variable behavior. They reinforced two porpoises whenever they emitted new behavior in a training session. Generally, they did not reinforce behavior that was already familiar to the trainers. The two porpoises did after several training sessions establish a highly increased probability of emitting new types of behavior. Goetz and Baer (1973) got similar results from their experiment with three preschool girls and block-building. They socially reinforced new forms of block-building by having the teachers say something e.g.: "That's very nice – that's different!" (Goetz & Baer, 1973, p. 212), to the three girls who in the baseline sessions had constructed very simple and repetitive constructions. The result of this experiment was that all three girls showed increasing form diversity when they received social reinforcement for creating different forms.

Allen Neuringer has investigated variability, randomness and behavior in numerous studies, with focus on the relationship between positive reinforcement and variability. Several of his experiments have shown that response variability can directly be reinforced. E.g. Page and Neuringer's (1985) experiment with pigeons using the same checkerboard-like matrix as in Schwartz's experiments explained above, where the subjects had to move a light from the upper left corner to the bottom right corner, pressing either a right key or a left key. They removed the contingency that either key could only be pressed four times, and since each trial consisted of eight responses this gave 256 (2^8) different possible patterns of L and R. In the variability reinforcement phase, reinforcement in the form of food, was provided if the trial differed from the previous 50 trials. The trial ended with a time-out, a brief darkening of all the lights, if the current sequence had already been emitted in any one of the previous 50 trials. The result of this experiment was that the pigeons received reinforcement on approximately 70% of the trials, as they learned to respond in a random-like fashion. Whereas

on about 30 percent of the trials, they happened by chance to repeat a sequence that had already been emitted, and it therefore led to a time-out (Page & Neuringer, 1985).

Within the field of behavioral brain research Golob and Taube (2002) have investigated how appetitive reinforcement vs. aversive conditions affect behavior. Their findings were that rats given positive reinforcement (appetitive, drops of water when water deprived) did not do well in distinguishing two geometrically similar corners in a maze, despite the presence of a visual cue to differentiate the corners, after they had been subjected to a disorientation procedure. On the other hand, when the rats were put in the same maze, this time filled with water (aversive) after the disorientation procedure, they were much more successful in finding the right corner. This corner then had a hidden platform where the rats could escape the water. They conducted two experiments, wet-dry and dry-wet. The same rats were therefore subjected to both positive reinforcement and aversive conditions, but in reversed order. The rats seemed to remember from training the right corner in the aversive stimulus procedure but performed nearly at chance under the positive reinforcement procedure.

Operant variability?

Variation in our behavior is fundamental to the selection process (Donahoe, 2012). According to Donahoe, Skinner defined both the environment and behavior as classes of events. These classes will never be exactly the same. A light in the environment, a stimulus class, might be seen from different angles, or is perceived to have different intensity. A behavior, as several lever presses, will probably occur with different topographies and force, a response class. “The variation between behavioral responses within a given environment (the behavioral phenotype) is the variation upon which reinforcers are contingent” (Donahoe, 2012, p. 252). Donahoe’s article gives a thorough description of the variation that exists due to all the different mechanisms in the body that are at work when e.g. a rat presses a lever. But, it does not give the same thorough description when it comes to the variation in behavior when e.g.

an individual answers the same question completely differently on different occasions.

Morgan and Lee states

In short, to do justice to a selectionist account of behavior, we need to know what processes at the ontogenic level mimic sexual combination and mutation. Of course, what is needed here is a functional equivalence; no structural or mechanistic isomorphism is implied (Morgan & Lee, 1996, p. 2)

Allen Neuringer, sometimes with colleagues (e.g. 2002, 2009; 2010, 2012) has suggested the possibility that variability in behavior is an operant;

When a dimension of behavior both controls reinforcement and is controlled by reinforcement, the behavior is generally referred to as “instrumental” or “operant”. For example, when reinforcement is contingent upon a particular class of responses, such as leverpresses, and presses increase in probability, the press response is called an operant. So too for response location, topography, latency, rate, probability and force. Behavioral variability may also be an operant (Morgan & Neuringer, 1990).

This suggestion has been, and still is, a source of debate. Although there is a lot of evidence that variability will increase when reinforcement is contingent upon it (e.g. Neuringer, Kornell, & Olufs, 2001; Page & Neuringer, 1985). Holth (2012) argues that the notion of variability as an operant might be misleading, as experiments have shown that varying is generally limited to the reinforced set, hence it does not transcend the range of specific responses that are followed by reinforcement. In addition, the variability in the experiments conducted so far can be explained by already familiar basic behavioral principles, e.g. extinction. “All procedures used in experiments referred to by Neuringer and colleagues as showing that variability is an operant dimension of behavior have the differential extinction of repetitious behavior as a common variable” (Holth, 2012, p. 246). The subjects in these

experiments, whether animal or people, try familiar behavior. When this is unreinforced, they try different kinds of behaviors since they know the possibility for reinforcement is present. What seem to be evident from this research is that the ability to vary once behavior is dependent on feedback, as in reinforcement or no reinforcement. In real life direct feedback from the surroundings if the behavior functions properly does not always occur. What seems evident from the variability research is that correct feedback is essential for people to vary their behavior when needed.

Creativity, intrinsic motivation and extrinsic rewards

Creativity requires more than variation in behavior, but Campbell (1960) argued that variability, behaving in an unusual, novel and nonrepeating manner, is a part of and necessary for creative productions.

Research on creativity was for a long time dominated by the personal characteristics which were thought to be predictive of creative performance (Oldham & Cummings, 1996). Only about the last twenty-thirty years has researchers within cognitive psychology started to investigate whether contextual factors could influence individual's creativity. According to Oldham and Cummings:

Most of this research has been conducted in behavioral laboratories and has followed an "intrinsic motivation" perspective. According to this perspective, the context in which an individual performs a task influences his or hers intrinsic motivation.

Individuals are expected to be the most creative when they experience a high level of intrinsic motivation – that is, when they are excited about a work activity and interesting in engaging in it for the sake of the activity itself (Oldham & Cummings, 1996, p. 609).

Eisenberger and Rhoades (2001) claims that “the confound in behavioral studies between reward and cues indicating creativity’s desirability has been eliminated by cognitively oriented researchers who promised participants reward on a single occasion without any indication that creativity was preferable” (Eisenberger & Rhoades, 2001, p. 729). They give two examples of how experimenters use the procedure of establishing a reward expectancy without indicating that creativity is preferable. The first example is an experiment where students were promised a reward, or no reward for producing a list of possible titles for a paragraph. The students who was promised a reward produced less creative titles than the control group, which were not promised a reward, as assessed by judges. The second example is an experiment conducted by Amabile (1982) where children who were offered a reward for constructing a collage, without information that creativity was desired, created collages that were judged less creative, though better planned and organized and more representational than children who was not promised a reward. “Similar decremental effects of expected reward for unspecified performance on creativity have been reported in many studies, leading cognitive researchers to the conclusion that expected rewards reduces creativity” (Eisenberger & Rhoades, 2001, p. 729)

According to Cognitive Evaluation Theory (CET) intrinsic motivation is:

The innate, natural propensity to engage one’s interest and exercise one’s capacities, and in so doing, to seek and conquer optimal challenges. Such motivation emerges spontaneously from internal tendencies and can motivate behavior even without the aid of extrinsic rewards or environmental controls (Ryan & Deci, 1985, p. 43)

The CET theory suggested that external factors such as tangible rewards, deadlines, surveillance and evaluations tends to diminish feelings of autonomy, thereby undermining intrinsic motivation (Gagné & Deci, 2005). In a review of Ryan and Deci’s book about

cognitive evaluation theory, Bernstein writes: “Whereas Deci and Ryan value and seek to create behavior perceived to be free, behavior analysts will persist in identifying the environmental conditions that produce that perceived state” (Bernstein, 1990, p. 330). In 2000 Ryan and Deci “updated” the CET theory to Self-Determination Theory (SDT) (2000). The authors say this was because interests in CET had waned. The authors thought this was mainly due to, among other reasons, that many activities needed in work or school environments are not, to most people, intrinsically interesting. The solution CET suggested to this problem was the use of strategies such as participation to enhance intrinsic motivation, but this was not always feasible. They also saw that since people need to earn money, using monetary rewards seems practical and appealing. They also realized that CET seemed to imply that you had to choose. Either participation and empowerment (intrinsic motivation) or extrinsic contingencies. An important aspect of the new theory, SDT, is the proposition that extrinsic motivation can vary in degree, with autonomous on one side and controlled on the other side of a continuum. Activities that are not intrinsically motivating needs to be regulated externally. People who act with intention of obtaining a desired consequence or escaping an undesired one is said to be externally regulated. According to the Self-Determination Theory, external regulation can be internalized. The continuum starts with “amotivation” on the one side, and continuous with “external regulation”, “introjected regulation”, “identified regulation”, “integrated regulation” and ends with “intrinsic motivation” on the other side of the continuum (Gagné & Deci, 2005). According to the theory people have a full sense that the behavior is an integral part of who they are when external regulation has been integrated at the level of “integrated regulation”.

Integrated regulation does not, however, become intrinsic motivation but is still considered extrinsic motivation (albeit an autonomous form of it) because the motivation is characterized not by the person being interested in the activity but rather

the activity being instrumentally important for personal goals (Gagné & Deci, 2005, p. 335).

Amabile (1998) writes, in her often cited article “How to kill creativity”, that there are three components of creativity; expertise, creative-thinking skills and motivation. Expertise as defined by Amabile “encompasses everything a person knows and can do in the broad domain of his or her work” (Amabile, 1998, p. 78). Creative thinking is how people approach problems, if they manage to use existing ideas in new ways, and thereby come up with different solutions. Motivation consist, according to Amabile, of two types; extrinsic and intrinsic. Extrinsic motivation is something that comes from outside a person, as defined by Amabile, in the business world that she writes in it is often money, in the form of bonuses. “Money doesn’t necessarily stop people from being creative, but in many situations, it doesn’t help” (Amabile, 1998, p. 79) Intrinsic motivation is according to her research by far the most important motivation type for creativity. To explain intrinsic motivation Amabile uses several famous scientists and athletes as examples who talk about the labour-of-love aspect. It is possible to work so hard, put in long hours, exercise hard because it does not feel like work - it is passion and interest. “A person’s internal desire to do something”(Amabile, 1998, p. 79). Interestingly enough, Amabile’s research has shown that intrinsic motivation is the easiest, fastest and cheapest way for managers to improve their workers creativity. Expertise and creative-thinking skills can of course be improved, “but the time and money involved in broadening her knowledge and expanding her creative-thinking skills would be great. (...) those that affect intrinsic motivation will yield more immediate results” (Amabile, 1998, p. 80). According to her research, the managerial practices that will result in more creativity among the workers, by affecting intrinsic motivation, are challenge, freedom, resources, work-group features, supervisory encouragement and organizational support. According to Neuringer and Jensen (2013) these studies and the literature is deeply controversial.

Creativity, antisocial behavior and depression

Alas, the children who continue to express creativity throughout the school years are the ones who are difficult to socialize. In other words, our society inadvertently makes creativity the nearly exclusive property of antisocial personality types (Epstein, Runco, & Pritzker, 1999, p. 765).

Akinola and Mendes (2008) writes that decades of empirical research of creative individuals has identified a relatively consistent set of characteristic. These traits include introversion, emotional sensitivity, openness to experience, impulsivity and at the extreme - mood disorders. They go on stating that even though traits have been reliably linked to creativity, situational factors have also been reliably linked to creative behavior. A few studies have suggested that positive mood can enhance creativity, but the majority of studies have shown that “negative affect can have a facilitative effect on creativity” (Akinola & Mendes, 2008, p. 1678). Their experiment measured creativity after social rejection, social approval or a control group. They also divided the participants by a measure of biological products linked to depression (DHEAS). Their result was that individuals who were more depressed had a greater affective vulnerability when receiving rejecting social feedback. Social rejection resulted in greater artistic creativity than social approval or non-social situations. Social rejection *and* biological vulnerability resulted in better performance on the artistic creativity task.

Conversely several studies conclude that depressed individuals have maladaptive behavior due to low variability (Neuringer, 2002). E.g. an experiment where moderately depressed students were varying less and being less successful in identifying faults in a series of interconnected circuits than the non-depressed control group (Channon & Baker, 1996). In another experiment, depressed patients generated less variable response sequences when

asked to generate random sequences of numbers, than those of non-depressed controls (Horne, Evans, & Orne, 1982).

Akinola and Mendes (2008) quotes several other articles when they argue that negative moods can enhance the results during tasks that “require concentration, precise execution, divergent thinking, and analogical problem solving” (Akinola & Mendes, 2008, p. 1678). Whereas in other cases positive moods can enhance creativity in tasks that require “rapid, less effortful judgment heuristic strategies that show little systematic and analytical processing” (Akinola & Mendes, 2008, p. 1678).

Generativity Theory

Generativity Theory (Epstein et al., 1999) suggests that creative, novel and variable behavior is previously established behavior which compete in an orderly and dynamic way when individuals vary their behavior. According to this theory, what elicits creative behavior is extinction, reinforcement, resurgence and automatic chaining. Extinction, the cessation of reinforcement, make individuals, whether human or animal, understand that their current behavior is insufficient or wrong. When altering their behavior they are trying previously learned behavior not used in this setting before, resurgence. This can lead to that they, by chance, stumble over a solution that solves the problem. They are reinforced. According to generativity theory this happens due to automatic chaining. “A process wherein a sequence of behaviors emerges when one behavior accidentally produces a stimulus that makes another behavior more likely” (Epstein et al., 1999, p. 759). An example of this, given by Epstein et al., is Norman Maiers “two-string” problem. Subject have to solve how to tie two strings together, suspended in the ceiling too far apart to be reached simultaneously. They are shown an object, such as pliers, before starting to solve the problem. Normally the subject take hold of one string and try to reach the other, which is impossible. Most subject then take hold of

the other string and tries to reach the first string, still impossible. Some subjects repeat this several times. After a while though, subjects will try to use the object (extinction and resurgence). They tie the object, which in this example was pliers, to one of the strings and then attempts to hold in the pliers and reach the other string. But, the other string is still out of reach. The solution to the problem is to tie the object to one string and set that string in motion. The subject can then walk over to the other string and catch the string with the pliers tied to it, which has been set in motion. Tying the two strings together is now a simple matter. The automatic chaining in this example is that when realizing that one cannot reach the two strings, the subjects ties the pliers to the string. They do this because they hope the string, with pliers, will now be long enough to reach the other string. When this does not function, the fact that they have tied the pliers to the string make it more likely for them to set the string in motion, automatic chaining.

According to Generativity Theory, novel behavior (including the verbal and perceptual behaviors we often call “ideas”) is the result of an orderly and dynamic competition among previously established behaviors, during which old behaviors blend or become interconnected in new ways (Epstein et al., 1999, p. 763).

According to this theory there are four core competency areas that are essential for the expression of creativity in individuals. The first competency is the preservation of new ideas. Remembering or writing down new ideas that might come to mind at any time. The second competency is to seek challenges. Individuals need to subject themselves to difficult and challenging tasks. Tasks that will require performance exceeding current level of knowledge. Through trial and error resurgence of old behaviors will occur, when current behavior is ineffective. “Thus, learning to manage failure – and not to fear failure – is an important means of boosting creativity (Epstein et al., 1999, p. 765). The third competency is to broaden skills and knowledge. Knowledge outside areas of expertise will lead to a more diverse repertoire of

behaviors. The fourth and last core competency is changes in the physical and social environment. “A static environment is deadly for generative processes” (Epstein et al., 1999, p. 765).

Feedback

Thorndike’s “law of effect” is considered to be the foundation of feedback thinking today.

Thorndike’s law of effect states:

When a modifiable connection between a situation and a response is made and is accompanied or followed by a satisfying state of affairs, that connection’s strength is increased. When made and accompanied or followed by an annoying state of affairs, its strength is decreased (Thorndike, 1913, p. 4) (As cited in Bangert-Drowns, Kulik, Kulik, & Morgan, 1991, p. 213).

This same “law of effect” is also the foundation of the principle of reinforcement in behaviorism. This principle states that behavior is followed by consequences that either increase (reinforcement) or decrease (punishment) the probability of the same response in the future (Pierce & Cheney, 2008).

Bangert-Drowns et al. states:

Not only behavioral and cognitive paradigms incorporate feedback as an essential element of learning. Any theory that depicts learning as a process of mutual influence between learners and their environment must involve feedback implicitly or explicitly because, without feedback, mutual influence is by definition impossible. Hence, the feedback construct appears often as an essential element of theories of learning and instruction (Bangert-Drowns et al., 1991, p. 214).

In a meta-analysis on the effects of feedback interventions on performance Kluger and DeNisi (1996) conclude that feedback interventions are double-edged swords because they only sometimes improve performance. Other times, under certain conditions, feedback interventions are detrimental to performance. The results of their meta-analysis demonstrated that feedback intervention effects are very variable. The interventions reduced performance in over one third of the cases included in the meta-analysis. This stands in contrast to, what Kluger and DeNisi call, “a widely shared assumption that FIs consistently improve performance” (Kluger & DeNisi, 1996, p. 254).

A meta-analysis of the effects of feedback type on discrimination learning in children was conducted in 1985 (Getsie, Langer, & Glass, 1985). Their results show that verbal punishment give the most effective learning, compared to symbolic, tangible and verbal reward and symbolic and tangible punishment. Since it is a meta-analysis, the exact method of each experiment is not explained. The literature used in the meta-analysis is not included in the reference list, which makes it somewhat difficult to interpret how reward and punishment is defined in the different experiments. Reward is explained as “a light flash, the word “right”, or a tangible reward (e.g., a piece of candy)” (Getsie et al., 1985, p. 10). When it comes to punishment, only tangible punishment is explained. Tangible objects are usually awarded for correct response and tangible punishment is retraction of the awarded objects for incorrect responses. The typical types of verbal and symbolic punishment used in the studies included in the meta-analysis is not explained.

Hattie and Timperley (2007) argues that the commitment to a goal is a major mediator for the effect of positive and negative feedback. According to their research individuals who are committed to a goal, is doing something they want to do, will learn more from positive feedback compared to negative feedback. But, when doing something they have to do, not committed to, negative feedback will increase motivation relative to positive feedback. The

authors do note that “It is likely, however, that this effect is short lived in that it may lead to future task avoidance behavior” (Hattie & Timperley, 2007, p. 99).

In the article “Tell me What I did Wrong: Experts Seek and Respond to Negative Feedback” (2012) Finkelstein and Fishbach reach a conclusion that appears contradictory to Hattie and Timperleys (2007) conclusion. Finkelstein and Fishbach (2012) conducted five studies to see if there is a shift toward seeking and responding to negative feedback as consumers gain expertise. Two of the studies measures the expertise of the subjects while three studies manipulate the feeling of expertise. The five different studies were on a language class, environmental friendly actions, beauty products, learning a new language and recycling programs. The research addressed situations where people looked for feedback to motivate themselves to pursue their goals, and measured both how they sought feedback and how they responded to the feedback by changing their attitudes and behavior. Finkelstein and Fishbach (2012) found that the subject in general sought and endorsed negative feedback. Subjects manipulated, or measured to be experts sought and was more motivated to learn, donate and recycle when receiving negative feedback. Their findings was that experts not only tolerated constructed negative feedback, but actually preferred it over constructive positive feedback. Novices were more motivated, learned, donated and recycled more when receiving positive feedback, but were not averse to negative feedback. “In particular, negative feedback seems to serve an important function when it is constructive, rather than detrimental, and when people desire to acquire new habits or improve existing ones, rather than enhance their self-image (Finkelstein & Fishbach, 2012, p. 36).

Nelson and Craighead (1977) conducted an experiment where they, among other tests, gave 24 depressed and 21 non-depressed undergraduates a high rate of reinforcement and a low rate of punishment. Whether the subjects were depressed or not was assessed using Beck’s Depression inventory. High reinforcement – low punishment made the depressed subjects

recall more negative and less positive feedback than the non-depressed controls. The depressed subject were accurate in their recall of the rate of reinforcement/punishment, whereas the non-depressed controls underestimated the rate of negative feedback.

Langer (1989) discusses the difference between mindfulness and mindlessness. She views mindfulness as a state of awareness or an alertness with active information processing where individuals create categories and distinctions. Whereas response patterns that are symptomatic with mindlessness, attends to less information, and the information is not readily available later for conscious consideration. She states: “When mindful, the individual is in a position to notice more in the environment. And this openness may enable the individual to see opportunities (...) that the mindless person would overlook” (Langer, 1989, p. 144). This ability promotes, among other skills, greater creativity according to Langer and Piper (1987) and enhances flexibility (Langer, 1989). Wofford and Goodwin (1990) conclude that when things are going well, receiving positive feedback, individuals abbreviate the interpretation stage activities, and when things are going poorly, receiving negative feedback, the interpretation stage activities appear more extensive. In *Feedback and mindless information processing: A negative side of positive feedback?* Dunegan (1990) discusses the findings of his study conducted to test whether the emergence of mindful versus mindless decision processes might be related to the type of feedback decision makers receive. His experiment was a classroom exercise on decision making. Feedback was manipulated to be either negative, mixed or positive. The results of his experiment indicate that negative or mixed feedback made participants more likely to engage in decision processes that would be described as mindful by Langer (1989). Whereas the participants who received positive feedback exhibited process characteristics Langer associates with mindlessness. Dunegan (1992) states that there is no empirically-based defense for labeling mindful decision

processes better than mindless processes. Mindful processes will probably take more time and effort, and it is not certain that the decision turns out to be correct anyway.

Feedback and creativity

Although creativity requires more than just variation in behavior it has been argued that variation, possibly random variation are necessary (Campbell, 1960). Neuringer's (1986) study concluded that what people needed in order to manage to respond randomly was feedback. Some earlier experiments had concluded that people could not respond randomly (e.g. Brugger, 1997). According to Neuringer (1986) this experiments had typically been to ask people to fill in "H" for heads and "T" for tails in boxes on a form. They were asked to do so in an unbiased manner, thinking of a coin being tossed. The analysis of these type of experiments showed that the responses differed from those who would be expected by chance. Neuringer's (1986) experiment included undergraduates students who in baseline conditions failed to respond randomly, they entered the digits "1" and "0" on a computer and where asked to do so randomly, thinking of coin tosses. The difference with this experiment was that the subjects received statistical feedback after each set of a hundred responses to see if feedback would enable them to respond randomly. The study were the first to prove that random behavior in humans can be taught by statistical feedback. It concluded that individuals generate highly variable response sequences when the environment explicitly requires and support such variability.

The Dunegan (1992) experiment mentioned above was not about feedback and creativity. But, one can be tempted to suggest that individuals who receive positive feedback, and according to Dunegan exhibited behavior associated with mindlessness, would be less flexible, open and creative. Skills that Langer (1989; 1987) relate to individuals who are in a more mindful state.

Shalley and Perry-Smith (2001) manipulated the controlling and informational aspects of expected evaluation and gave different examples of solutions as modeling experience. The individuals were provided with either no example, a standard example, or a creative example of a solution to a representative management problem. They reported that individuals anticipating an informational rather than a controlling evaluation had significantly higher creativity and intrinsic motivation, and individuals given a creative example had a higher creative performance than subjects given no example. When expecting a controlling evaluation and a standard example was given, the lowest levels of intrinsic motivation and creativity were found. In their article “Managing Creativity Enhancement Through Goal-Setting and Feedback” Carson and Carson (1993) showed that individuals who got informational feedback about their creativity on a task, exhibited higher creativity on subsequent trials of the same task, than the individuals who received no feedback.

The real world – learning to behave

Flora (2004) states an obvious, but I do believe, often overlooked fact in his book “The power of reinforcement”. From we are children we learn to behave conventional. “A lot, perhaps most of what is expected and reinforced in early childhood centers on behaving socially approved, standard, conventional – that is, noncreative – ways” (Flora, 2004, pp. 80-81). He gives several examples of this. E.g. talking appropriately, when the child has acquired the skills to do so, will be reinforced, baby talk or creative non-conventional talking will not be reinforced at this point. Flora uses this fact to explain why, in many experimental situations designed to see which effect positive reinforcement has on creativity, the experimenters find that positive reinforcement, expected rewards, is detrimental to creativity. We all learn from early age that in testing situations, circumstances where our behavior will be evaluated, conventional behavior is reinforced. E.g. in a math or spelling test at school, creative behavior

is seldom reinforced, whereas conventional behavior is correct and “good work”. Flora also tells the story of an art teacher who instructs her student to draw monster pictures, in first grade the monster pictures are highly creative, but by fourth or fifth grade she finds it next to impossible to make the children draw creative monster pictures. Even if she tries to encourage them to draw creative pictures, the other pupils will tease and laugh at the pictures who do not resemble the monsters they know from the media.

Epstein et al. (1999) argues that the socialization process starts when children enter the first grade. Educational demands discourage them from expressing unusual ideas or daydream. They argue that children who were creative in kindergarten stops expressing creativity by the end of first grade. Only a small number of people acquire the four competencies, that Epstein et al. deems necessary for creative expression, and they learn them by chance or accident, but the majority of people have very few of the skills needed for the expression of creativity. “Few people have the appropriate competencies necessary for the expression of creativity because our educational system does not teach these competencies and because society in general discourages most people from expressing creativity” (Epstein et al., 1999, p. 766).

Exploration vs exploitation

Creativity is, as mentioned earlier, much in demand in organizations today. But, as noted by, among others, Axelrod and Cohen (2000) the testing of new types, varying behavior and creating new products, comes at the expense of realizing the benefits of those already available. There is a trade of principle between already tested types, that so far has proven best, and untested types that may, or may not, prove superior. Testing new types will be especially costly in the cases were the new, untested types does not prove superior to the existing ones. Or, the cases where even though they are superior, they are not wanted or selected by others.

Neuringer states; “Of course survival also depends upon learning to respond in consistent or repeatable ways to certain environmental conditions, and an organism must therefore learn when to vary, when to repeat, and adaptive levels of variation between these two” (Neuringer, 2009, p. 321).

It is also worth noting that creativity is not only a desirable resource, it can also be harmful and potentially threatening if used for destructive purposes (Kampylis & Valtanen, 2010). The majority of creativity researchers focus on benevolent creativity, “good” creativity that leads to ethical and constructive purposes. It is evident though, as put forward by Kampylis and Valtanen (2010), that creativity is also being used for deliberately planning to damage others, often related to crime, competition and terrorism, malevolent creativity.

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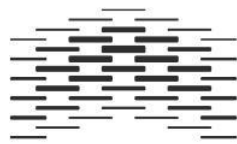
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Does feedback sign in the learning history affect variability?

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Abstract

This experiment involved college students and kindergarten employees (N = 53) completing a simple computer experiment under three conditions: only positive feedback on correct answers, only negative feedback on wrong answers or persistent negative feedback on wrong answers. Additionally, the time the subjects used was recorded, and they were asked to comment on what they thought of completing the experiment. Negative feedback was found to relate to variability in answering and positive feedback was found to relate to repetition in answers in subsequent tasks where no feedback was provided. The results from persistent negative feedback is unclear. Acquisition took significantly longer in time and quantity of tasks when receiving only positive feedback than when receiving only negative or persistent negative feedback. There were very little difference in how the subjects perceived the different feedback signs in this brief and relatively easy experiment. This study concludes that we vary our behavior when receiving negative feedback – our current behavior is wrong and need to be changed, and we repeat when receiving positive feedback – our behavior works and there is no need to try something else. The results of this study indicates that these behaviors, varying and repeating transfers to subsequent and similar tasks where there is no feedback.

Introduction

Feedback is often considered vital to the learning process (e.g. Bangert-Drowns, Kulik, Kulik, & Morgan, 1991). In order to learn what is correct or find the best practice we need to receive feedback. “The manner in which different types of feedback affect learning has long been of central concern in psychological studies of decision making” (Hogarth, Gibbs, McKenzie, & Marquis, 1991, p. 734). For close to a hundred years, commencing with Edward L. Thorndike at the beginning of the 20th century, there has been quite extensive research on feedback theories.

In the complex world we live in, which is getting more complex every day, creative employees has been and are still highly in demand in organizations (e.g. Berman, 2010). Cognitive scientist did, when starting creativity-research, believe that creativity was a trait. Either one had the creativity trait, or one did not. Recognizing the trait in the creative individuals was of major concern for the scientists. More recently, although some decades ago, most cognitive scientists acknowledged that factors in the surrounding environment can affect creativity in individuals. According to behaviorism, variability in behavior, or creativity, is entirely the result of the contingencies in the environment. “Operant behavior is a joint function of past and present contingencies of reinforcement and punishment, including those responses deemed “novel” or “creative”.” (Lieving & Lattal, 2003, p. 217).

With more or less everyone recognizing the need for change and development both in organizations and in the society, in order to, among other things, survive as an organization and preserve the planet. Along with the extensive research performed to discover how feedback affect behavior, it was surprising to search in vain for studies looking at the relationship, if there is any, between feedback and variability or creative behavior. The basic

goal of this study is to explore the aspect of positive and negative feedback and their effect on variability in behavior.

Variability, Creativity, and Stereotyped behavior

According to Neuringer (2002) variability in behavior implies dispersion and unpredictability.

“Behaving in an unusual, variable, or unpredictable manner is sometimes functional.”

(Neuringer, 2002, p. 672). When individuals vary their behavior there exists variability. When an individual tries to open a door by pushing it, but the door does not open, pulling the door to try to make it open up will be variability in behavior. Stereotyped and repetitive behavior is according to Neuringer (2002) at the other end of the scale from stochastic behavior. It is a persistent repetition of behavior, without variation. Persistent repetitive behavior is also sometimes functional, e.g. working on an assembly line in a factory. This study does not imply that variability is “correct” or a more functional behavior than stereotyped behavior. Schwartz (1982b) concludes that stereotyped behavior will be efficient in circumstances where doing what has succeeded in the past is an effective strategy. But, in situations where repetition of past success is inappropriate it may be inefficient or even counterproductive.

“Creativity is the ability to produce work that is both novel (i.e. original, unexpected) and appropriate (i.e. useful, adaptive concerning task constraints) (Sternberg, 1999, p. 3). Among others, Campbell (1960) argues that variations in behavior are an essential part of creativity. Runco (2012) argues for the concept of divergent thinking as an indicator of creative thinking. Although, he warns, divergent thinking is not creativity. “Divergent thinking often leads to originality, and originality is a the central feature of creativity, but someone can do well on a test of divergent thinking and never actually perform in a creative fashion” (Runco & Acar, 2012, p. 66). Convergent thinking, typically leading to conventional and “correct” ideas and solutions, is the contrast of divergent thinking. Tests on divergent thinking can include, among others, the following components - fluency, originality and flexibility. “A fluent

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individual gives a large number of ideas. Originality is usually defined in terms of novelty or statistical infrequency. Flexibility leads to diverse ideas that use a variety of conceptual categories (Runco & Acar, 2012, p. 67). It would be natural, although to my present knowledge not empirically tested, to believe that these components require variability in behavior.

Within the field of behaviorism, several experiments give a clear indication that variability in animal and human behavior can be elicited with reinforcement (e.g. Neuringer, 2009; Pryor, Haag, & O'Reilly, 1969). An example of this is Goetz and Baer's (1973) experiment with three preschool girls and block-building. They socially reinforced new forms of block-building by having the teachers say something e.g.: "That's very nice – that's different!" (Goetz & Baer, 1973, p. 212), to the three girls who in the baseline sessions had constructed very simple and repetitive constructions. The result of this experiment was that all three girls showed increasing form diversity when they received social positive reinforcement for creating different forms.

Schwartz (1982a) on the other hand failed to produce response variability with positive reinforcement. Schwartz's experiment used a checkerboard-like light matrix. The subjects had to move the light from the upper left corner to the bottom right square, pressing either a right key or a left key. They were only permitted to press either key four times each. Whenever they pressed one of the keys a fifth time there was a time-out. The variability requirement was, in one of the experiments (Schwartz, 1982a), that a correct sequence had to be different from the preceding trial. The results of these experiments was that the subjects received very little reinforcement when the procedure required sequence variability, because they either used the same sequence over and over or pressed one of the keys more than four times. Schwartz concluded that reinforcement produced stereotyped response patterns and therefore that reinforcement interferes with problem solving. After several experiments Schwartz

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concluded “When reinforcement depends on the execution of a sequence of responses, stereotyped sequences develop although the reinforcement contingency permits variability” (Schwartz, 1982b, p. 48). Holth (2012) argues that it is a well-established empirical finding that contingencies that do not require, only permit variability, produces repetitious topographies.

Several experiments show that extinction make individuals vary their behavior (e.g. Iversen, 2002; Morgan & Lee, 1996). Iversen’s (2002) experiment demonstrated how extinction alternating with continuous reinforcement schedules made rats vary their topographic behavior. When the rats operated and omnidirectional pole, which under continuous reinforcement schedules led to reinforcement, they automatically took snapshots of themselves, and thereby showing their topographic behavior at the time. These pictures show that the rats have about the same topographic behavior when operating the pole under continuous reinforcement. Whereas under extinction their topographic behavior changes quite dramatically.

Generativity theory suggests that novel behavior “is the result of an orderly and dynamic competition among previously established behavior”(Epstein, Runco, & Pritzker, 1999, p. 763). According to this theory extinction, reinforcement, resurgence and automatic chaining is what provokes creative behavior. Extinction, the cessation of reinforcement make it clear that the current behavior is wrong. When altering the behavior, individuals try previously learned behavior not used in that setting before, called resurgence. Automatic chaining is “a process wherein a sequence of behaviors emerges when one behavior accidently produces a stimulus that makes another behavior more likely” (Epstein et al., 1999, p. 759). By chance, they may stumble over a solution that solves the problem, and receives reinforcement. According to Epstein subjects confronted with the “two-string” problem is an example of the theory. In the “two-string” problem, subjects are in a room where two strings hang suspended from the

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ceiling. Their task is to tie the two strings together. An object, such as pliers, may help to solve the problem. The two strings are too far apart to be touched simultaneously. Subjects will, after trying in vain to pull either string towards the other, tie the object to one string to make it longer and then try to reach the other string. Even with the object tied to one string, it is still not long enough to make contact with the other. The solution is to set the string with the heavy object tied to it in motion in a large arc, walk over to the other string, pull the other string towards the string set in motion and catch the swinging string when it swings within reach.

Feedback sign

“There is no widely agreed scholarly definition of ‘feedback’. Indeed, in much of the literature, the definition of the term is left implicit” (Scott, 2013, p. 49). The search for definitions on feedback signs has therefore yielded several more or less suitable definitions. One definition which is considered useful by researchers relates to information presented that allows comparison between actual and a desired outcome (Ramaprasad, 1983). Latham and Locke (1991) describes feedback as information, data, that does not necessarily have any consequences on behavior at all, “its effect on action depends on how it is appraised and what decisions are subsequently made with respect to it” (Latham & Locke, 1991, p. 224)

Feedback sign refers to whether the feedback is supposed to be positive (feedback when correct) or negative (feedback when incorrect) (Van-Dijk & Kluger, 2004).

Thorndike’s “law of effect” is regarded as the foundation of feedback thinking.

When a modifiable connection between a situation and a response is made and is accompanied or followed by a satisfying state of affairs, that connection’s strength is increased. When made and accompanied or followed by an annoying state of affairs,

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its strength is decreased (Thorndike, 1913, p. 4) (As cited in Bangert-Drowns et al., 1991, p. 214)

In a meta-analysis on the effects of feedback interventions on performance Kluger and DeNisi (1996) concludes that feedback interventions are more effective when the feedback presents the correct solution (.43) than when the feedback does not contain the correct solution (.25). Feedback provided from a computer is more effective (.41) than if it is provided from other sources (.23). Feedback interventions are very effective when task complexity is low (.55), whereas if the task complexity is high feedback interventions are hardly effective at all (.03). The meta-analysis also concludes that feedback interventions are more effective when the task involves memorizing something (.69), than if the task is not about memorizing (.30).

A meta-analysis (Getsie, Langer, & Glass, 1985) investigated the effects of feedback type on discrimination learning in children. The meta-analysis concluded that verbal punishment gave the most effective learning, compared to symbolic, tangible and verbal reward and symbolic and tangible punishment. Verbal punishment is, in the studies included in the meta-analysis, defined as verbal feedback after incorrect responses.

Finkelstein and Fishbach's (2012) study within marketing research provided some interesting results about individuals feelings towards feedback. They conducted five different studies relating to several different topics, learning a foreign language, caring (donating) to environmental actions, beauty products and recycling. One part of their theory was that individuals, who conceived themselves as expert, whether true or not, would seek more negative feedback than those who perceived themselves to be novices. The other part of their theory was that individuals would increasingly seek negative feedback as they gained expertise.

Reinforcement and Punishment

Thorndike's law of effect, mentioned above, is also the foundation of operant behavior theory.

“Today, Thorndike's law of effect is restated as the principle of reinforcement. This principle states that all operants may be followed by consequences that increase or decrease the probability of response in the same situation.” (Pierce & Cheney, 2008, p. 15)

“A reinforcer that follows an operant increases the likelihood that the operant will occur in the future. The process by which the frequency of an operant is increased is called reinforcement.” (Baldwin & Baldwin, 1986, p. 48).

Positive reinforcement is often described, by among others Pierce and Cheney (2008) by the three-term contingency; $S^D : R \rightarrow S^f$. A discriminative stimulus (S^D) sets the occasion for operant behavior (R) that is followed by a reinforcing consequence (S^f). We know that the consequence is a reinforcer, when the rate of the behavior increases as a result of the stimulus that followed the behavior.

Punishment is the opposite of reinforcement. A consequence of a behavior is said to be punishing if in the future the behavior decreases (Pierce & Cheney, 2008). Punishment has not occurred if the aversive event presented after the behavior does not decrease the behavior.

Feedback sign vs Reinforcement and Punishment

To give an individual positive feedback is not the same as to give a positive reinforcer, although the terms have the same origin, Thorndike's law of effect as previously mentioned. There are several similarities between feedback and reinforcement/punishment, among others that a behavior has to occur before it can be reinforced (or punished) (Balsam & Silver, 1994). The same is true for feedback, feedback can only occur after an event or behavior has occurred. This study is about positive and negative feedback. Positive reinforcement and

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punishment has been included because a lot of the older, and some of the new, research studies do mix the terms, e.g. Kluger and DeNisi writes the following:

Based on the law of effect, a positive FI was equated with reinforcement and a negative FI with punishment. Reinforcement and punishment facilitate learning and hence performance. Both a positive FI and a negative FI should improve performance because one reinforces the correct behavior and the other punishes the wrong behavior (Kluger & DeNisi, 1996, p. 258).

FI is an abbreviation for feedback intervention. Several studies do also give the participants positive feedback and call it positive reinforcement (e.g. Goetz & Baer, 1973). Positive reinforcement is defined by the fact that when an individual receives a reinforcer it increases the probability that the behavior will happen again. Hence, if positive feedback after a behavior increases the probability of that behavior, then the positive feedback is by definition a reinforcer. Positive feedback is normally defined as giving an individual a comment, a signal or a tangible object, which has the meaning that the behavior was correct (at least when we are talking about external feedback from another individual or computer). While some researchers, as mentioned earlier, argue that feedback is only information and as such does not necessarily have a consequence on performance (Latham & Locke, 1991). Several researchers within the field of feedback does uncritically believe that positive feedback will improve performance (Kluger & DeNisi, 1996).

The same is true for punishment and negative feedback. Punishment, in the behavioristic meaning, indicates that the behavior that has been punished declines. Negative feedback means to give individuals a comment or some other sign that the e.g. behavior or answer is considered incorrect and should be altered or removed. Whether the behavior changes or declines is not of interest in most of the definitions on negative feedback.

Rationale and Aims

The present study is an initial endeavor to establish whether positive feedback on correct answers or negative feedback on wrong answers has any effect on future variability in behavior. As it is a preliminary study, it is elementary. There is, of course, several other possible elements affecting variability. And, even if it can be established that feedback sign does affect variability, it does not necessarily follow that it makes individuals creative.

The study uses a basic computer program, where the subjects learn simple tasks receiving either positive, negative or persistent negative feedback, moving directly on to a second phase with similar but not identical tasks, where they receive no feedback and are free to choose. This makes it possible to suggest that the feedback they received in the learning session are, at least in part, in control of the following behavior. It can be argued that receiving only positive feedback when correct or negative feedback when incorrect is spurious and far from a real learning experience, but in order to see the effects of the different feedback signs it is at this point deemed necessary.

The dependent variable in this study is variation in the answers given by the subjects in phase 2. This is operationalized as where the subjects choose to click when asked to choose two out of four possible items, and if they choose the same or different items when subsequently receiving exactly the same task later on. The time spent learning is another dependent variable, it is measured in seconds and how many rounds the subjects use before learning what is correct. The independent variables are positive feedback on correct answers - blank when answering wrong, negative and persistent negative feedback on wrong answers – blank when answering correct, given to the subjects in phase 1. Emotion towards the experiment is measured through self-reported comments after completion of the experiment. It is recorded

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in order to evaluate how individuals feel depending on the feedback sign, and also due to the possibility that it might be an intervening variable.

As mentioned earlier, extensive search in different article databases, within learning, management, psychology, marketing and behaviorism has, quite surprisingly, not yielded any other experiments who has looked for a connection between positive and negative feedback and variability or creativity. The main aim of this study is to investigate whether;

The use of positive or negative feedback in a learning session will affect the later use of repetition or variability?

As this is a preliminary study, there are no earlier research to indicate if, or how, feedback sign affect variability. Research on positive reinforcement, extinction and variability does not give a straightforward indication on how feedback may affect variability. As a result, the hypothesis in this experiment is two-sided.

H₁: Feedback sign in the initial learning session, phase 1, will affect the variability in answers in a subsequent session, phase 2, where there is no feedback.

Earlier research on discrimination learning in children has, as mentioned earlier, brought forth a clear indication that feedback on incorrect answers yields the most effective learning. The time and the number of rounds each subject used in phase 1 of the experiment were therefore recorded, to see if this experiment yielded the same results. The time spent on phase 2 was also recorded in order to see if feedback sign in phase 1 affected the time spent on subsequent tasks, and to ensure that the difference in time spent on phase 1, if there was any, was not simply due to the fact that the subjects who received positive feedback was generally slower.

H₂: The subject receiving positive feedback in phase 1, the learning session, will learn slower than the subjects who receive negative or persistent negative feedback.

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The subjects had the opportunity to comment, in writing, how they felt regarding the experiment, in order to see if there was any difference in feelings towards the experiment dependent on feedback sign. Several researchers has suggested that individuals are negative feedback avoiders (e.g. Tormala & Petty, 2004). Common sense would also be that the subjects receiving positive feedback on correct answers are likely to be more positive to the experiment, than those receiving only negative or persistent negative feedback on wrong answers.

H₃: Subject receiving positive feedback will have a more positive attitude towards the experiment.

Method

Participants

Participants for the experiment were 42 bachelor students at Oslo and Akershus University College of Applied Sciences and 11 employees in a kindergarten. The bachelor students signed up for the experiment at their own will, when the experimenter visited their class and asked for volunteers. The kindergarten employees were asked to volunteer when the experimenter visited their workplace. They vary in age from about 20 to around 50 years of age (age was not addressed in the study, as it was not considered important). They were all informed before the experiment started that phase 1 of the experiment consisted of trying to find out what “belonged together”, both verbally and in writing. They were also informed, in writing, that they could withdraw from the experiment at any time, if they so wanted (See appendix A). The bachelor students had the possibility of winning gift cards at the campus bookstore if they participated and finished the experiment. None of the participants withdrew

from the experiment after having agreed to participate. The type of feedback was randomly assigned by the experimenter.

Instrumentation

The experiment involved a computer session consisting of two phases. Phase 1 consisted of a “learning phase” with feedback. In this phase the subjects got either only positive feedback on correct answers or negative or consistent negative feedback on wrong answers. Consistent negative feedback meaning that the negative feedback stayed on the screen until the subject answered a subsequent answer correctly. The question could be; “which color belongs with orange?” The subject then had two choices, violet or purple. Violet was programmed to be correct, the subjects who got positive feedback, feedback type 1, who answered violet got a smiley face with thumbs up and the word “*correct*” written underneath, and a new question. The subjects who got negative feedback, feedback type 2, or consistent negative feedback, feedback type 3, who answered violet got no feedback, only a new question. If the subjects who received positive feedback answered purple, they got no feedback, only a new question. Whereas the subjects who got negative or persistent negative feedback who answered purple got an angry face with thumbs down, and the word “*wrong*” written underneath, and then a new question. The persistent negative feedback group had the angry face, thumbs down, with “*wrong*” written underneath on the screen at the same time as the new question, where it stayed until they answered a new question correctly (see appendix B).

The “learning phase” consisted of eight questions. Two questions with colors, two with different shapes, two with letters and finally two questions with numbers. Whether the subjects learned what was correct, was not considered to be of importance. What was important in this phase was that they received positive or negative/persistent negative feedback. The tasks were supposed to be arbitrary. It was important that the participants would just as easily answer correctly as wrongly. If the tasks had been to learn something that

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actually fitted together, as in number 2 and 6 belong together as they are even numbers whereas 5 does not belong as it is an odd number, it would have been possible for the subjects to understand what was correct and not receive any negative feedback. What was considered to be of importance was that the participants received about the same amount of feedback, whether they were in the negative, persistent negative or positive feedback group. The tasks were also supposed to be very easy, the intention being that even children could be participants.

Phase 1 was programmed in a way that if the subjects learned what belonged together, they went onward to phase 2 if they had at least six of the last eight questions correct in a round. If the participant did not learn, and therefore did not manage to get six correct answers of the last eight, they automatically went to phase 2 after four rounds.

Procedure

Before starting on the experiment the subjects read an information leaflet (see appendix A). They were then seated in front of the computer, which had one button to push which said “start”. After completing phase 1, there where information on the screen saying that they had now finished phase 1. The information also said that in phase 2 there would be no feedback. The participants had to click “*continue*” for phase 2 to start. In phase 2, they were presented with four different tasks, first was a picture of four colors, different colors than those in phase 1, and they were asked to choose two (see appendix C). After having ticked of two colors they pressed confirm and a new task appeared on the screen. The other questions were, choose two letters, choose two figures and choose two numbers, out of four possibilities. All of the objects - colors, letters, figures and numbers were different from those used in phase 1. These questions had to be answered four times each, before completing phase 2. The questions looked exactly the same in each round.

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After completing phase 2 they were asked to give a comment of how they had felt about completing the experiment. They were free to write what they wanted but the words “*ok, uncomfortable, fun*” were suggestions. Unfortunately, several of the first participants missed the comment box as it was easy to overlook. After about one third of the participants had finished the experiment, a warning was inserted if the subjects tried to finish the experiment without writing a comment in order to get more replies.

Eleven of the participants got a slightly different version of the experiment. The two differences in their experiment, from the main experiment, was that they needed seven out of the eight last question correct to proceed to phase 2. In phase 2, the colors, letters, numbers and figures that in the main experiment were fixed, alternated one place each time - anti-clockwise.

Scoring

Figure 1 Example of data results

<p>"New Test Started 10.03.2014 09:49:56" "Participant no.: 41", "Session no: 1", "Session type: 1" "Fase 1: " " No of correct answers in last round: 4" " Amount of time spent: 184" " No of rounds: 4"</p>	<p>" No of horizontal top: 4" " No of horizontal bottom: 4" " No of vertical left: 0" " No of vertical right: 4" " No of diagonal decrease: 4" " No of diagonal increase: 0" " Amount of time spent: 103"</p>
<p>" Fase 2: " "green-blue", "Horizontal bottom" "S-R", "Vertical right" "star-Square", "Diagonal decreasing" "3-9", "Horizontal top" "S-R", "Vertical right" "green-blue", "Horizontal bottom" "3-9", "Horizontal top" "star-square", "Diagonal decreasing" "green-blue", "Horizontal bottom" "S-R", "Vertical right" "star-Square", "Diagonal decreasing" "3-9", "Horizontal top" "S-R", "Vertical right" "green-blue", "Horizontal bottom" "3-9", "Horizontal top" "star-square", "Diagonal decreasing"</p>	<p>" Participant comment: ok. litt merkelig men sikkert en grunn til det" (Participant comment translated: ok. A bit odd but there is probably a reason for it)</p>

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The respondents has two different ways of varying. They can vary their answer, choosing different colors, letters, shapes and numbers. This is an example of a respondent who has not varied the answers at all. The other possibility of varying is where to click. As can be seen from the example in figure 1 this gives them six different ways of varying; horizontal top, horizontal bottom, vertical left, vertical right, diagonal decrease and diagonal increase. This respondent has varied some when it comes to where to click.

These responses where then calculated to variation in percentage. First, the percentage of variation on different colors, letters etc. were calculated, then the percentage of variation where the subjects clicked were calculated. These two numbers in percent where then added together and divided by two. If the respondent chose to repeat the same colors, letters etc. and did not vary where they clicked, but chose for example “horizontal top” each time, this was calculated to 0% variation. No respondent varied enough to get a 100% variation, but a few got 0% variation.

As mentioned above there where eleven respondents who got a slightly different version, where the colors, letters, shapes and numbers changed places anti-clockwise each time for a new answer. For these subjects the percentage was calculated from their answers on colors, letters, shapes and numbers and not from where they had chosen to click. Also, since they had to answer seven out of the last eight correct in phase 1 to precede to phase two, which was different for the other participants who only needed six, these eleven respondents time in phase 1 has not been included in the data.

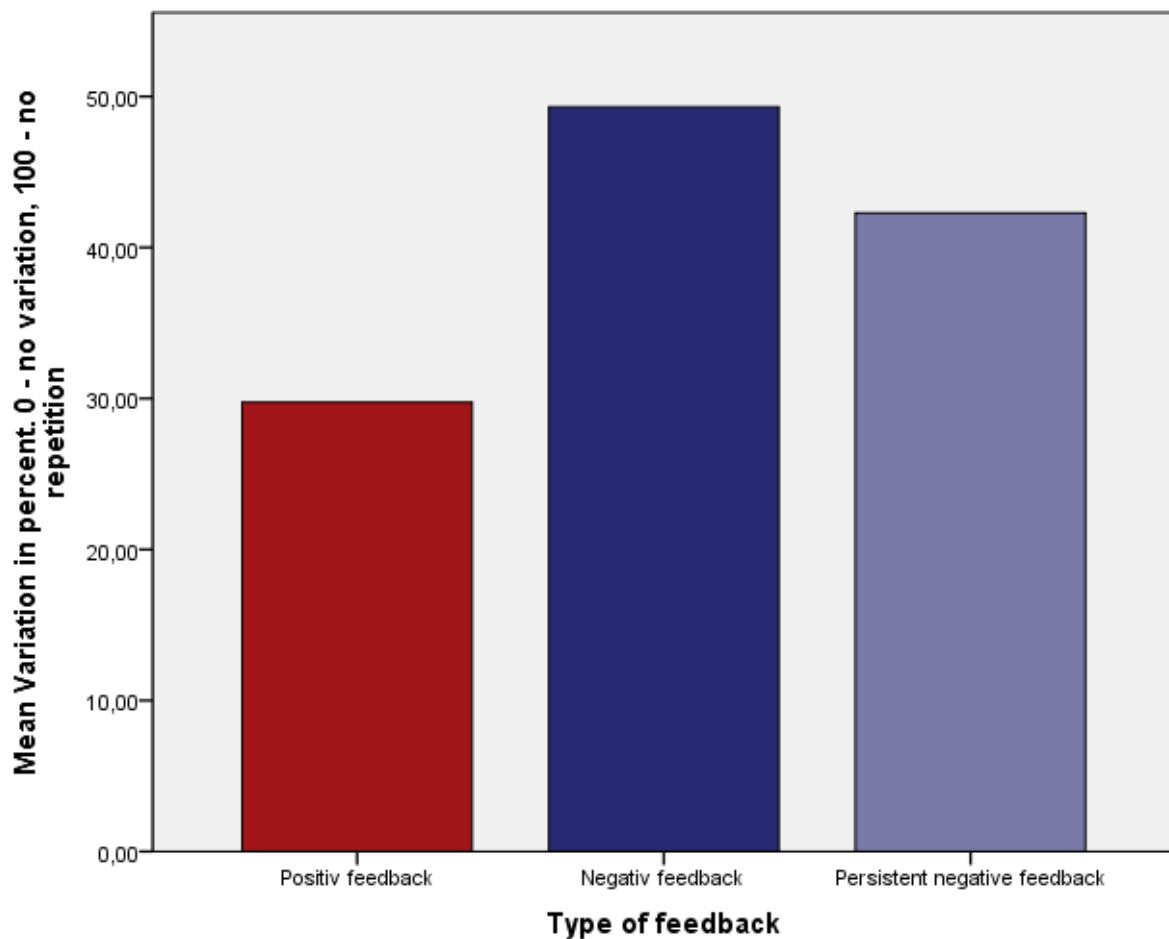
One subject managed, presumably by chance, to get 6 out of 8 replies correct on the first round. This subjects time and number of rounds in phase 1 has been excluded from the data.

Results

Variation

Hypothesis 1, the main question of the study, was whether feedback sign had any effect on the variation in answers in phase 2 of the experiment. Figure 2 illustrates how much the subjects averagely varied their answers in phase 2, divided in categories dependent on the type of feedback they received in phase 1.

Figure 2 Mean variation in percent



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Table 1 Variation mean, standard deviation and median phase 2

Variation in percent. 0 - no variation, 100 - no repetition

Type of feedback	Mean	N	Std. Deviation	Median
Positiv feedback	29,7545	20	25,25119	16,2500
Negativ feedback	49,3059	17	24,56695	51,5600
Persistent negativ feedback	42,2863	16	29,15669	37,5000
Total	39,8089	53	27,09541	37,5000

The data was analyzed using Kendall’s tau correlations analysis, as this is recommended when the data set is small, the distribution is not normal and the dataset has a large number of tied ranks (Field, 2009). The correlation test is two-tailed as hypothesis 1 do not predict a direction. There was a positive, although not significant, correlation between type of feedback in phase 1 and variation in percent in phase 2 $\tau = .159$ $p > .05$ (see appendix D). A positive correlation in this data means that as feedback increases, go from positive to negative to even more negative - positive feedback has the value of 1, negative feedback the value of 2, and persistent negative feedback the value of 3 – variation in percent increases. Figure 2 and table 1 shows that subjects receiving positive feedback in phase 1 varied the least in phase 2, whereas subjects receiving negative feedback varied their answers the most. Subjects receiving persistent negative feedback in phase 1, averagely varied their answers more than those receiving positive feedback but less than subjects receiving negative feedback.

Variability was significantly related to type of feedback, $\tau = .310$, $p < .05$ when excluding the data from persistent negative feedback group (see appendix E). Subjects receiving negative feedback in phase 1 varied their answers significantly more than those subjects who received positive feedback in phase 1.

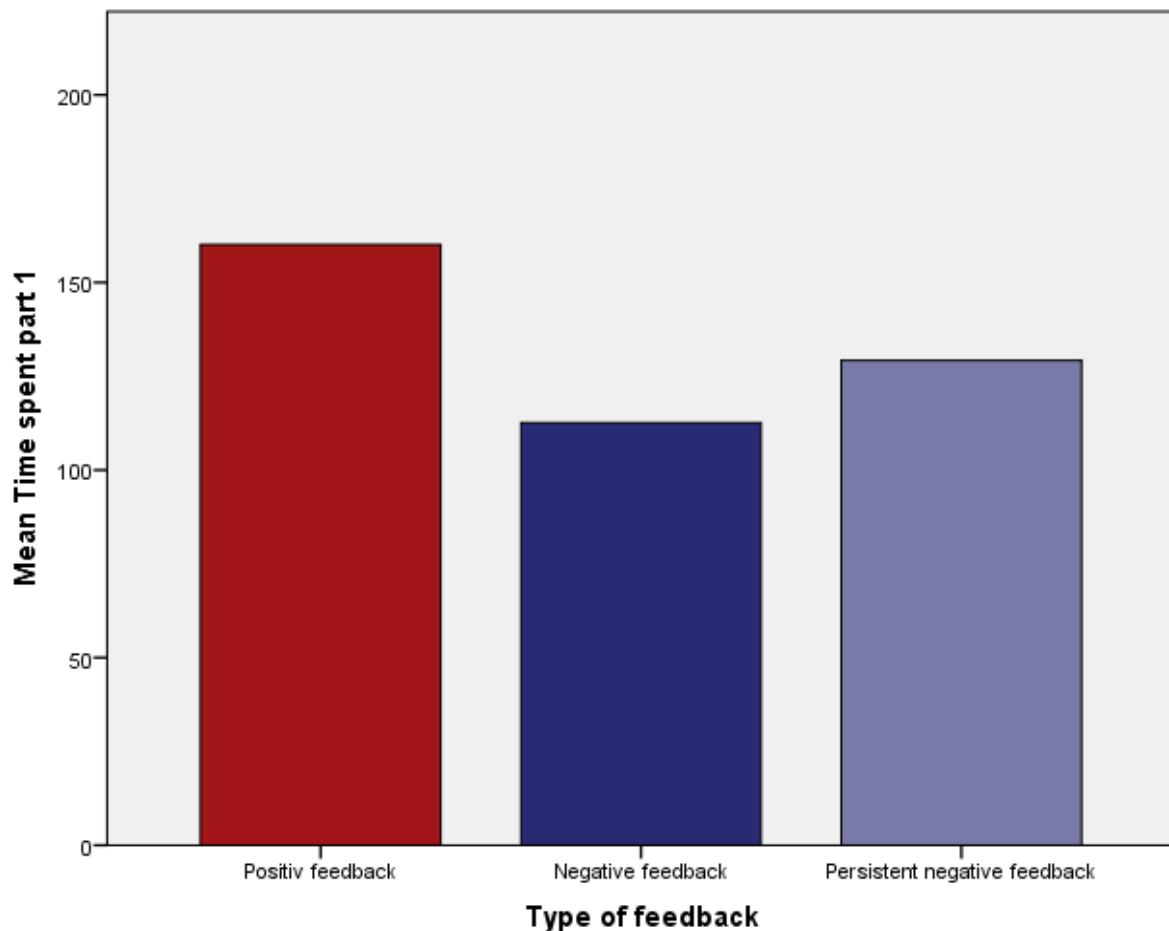
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Still excluding the data from the persistent negative group, the independent Samples Test gave the following results. On average subjects who received positive feedback in phase 1 varied less ($M = 29,7545$, $SE = 25,25119$) than subjects who received negative feedback ($M = 49,3059$, $SE = 24,56695$). This difference was significant $t(35) = -2,376$, $p < .05$. It represents a medium size effect $r = .37$.

Time phase 1 and 2

Hypothesis 2 anticipated a difference in the time spent in phase 2, on the basis of feedback sign in phase 1. Both the time used in phase 1 and phase 2 was analyzed.

Figure 3 Average time spent phase 1



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Figure 3 shows the average time, measured in seconds, the subjects used in phase 1, divided in the three categories positive, negative and persistent negative feedback.

Table 2 Time spent phase 1 mean and standard deviation

Time phase 1

Type of feedback	Mean	N	Std. Deviation	Median
Positive feedback	160,13	15	48,356	166,00
Negative feedback	112,62	13	21,018	105,00
Persistent negative feedback	129,25	12	37,490	131,00
Total	135,43	40	42,328	130,50

Feedback sign was significantly correlated to the time spent learning the tasks in phase 1, $r = -.325$, p (one-tailed) $< .05$ (see appendix F).

The Anova reported a significant difference in time spent learning the tasks in phase 1. $F(2, 37) = 5,67$, $p < .01$, $w = .43$ (see appendix F), $w^2 = 0.18$ which represents a large effect (Field, 2009). The post-hoc test Tukey HSD revealed that the significant difference was between the positive feedback and negative feedback group. The persistent negative feedback group did not differ significantly from any of the other two groups.

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Figure 4 Average time spent phase 2

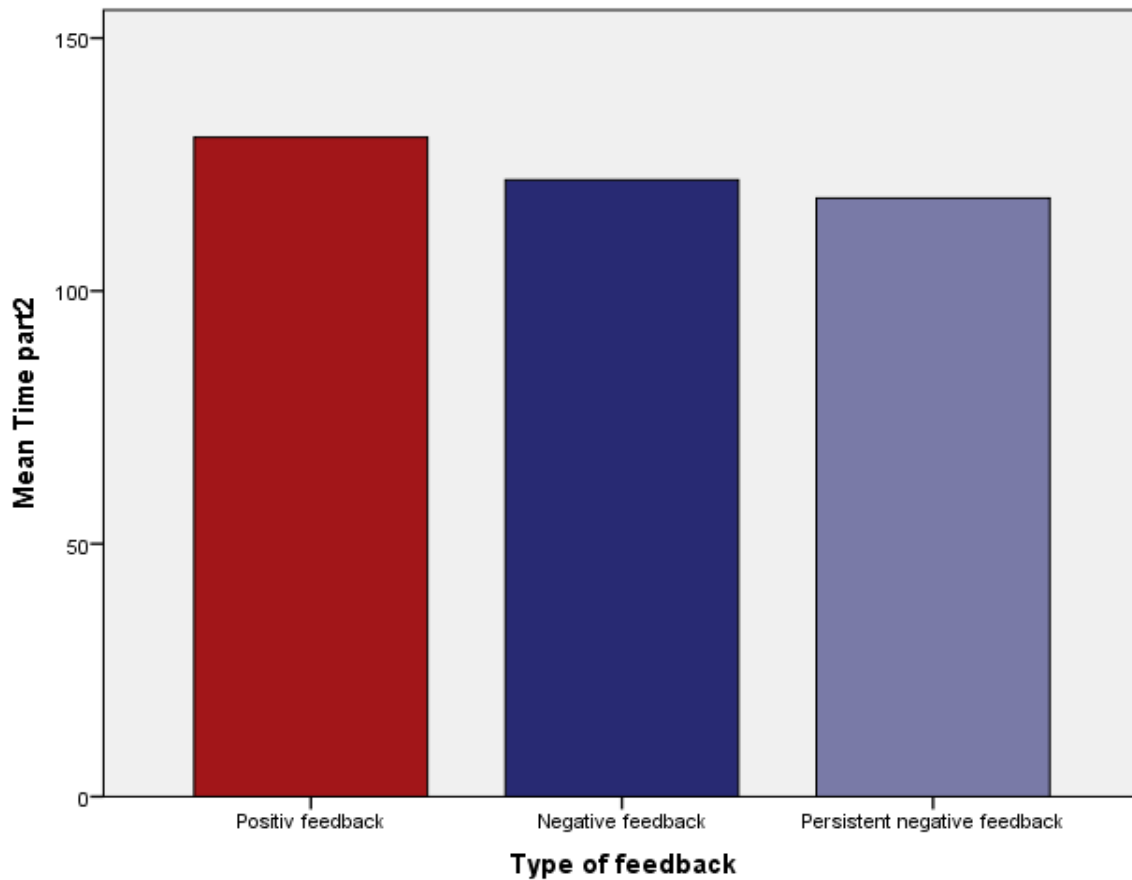


Figure 4 shows the average time, measured in seconds, the subjects used in phase 2, divided in the three categories positive, negative and persistent negative feedback.

Table 3 Time spent phase 2 mean and standard deviation

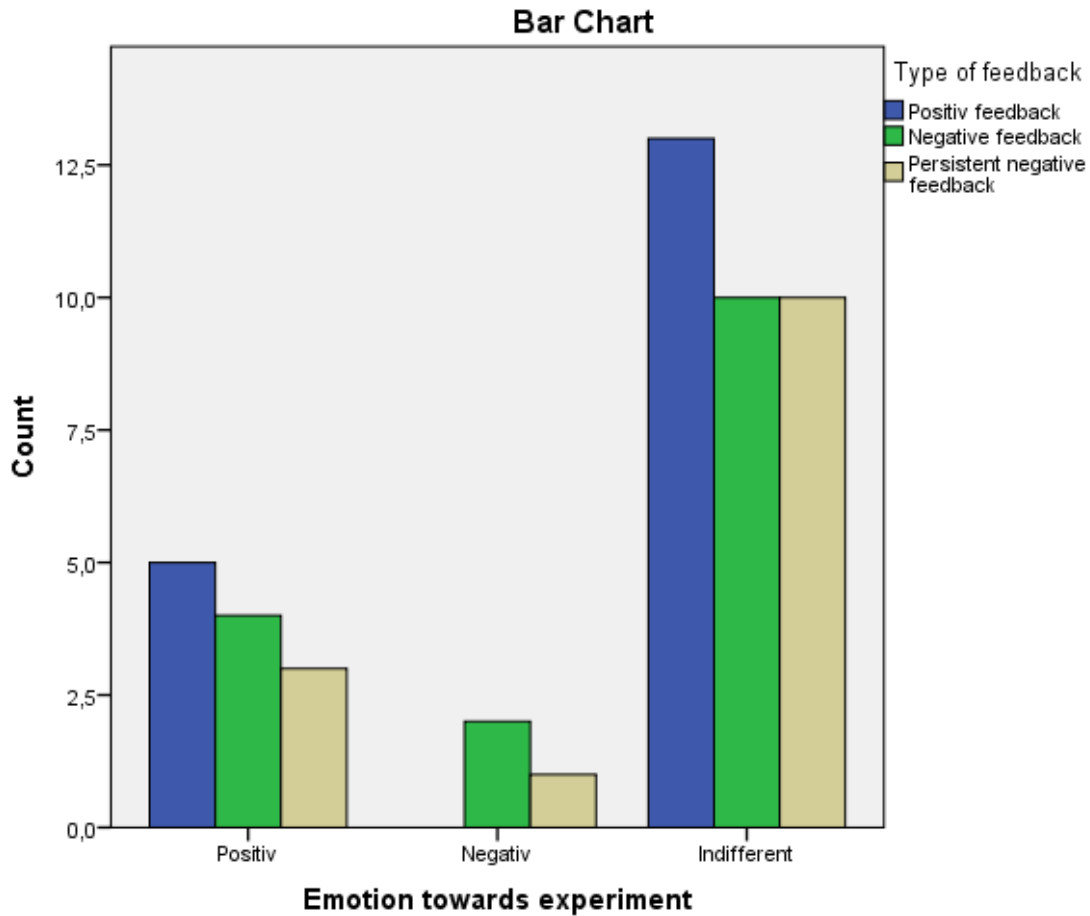
Time phase 2				
Type of feedback	Mean	N	Std. Deviation	Median
Positive feedback	130,40	20	41,622	120,00
Negative feedback	121,94	17	28,268	117,00
Persistent negative feedback	118,38	16	18,037	118,00
Total	124,06	53	31,616	118,00

Feedback sign was not significantly correlated to the time spent on phase 2, $r = -.160$, $p > .05$ (see appendix H).

Anova reported a non-significant difference in time spent phase 2 depending on feedback sign $F(2, 50) = .691$, $p > .05$.

Emotions towards the experiment

Figure 5 Emotions towards the experiment



As can be seen from figure 4 most subjects were indifferent towards the experiment. The subjects placed in the indifferent category answered “ok” in the comment section. The subjects placed in the positive category answered “fun” or a synonym. The subjects placed in the negative category answered “strange” or “do not see the point”.

Emotions as an intervening variable

Table 4 Variation divided by emotion mean, standard deviation and median

Variation in percent

Emotion towards experiment	Mean	N	Std. Deviation	Median
Positive	42,8917	12	28,29421	45,3100
Negative	44,5833	3	29,52972	51,5600
Indifferent	39,1221	33	28,09939	37,5000
Total	40,4058	48	27,67498	39,5300

The mean variation in percent compared to the emotion towards the experiment, in table 4, show that there is not much variation in how much the subjects varied or repeated compared to the emotion they reported feeling.

Anova reported a non-significant difference in emotion towards the experiment and variation in percent, $F(2, 45) = .114, p > .05$.

Discussion

This study attempted to shed light on the effects of feedback sign in the learning history and variability in behavior. It also inquired whether feedback sign would have an impact on the time spent learning, and on time spent on subsequent, similar tasks. Additionally, by the use of self-report, it examined the emotions the subjects had towards receiving the different feedback signs in the learning session. The emotion was also recorded in order to see if it could be an intervening variable on the variation in behavior.

Feedback sign and Variability

Hypothesis 1 suggested that feedback sign would affect the variability in later similar tasks. This hypothesis was partly proven. There was a significant effect between the group of subjects who received only positive feedback, and the group who received only negative

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feedback. The subjects who received only negative feedback varied significantly more than those receiving only positive feedback. The group who received persistent negative feedback did not significantly differ from any of the two other groups. This suggests that of the subjects who received negative feedback, and were instructed only when they needed to change their behavior in order to get it right, continued to change their behavior, even when the tasks changed and they knew they would get no feedback. The subjects who received positive feedback, and were with that instructed only when their behavior was correct, did not need to change their behavior in order to get it right in phase 1. Most of them continued not changing their behavior in phase 2, with no feedback and different tasks. The effect size for feedback sign on the variation in the answers was medium. Suggesting that there are, not surprisingly, other variables also affecting variation.

The results in phase 2 for the subjects who received persistent negative feedback in phase 1 are interesting. The data may indicate that some of the subjects perceived the persistent negative feedback the same way as subjects who received negative feedback, and hence continued to vary their behavior in phase 2. But, a significant amount of the subjects who received persistent negative feedback in phase 1 tended to repeat in phase 2. The data shows that the different subjects who received positive feedback both repeated and varied their behavior, but most chose to repeat as a main strategy. The subjects who received negative feedback also both repeated and varied their answers, but most chose more variation.

As mentioned earlier several articles e.g. Schwartz (1982b) and Holth (2012) concludes that contingencies that permit but do not require variability produces stereotyped behavior. This has become a well-established empirical finding through experiments. E.g. Schwartz's (1982b) experiment where humans received reinforcement for moving a light, in a light-matrix, from the top left corner to the bottom right corner. The subjects all found one sequence that resulted in reinforcement and kept repeating that sequence even though 69 other

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sequences could also result in reinforcement. A major question in this experiment, where there were no variability requirement, was if the subjects would vary their answers at all. As they, in phase 2 of the experiment, were informed that no feedback would be given. The easiest and most time saving strategy would have been to choose one place to click, e.g. horizontal top or vertical left, and choose whichever two objects which was at these places every time. The results of this study propose that when no reinforcement is involved, individuals who has learned to change their behavior when receiving negative feedback will continue to vary their behavior even when variability is not required. “Negative feedback encourages shifting strategies and seeking alternatives that may work better” (Hogarth et al., 1991, p. 736).

The result of this study can indicate that the theory of mindfulness by Langer (1989), where mindfulness is viewed as a state of awareness or alertness with active information processing and mindlessness as a state where individuals attends to less information, is the effect positive or negative feedback has on individual’s behavior. The results of Dunegan’s (1992) experiment supports this view. His study indicated that negative or mixed feedback made participants more likely to engage in decision processes that would be described as mindful by Langer. Whereas the participants who received positive feedback exhibited process characteristics Langer (1989) associates with mindlessness. The study of Wofford and Goodwin (1990) did also conclude that when things are going well individuals abbreviate the interpretation stage activities, and when things are going poorly, the interpretation stage activities appear more extensive.

This study gives an indication that negative feedback, not surprisingly, have several similarities to extinction. In this study the behavior is not reinforced before the negative feedback starts. But, as all the subjects understood how to perform the experiment it is natural to believe that they have been reinforced for similar simple tasks before. Negative feedback

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on wrong answers suggests that the behavior is wrong, not functional. As would extinction, when previously reinforced behavior stops producing reinforcement, indicating that the behavior is no longer functional. Both negative feedback and extinction conveys that the behavior is not functional and elicits variation in order to find functional behavior. In the “two-string” problem (Epstein et al., 1999), referred to earlier, it is very likely that one would get the same results if the subjects received negative feedback when trying to solve the problem, instead of just leaving the subjects to find out what does not work for themselves, extinction.

Latham and Locke (1991) describes feedback as information, as quoted earlier, that only has an effect on action depending on how it is appraised and the subsequent decisions made. The results of this study suggests otherwise. Feedback sign in this study affected behavior even if the subjects were unaware of it, as it is unlikely that the subjects in this study made a thoughtful decision in order to either vary or repeat their answer in the phase with no feedback.

Experiments have shown that depression, suffering from mood disorders, can have a facilitative effect on creativity (e.g. Akinola & Mendes, 2008). Whereas other experiments have given the result that depressed individuals generate less variable and creative results than non-depressed controls (e.g. Channon & Baker, 1996). According to Nelson and Craighead (1977) individuals diagnosed with depression will not overestimate negative feedback but report correctly. Not-depressed individuals underestimate how much negative feedback they receive. As this study suggests that people receiving negative feedback will vary their behavior more than individuals receiving positive feedback on subsequent tasks, this can be an explanation why depressed people in several experiments are more creative than non-depressed. Even though they receive the same amount of feedback, positive or negative, the

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depressed individuals notice and remember the negative feedback more than the non-depressed.

The persistent negative feedback group's results were somewhat different from the negative feedback group. As of yet I have found no theories or articles that can explain the differences in these data. As mentioned above depression is connected both with more creativity than non-depressed controls, and less variability and creativity than non-depressed controls. In this study the persistent negative feedback, thought to be more aversive than negative feedback, divided the 16 subjects. Most chose to vary their answers quite significantly whereas a few repeated significantly. It may seem as though both depression and "severe" negative feedback either makes individuals vary more than normal or repeat more than normal. The results of this study is not enough to draw even a tentative conclusion about the reasons for this phenomenon, but further investigations is in order.

Feedback sign and Learning

According to this study individuals learn faster when receiving only negative feedback compared to only positive feedback. Hypothesis 2 was confirmed. These findings are consistent with earlier studies on the subject. The data yielded a large effect size, which indicates that feedback sign is an important variable regarding learning in this study. The significant difference is between the groups who received positive feedback and the group who received negative feedback. The subjects in the persistent negative feedback group learned slightly slower than the negative feedback group, but still faster than the subjects who received only positive feedback. Most of the subjects receiving only positive feedback had still not learned what belonged together, and thereby receiving only positive feedbacks and no blanks, when the program sent them automatically to phase 2. In the negative feedback group all participants learned what belonged together, and was therefore receiving no or very little feedback (they needed 6 out of the last 8 correct) at the end of phase 1. In the persistent

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negative feedback group, two subjects had not learned what belonged together after the obligatory four rounds, while the rest learned after only 2 or 3 rounds. These subjects also received very little, if any, feedback at the end of phase 1.

A meta-analysis (Getsie et al., 1985) included 89 articles concerning positive and negative feedback. The experiments included in the meta-analysis gave children either feedback after both correct and incorrect responses, or they gave the children only feedback after correct responses, and finally they gave feedback only after incorrect responses. The feedback could be either verbal, symbolic or tangible. The result of this meta-analysis is that out of reward and punishment, whether symbolic, tangible or verbal, verbal punishment is the most effective during discrimination learning. Only reward, compared to only punishment or punishment and reward, is consistently the least efficient form of feedback. This study came to the same conclusion as the meta-analysis.

Also, a review of effects of type and combination of feedback concludes “Wrong-blank has usually resulted in the most efficient performance during acquisition and the greatest resistance to extinction when all feedback was discontinued” (Barringer & Gholson, 1979, p. 460). Although the review do not give any information about how the resistance to extinction was measured, it is tempting to suggest that the slower extinction rate when feedback is discontinued is due to the fact that the subjects in the wrong-blank group, were receiving less feedback when the extinction phase started. Subjects receiving correct – blank or correct - wrong, who has learned are receiving feedback on just about every answer (correct – blank may occasionally answer wrong and get no feedback). Pierce and Cheney (2008) explains the similar effects with intermittent reinforcement schedule and extinction. They argue that it is easier for individuals to discriminate between reinforcement and extinction when reinforcement is on a continuous reinforcement schedule, than when reinforcement is on an intermittent reinforcement schedule. Individuals are more in contact with the contingencies,

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when on a continuous reinforcement schedule, than on intermittent. Receiving wrong – blank feedback and having learned the correct answers, individuals would hardly be in contact with the contingencies at all. The learning phase and the extinction phase would be nearly indistinguishable.

The aforementioned meta-analysis of Kluger and DeNisi (1996) concluded that feedback interventions are more effective when the feedback presents the correct solution than when the feedback did not contain the correct solution. As there were only two choices in this experiment it was evident that when one answer was wrong the other would be correct, it can be argued that the feedback contained the correct answer. Feedback provided from a computer, as it was in this study, is more effective than if it is provided from other sources. Feedback interventions are very effective when task complexity is low, and when the task involves memorizing something. The feedback in this experiment should, on account of the above, be very effective.

In their article “The power of feedback” Hattie and Timperley writes “Feedback is more effective when it provides information on correct rather than incorrect responses” (2007, p. 86), and Hattie (2009) repeats this. In both cases this is with reference to Kluger and DeNisi’s (1996) meta-analysis. Since this study yielded exactly the opposite result, the meta-analysis of Kluger and DeNisi was carefully studied. Not at any point do they conclude that positive feedback on correct responses are more effective than negative feedback on incorrect ones. What the meta-analysis does conclude is that feedback containing the correct solution is more effective than feedback that does not inform individuals what the correct solution is, as mentioned earlier.

On that note - including the correct solution and specifying the feedback - Goodman, Wood and Hendrickx (2004) argues that specific feedback is not always beneficial. The result of

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their study indicate that the greater the guidance in high feedback specificity resulted in less exploration than the lower guidance in the low and moderate specificity feedback groups. The conclusion of their study is that “increasing the specificity of the feedback intervention positively affected practice performance, but these benefits did not endure over time, modification of the task, and removal of the intervention” (Goodman et al., 2004, p. 261).

Feedback sign and Emotions

Hypothesis 3, suggesting that the subjects who received only positive feedback would be more positive towards the experiment, was not confirmed. Most subjects were indifferent towards the experiment and commented “ok”. There were some positive subjects in all the groups, who commented fun, or something to that extent. None of the subjects receiving positive feedback was negative to the experiment, but a few of the subjects receiving negative or persistent negative feedback had comments interpreted to be negative.

The data is also clear on the point that the self-reported emotion towards the experiment did not function as an intervening variable, and it did not affect the variation in the answers.

Subjects receiving negative feedback all learned to answer correctly after two or three rounds. The fact that they all avoided the negative feedback and quite rapidly answered in a way that resulted in no feedback can be an indication that they perceived the negative feedback as punishing. Then again, when asked how they felt about carrying out the experiment most subjects were indifferent (they have replied “ok” in the commentary box after completion of the experiment). Most of the subjects receiving persistent negative feedback also replied ok, but there are other indications that at least some of these subjects may have felt the persistent negative feedback as a punisher.

The studies of Finkelstein and Fisbach (2012) concluded that, under certain conditions, subjects preferred negative feedback to positive. In one of the study undergraduates student

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participated in a German language class. They wrote passages of text and were asked after each trial if they would like to receive positive feedback about what they had done well or negative feedback about how they could improve. In this study 50% of the participants chose negative feedback after the first trial and 82% chose negative feedback after the fifth trial. “These results are consistent with the hypothesis that as people gain expertise, they switch from seeking positive feedback to seeking negative feedback” (Finkelstein & Fishbach, 2012, p. 31). The authors suggests that instead of always being negative-feedback avoiders, there are situations where individuals seek and endorse negative feedback. They conclude that negative feedback serves an important function when it is constructive rather than detrimental. It is important to note though, that both Finkelstein and Fishbach’s studies and this study consisted of reasonably easy tasks, with no real consequences for the participants.

Limitations

Several potential limitations to this study should be noted. The most important one is that the experiment is short, the average time the participants used on the experiment is just under four and a half minutes. The other important limitation is that the tasks in the experiment were simple and arbitrary. It would also be unusual to give only positive or only negative feedback in a normal learning situation. It would therefore, not be recommended to generalize these results to a normal learning experience.

The sample of this study comprised mostly of university student, within the same field of education. But, most being part time student they were not uniform in age, and a smaller sample of subjects were older (compared to the students), mostly women, working in a kindergarten. Their results were comparable to the result of the main sample and are included in the final data. (With the exception of time in phase 1, which was measured differently in their study, but these data were also similar to that of the main sample.)

Directions for future research

The present study demonstrated that individuals are more likely to vary their behavior in subsequent situations when given negative feedback during a learning session. It also demonstrated that individuals learn faster when receiving negative feedback – blank, compared to positive feedback – blank. In this study there was a 50 percent chance for the subjects to get the answer correct or wrong. One venue for further research would be to look at a more complex learning situation. Where the percentage for getting the right answer is lower, making the subjects use more time to manage or learn the task, and therefore receive more negative feedback. If they are given almost exclusively negative feedback for a longer period of time and over more tasks will this lead to extinction? If it does not lead to extinction, will they still vary their behavior on subsequent tasks?

As mentioned earlier positive feedback has been used as a positive reinforcer and negative feedback has been used as a punisher in several studies. Further studies should be carried out in order to see if, how and when negative feedback can be seen as an equivalent to punishment. In this experiment it seem unlikely that the subject who received negative feedback regarded this as a punisher, but there are indications that maybe persistent negative feedback was considered punishing. Further studies should look at different degrees of severity of negative feedback, in order to conclude whether more severe negative feedback will have another effect on behavior than what is the conclusion in this study.

The conclusion of Goodman et al. (2004) that increasing the specificity in feedback cause less exploration could be of interests to this type of experiment. Will the variability in future behavior, when receiving negative feedback, be affected by the level of specificity in the feedback? If the correct answered is specified when the negative feedback on a wrong answer is given, one would still have to change the answer to get it right the next time, but will this interfere with the subsequent variation in answering?

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After completion of the main experiment, six other subjects completed a new version of the experiment. This version gave the subject both positive and negative feedback. From the preliminary results, it seems like these data coincide with the data of the negative feedback – blank group, but this should be studied further. Getsie et al. (1985) writes that, in discriminative learning, results from positive and negative feedback and learning are more unclear than negative – blank feedback.

The effect of feedback sign on variability was medium. There were some subjects receiving only positive feedback and still varied and subjects receiving negative feedback who hardly varied at all. This suggests that there are other variables affecting the variation in the answers. As it takes slightly more effort to answer varied than to repeat, it is plausible that one such variable could be the perception of having enough time. This study did not incorporate if the subjects perceived to have plenty of time or if they felt they were in a hurry. It is possible that one of the other variables, explaining more of the variation, is the individual's subjective perception of having enough time.

Conclusion

This study endeavored to uncover whether feedback sign in a learning situation had any effect on the variability in subsequent situations. It also attempted to uncover whether feedback sign affect learning, as earlier research has shown. And, in addition, how and if individual's emotions are affected by feedback sign.

The condensed conclusion of this study is as follows: Those who receive negative feedback on wrong answers, vary in order to get the answers correct. Those who receive positive feedback on correct answers, repeat the same answers. This approach, varying and repeating, persists in succeeding situations. In order to learn rapid, negative feedback on wrong answers

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are more effective than positive feedback on correct answers, at least on simple tasks. And, again relating to simple tasks, individuals do not seem to mind the negative feedback.

The results of this study contradicts the suggestion by Latham and Locke (1991) that feedback is only information which does not necessarily have any effect on behavior. In this study feedback sign did significantly affect the variation in behavior on subsequent answers, even though the subjects were not aware that variation and repetition would be measured.

Ending off with a word of caution. In order to be creative, behavior has to be novel and useful. The end-result, when eliciting variability in behavior with extinction or negative feedback, will not necessarily be original and *appropriate*. When individuals challenge themselves to exceed current performance by trial and error, it may end in chaos. As Epstein so eloquently says; “Thus, learning to manage failure – and not to fear failure – is an important means of boosting creativity” (Epstein et al., 1999, p. 765).

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Appendices

Appendix A

Leses før deltagelse.

Forsøket:

Forsøket er en del av min masteroppgave innen adferdsanalyse. På grunn av forsøkets art vil detaljer rundt hensikten med forsøket først kunne meddeles etter endt deltagelse av alle forsøkspersoner.

Gjennomføring:

Forsøket skal gjennomføres med én person av gangen. Forsøket tar mellom 5 og 10 minutter. Gi beskjed dersom noe oppleves som ubehagelig. Det er mulig å trekke seg på et hvilket som helst tidspunkt i løpet av forsøket. Jeg vil være tilgjengelig under hele gjennomføringen av eksperimentet.

Data:

Data angående tidspunkt, deltagers responser, varighet osv. fra forsøket blir overført og lagret i tekstfil og kumulativ skriver. Disse data skal kunne brukes i masteroppgaven og eventuelt i videre Phd. arbeid. Ingen personlige data blir registrert, og det vil ikke være mulig å spore hvem som har deltatt i forsøket.

Instruksjon:

I del 1 er oppgaven å finne ut hva som ”hører sammen”.

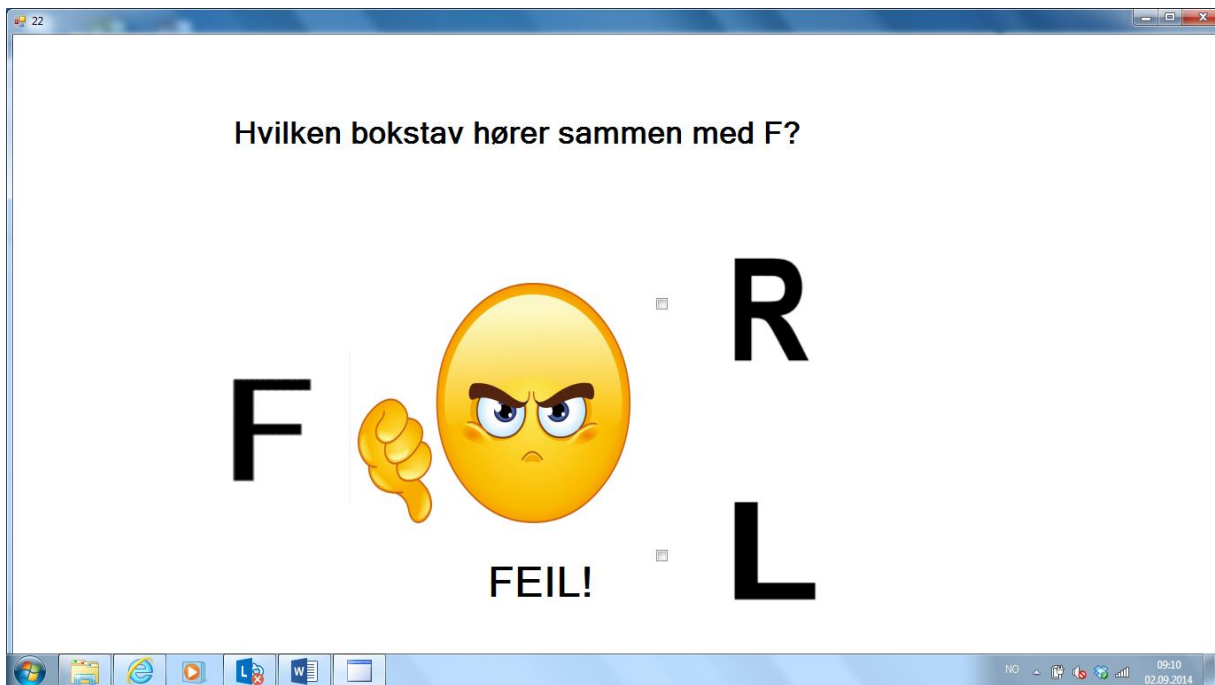
Følg ellers henvisningene i programmet.

Takk for at du deltar som forsøksperson!

Siv K. Nergaard

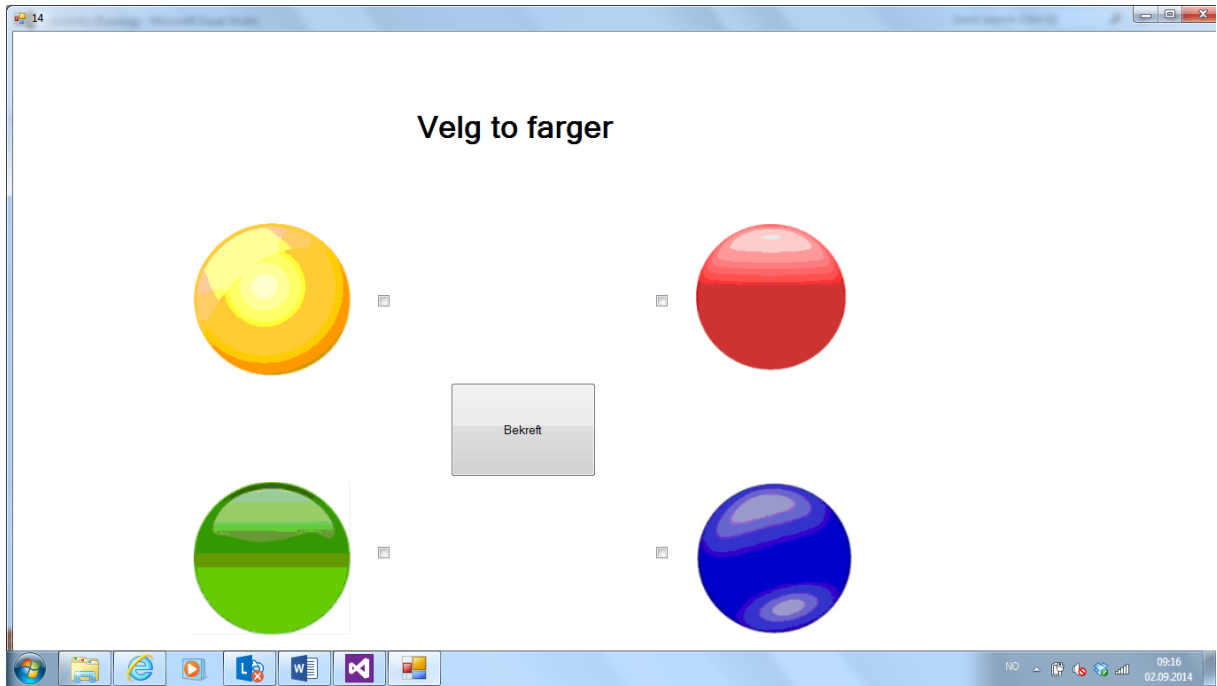
Does feedback sign in the learning history affect variability?

Appendix B



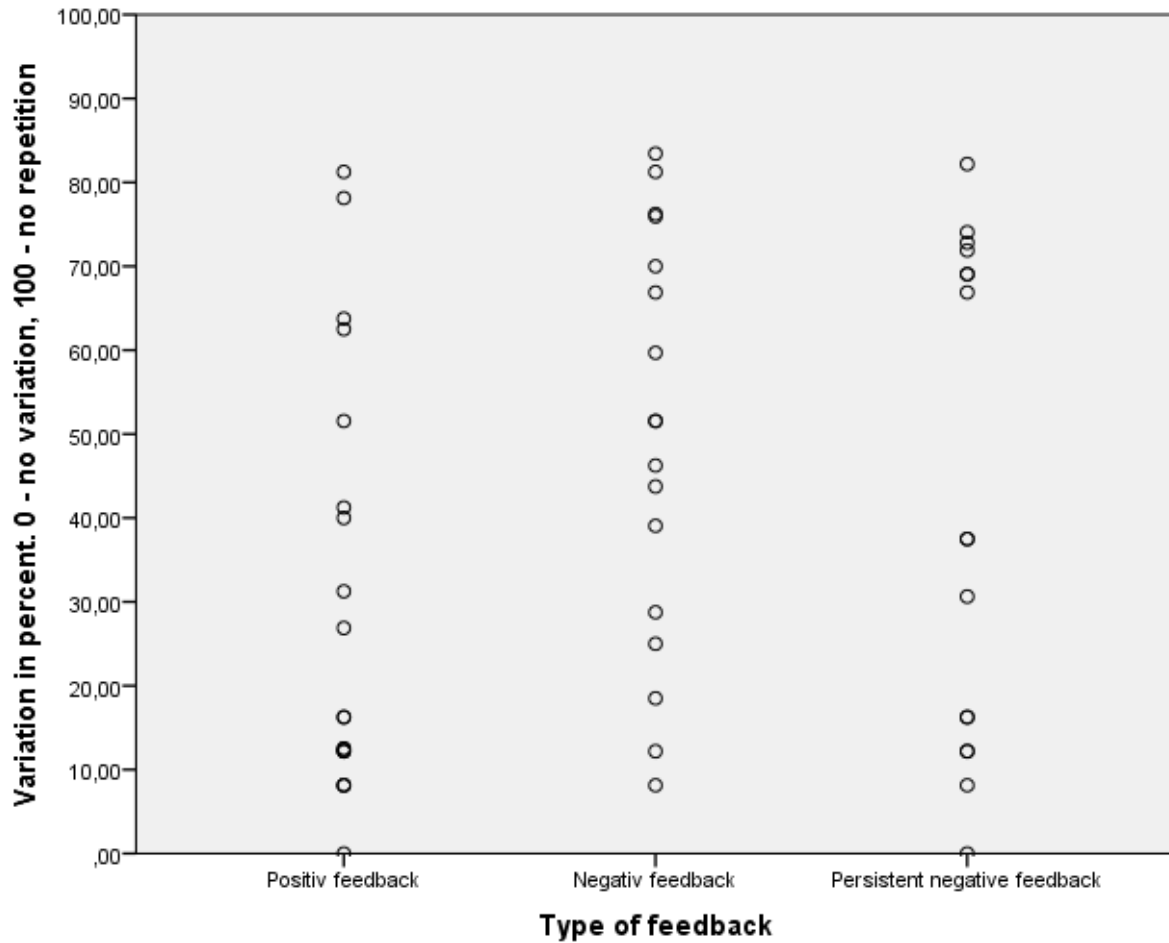
Does feedback sign in the learning history affect variability?

Appendix C



Does feedback sign in the learning history affect variability?

Appendix D



Correlation 1

		Type of feedback	Variation in percent
Kendall's tau_b	Correlation Coefficient	1,000	,159
	Type of feedback		
	Sig. (2-tailed)	.	,145
	N	53	53
	Correlation Coefficient	,159	1,000
	Variation in percent		
	Sig. (2-tailed)	,145	.
	N	53	53

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Appendix E

Correlation 2

		Type of feedback	Variation in percent
Kendall's tau_b	Correlation Coefficient	1,000	,310*
	Type of feedback Sig. (2-tailed)	.	,026
	N	37	37
	Correlation Coefficient	,310*	1,000
	Variation in percent Sig. (2-tailed)	,026	.
	N	37	53

*. Correlation is significant at the 0.05 level (2-tailed).

Group Statistics

	Type of feedback	N	Mean	Std. Deviation	Std. Error Mean
Variation in percent	Positiv feedback	20	29,7545	25,25119	5,64634
	Negative feedback	17	49,3059	24,56695	5,95836

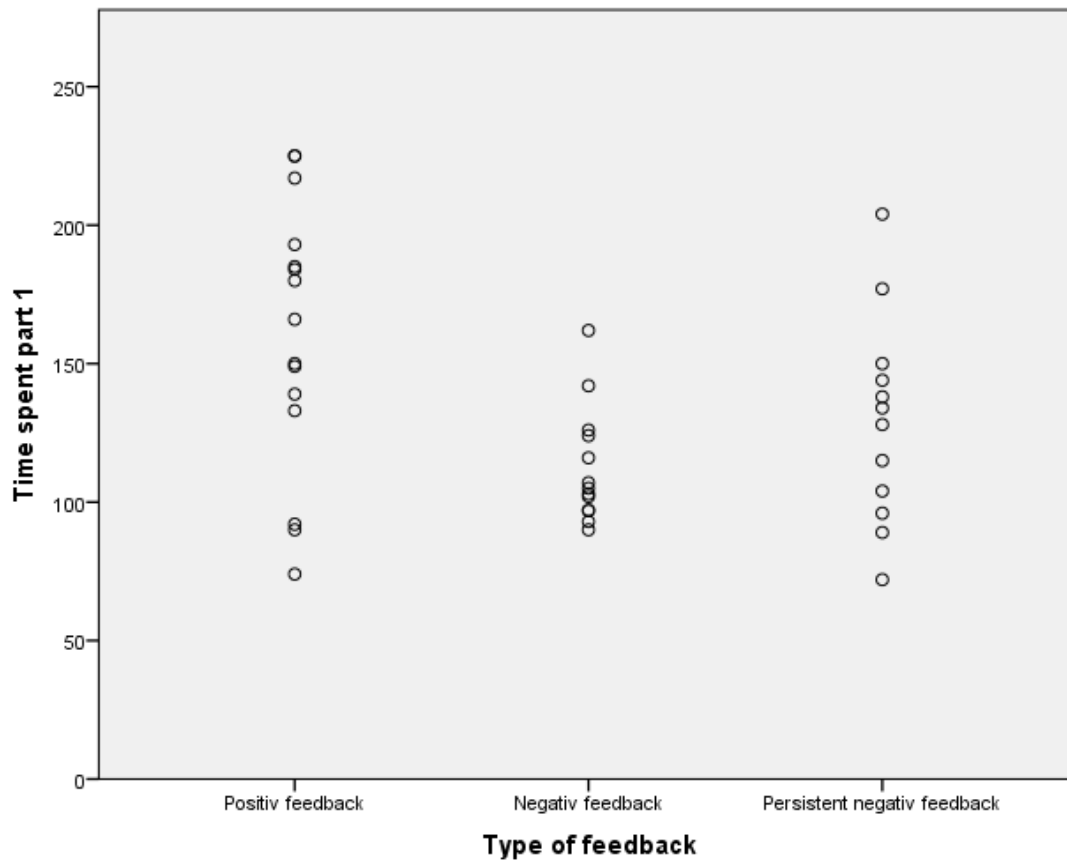
Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Variation in percent	Equal variances assumed	,039	,845	-2,376	35	,023	-19,55138	8,22755	-36,25420	-2,84857
	Equal variances not assumed			-2,382	34,328	,023	-19,55138	8,20873	-36,22766	-2,87510

The Levene's test of homogeneity of variance was not significant for variation in percent, suggesting that it is necessary to use equal variance assumed.

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Appendix F



Correlation 3

		Type of feedback	Time spent part 1
Type of feedback	Pearson Correlation	1	-,325*
	Sig. (1-tailed)		,020
	N	53	40
Time spent part 1	Pearson Correlation	-,325*	1
	Sig. (1-tailed)	,020	
	N	40	40

*. Correlation is significant at the 0.05 level (1-tailed).

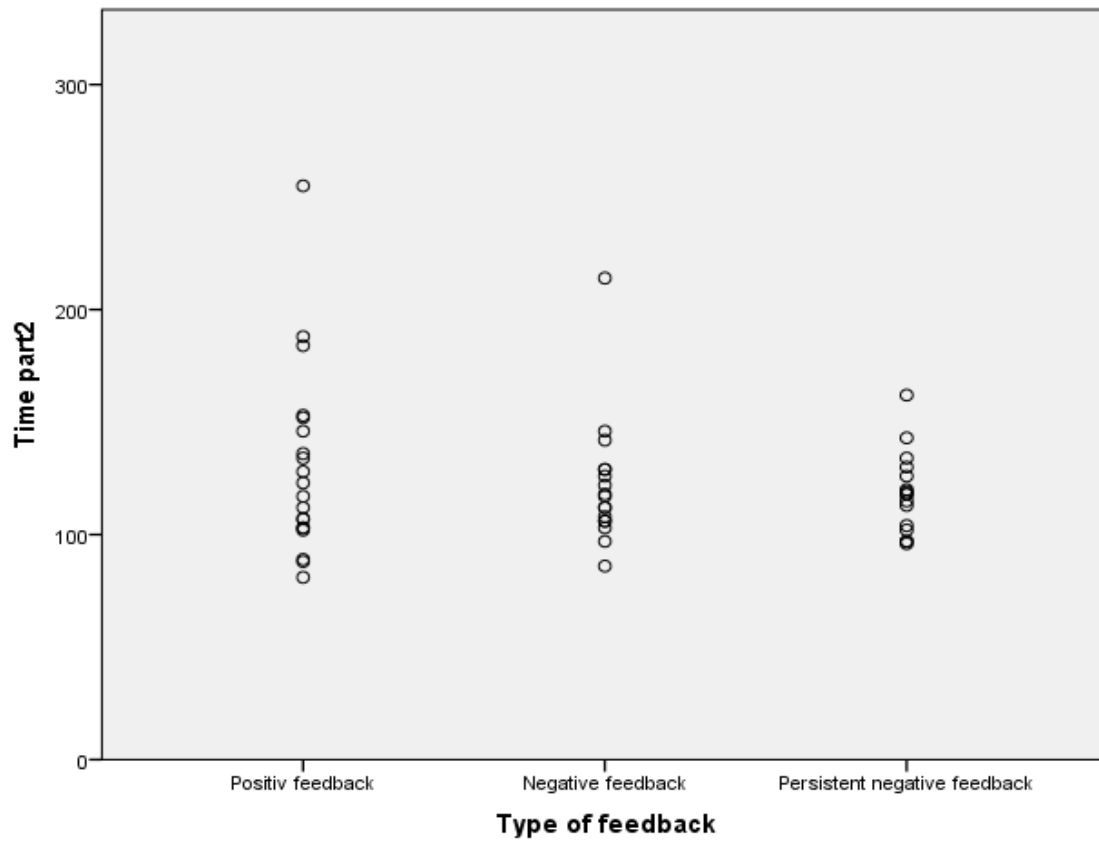
ANOVA

Time spent part 1

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	16378,715	2	8189,357	5,664	,007
Within Groups	53497,060	37	1445,866		
Total	69875,775	39			

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Appendix H



Correlation 4

		Type of feedback	Time part2
Type of feedback	Pearson Correlation	1	-,160
	Sig. (2-tailed)		,253
	N	53	53
Time part2	Pearson Correlation	-,160	1
	Sig. (2-tailed)	,253	
	N	53	53

ANOVA

Time part2

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1397,339	2	698,670	,691	,506
Within Groups	50579,491	50	1011,590		
Total	51976,830	52			

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Appendix I

Emotion towards experiment * Type of feedback Crosstabulation

Count

		Type of feedback			Total
		Positiv feedback	Negative feedback	Persistent negative feedback	
Emotion towards experiment	Positiv	5	4	3	12
	Negativ	0	2	1	3
	Indifferent	13	10	10	33
Total		18	16	14	48

ANOVA

Variation in percent

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	180,888	2	90,444	,114	,893
Within Groups	35816,628	45	795,925		
Total	35997,516	47			