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INTRINSIC MOTIVATION

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Intrinsic Motivation: Psychological and Neuroscientific Perspectives

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I hereby certify that all material in this final year project which is not my own work has been identified and that no work is included for which a degree has already been conferred on me.

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Abstract

The aim of this essay is to give an overview of the topic of intrinsic motivation based on psychological and neuroimaging research. More specifically, the objective is to give an overview of the various benefits of intrinsic motivation, discuss its relationship to extrinsic rewards, and review the existing neuroimaging research that has explicitly explored intrinsic motivation. A positive relationship between intrinsic motivation and persistence, conceptual learning, creativity and both hedonic as well as eudaimonic well-being has been demonstrated. A wealth of studies has shown that extrinsic rewards undermine intrinsic motivation, while the validity of these findings has been debated. Initial neuroimaging studies concerning the neural basis of intrinsic motivation have been conducted, showing unique activations in the intrinsic motivation conditions in e.g. the anterior precuneus and the right insular cortex. Conceptual and methodological problems have been discussed, and it is suggested that the neuroscientific findings mentioned above can be interpreted in terms of the neural distinction between wanting and liking, rather than in terms of intrinsic and extrinsic motivation, and that psychological research can draw on neuroscientific findings in order to make its research more precise.

Keywords: intrinsic motivation, self-determination theory, undermining effect, motivational orientation, reward, neuroimaging

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1. Introduction

The study of motivation has to do with the processes that energize and direct behavior (Reeve, 2009). A person who is energized or activated in order to pursue a certain goal or engage in an activity is therefore viewed as motivated, while a person who has no interest to act is regarded as unmotivated (Ryan & Deci, 2000a). This fundamental quality of motivation to move people into action can also be observed in the Latin root of the word, *movere*, which means to move or be moved (Ryan, Lynch, Vansteenkiste, & Deci, 2010). In the field of psychological science, motivation is a central topic, since it is at the core of most of our behavior and research is carried out to investigate factors that initiate, direct or sustain such behavior (Ryan & Deci, 2000b; Gazzaniga & Heatherton, 2006).

Motivation can vary in level. It can vary in level in a specific situation, meaning that different people will be differently interested in engaging in a specific activity or to attain a specific goal (Mizuno et al., 2008; Silverstein, 2010). It can also vary between individuals as a more general quality: some people can be very driven to engage in all kinds of behaviors while others are less inclined to get engaged in general (Mizuno et al., 2008; Silverstein, 2010). Motivation does not only vary in degree, however, it also varies in kind. One common way of distinguishing between different kinds of motivation is to speak about intrinsic and extrinsic motivation (Ryan & Deci, 2000a). The concept of intrinsic motivation has been defined in several different ways (Deci & Ryan, 1985). The definition that is used in most of the research on the topic is that intrinsic motivation is the kind of motivation that is present when people pursue activities for the inherent satisfaction that the activity gives them (Ryan & Deci, 2000a). Extrinsic motivation, on the other hand, is the kind of motivation that is present when people pursue activities mainly to attain a specific outcome, without being particularly interested in the activity itself.

During the first half of the 20th century, psychologists studying motivation focused mainly on extrinsic motivation, studying how different kinds of reinforcers change behavior (Reiss, 2005). Later on many researchers turned their attention to more internal sources of motivation. One of the first persons to address this issue more explicitly was White (1959, as cited in Kaplan & Oudeyer, 2007) when he introduced the concept of competence or effectance motivation. Since then, a substantial amount of research has been dedicated to exploring intrinsic motivation from different perspectives. Some of the research has focused on the benefits of intrinsic motivation on factors such as well-being and learning (e.g. Ryan & Deci, 2000b). Other studies have focused on the risk of undermining intrinsic motivation

through the usage of extrinsic rewards (e.g. Deci, Koestner, & Ryan, 1999). Lately, studies exploring the neural basis of intrinsic motivation have appeared (e.g. Linke et al., 2010; Murayama, Matsumoto, Izuma, & Matsumoto, 2010; Lee & Reeve, 2012).

The study of intrinsic motivation has important practical implications. Since intrinsic motivation has been demonstrated to be beneficial for learning, creativity, persistence and hedonic as well as eudaimonic well-being (e.g. Ryan & Deci, 2000b; see chapter 3 for definitions of concepts as well as for a review of research) it makes sense for schools and workplaces to enhance the degree of intrinsic motivation experienced by their students and employees. To clarify the usefulness of enhancing intrinsic motivation in these settings, this essay will give an overview of the benefits of intrinsic motivation.

Furthermore, there is an abundance of studies pointing to that extrinsic rewards undermine intrinsic motivation (e.g. Deci et al., 1999). There is also a substantial amount of criticism concerning the validity of these studies and the conclusions drawn from them (e.g. Reiss, 2005). Since schools and work-places frequently use extrinsic rewards to increase students' and employees' motivation it is important to have an understanding of the potential down-sides of this custom. To facilitate the making of informed decisions concerning the use of extrinsic rewards this essay will give an overview of the research and debate concerning this phenomenon.

Although the concept of intrinsic motivation is generally accepted, there are researchers who question the current understanding of the concept. For example, Reiss (2005) has questioned the meaningfulness of dividing motivation into the two categories of intrinsic and extrinsic motivation. Also, with regards to the effects of extrinsic rewards on intrinsic motivation, some (e.g. Bateman & Crant, 2003) have speculated that these effects do not lead to the same results in all individuals but that they vary depending on motivational orientation, i.e. how much the specific individual values the particular reward in general, or in a specific situation.

The usage of neuroscientific tools to investigate the neural substrates of psychological constructs can help clarify the existence and generalizability of intrinsic motivation as well as its relationship to extrinsic rewards.

Therefore, the overall aim of this essay is to give an overview of the topic of intrinsic motivation based on psychological and neuroimaging research. More specifically, the objective is to give an overview of the various benefits of intrinsic motivation, discuss its relationship to extrinsic rewards, and review the existing neuroimaging research that has explicitly explored intrinsic motivation. First, the background of the concept of intrinsic

motivation will be reviewed, including an overview of some of the different ways in which intrinsic motivation has been conceptualized with a particular focus on self-determination theory (SDT). This will be followed by a description of the beneficial effects of intrinsic motivation, with an emphasis on well-being, persistence, conceptual learning and creativity. Thereafter, an overview of how intrinsic motivation can be undermined by extrinsic rewards will be given, followed by a brief review of the debate concerning the undermining effect. Next, an overview of the neural basis of extrinsic motivation will be given, followed by a review of the neuroimaging studies that have explicitly considered intrinsic motivation. In the discussion, conceptual and methodological issues will be addressed, and the existence and generalizability of intrinsic motivation as well as its relationship to extrinsic rewards will be discussed based on neuroscientific findings.

2. Conceptualizing Intrinsic Motivation

Intrinsic motivation has been conceptualized in many different ways by different theorists. Deci and Ryan (1985) divide these different conceptualizations into six categories, namely; approaches based on drive-naming, psychodynamic drive theory, physiological arousal, psychological incongruity, competence and self-determination, and emotion. Most of these theories do not explicitly talk about intrinsic motivation. However, all of the theories do attempt to explain behavior that seems to be motivated by the activity itself rather than environmental incentives or physiological drives, i.e. what is generally today referred to as intrinsic motivation. In this chapter, the overall features of each of these categories will be briefly described and a few examples from each category presented. These six categories, to the author's best knowledge, broadly encompass all of the ways that intrinsic motivation has been conceptualized in the psychological literature. Also, it must be noted that what is described here is merely how the theories attempt to explain intrinsic motivation, while a general description of these theories lies outside the scope of this essay.

The concept of intrinsic motivation emerged as a reaction to behaviorism, which was the main direction within psychological science from the 1920s to the 1960s (Ryan & Deci, 2000a). The two main behavioral theories, operant theory (Skinner, 1953, as cited in Ryan & Deci, 2000a) and learning theory (Hull, 1943, as cited in Ryan & Deci, 2000a), explained motivation in two different ways. Operant theory viewed human behavior as based on the motivation to attain rewards. Learning theory, on the other hand, saw behavior as an attempt to satisfy basic physiological drives. While these theories did not explicitly talk about intrinsic

motivation, they however eventually started having problems with explaining behaviors that were not easily explained by incentives or physiological drives. This led many behaviorists to extend the general drive theory by naming other drives than the purely physiological ones, such as the drive for exploration (Montgomery, 1954, as cited in Kaplan and Oudeyer, 2007) and the drive to manipulate (Harlow, 1950, as cited in Kaplan and Oudeyer, 2007), hence known as the drive-naming approach to intrinsic motivation.

Psychodynamic theorists, while having very different views on human functioning as compared to the behaviorists, also maintained that motivation was based on certain basic drives, namely the sexual and aggressive drives, as was originally proposed by Freud (Deci & Ryan, 1985). As this approach eventually encountered similar problems as the behaviorists' drive-naming approach, later psychodynamic theorists attempted to explain intrinsic motivation in other ways, for example by adding an "instinct to master" to the psychoanalytic conception (Hendrick, 1942, as cited by Ryan & Deci, 1985), similar to the behaviorists' attempts to identify new drives.

Another way of explaining intrinsic motivation was developed by Hebb (1955, as cited in Deci & Ryan, 1985), who postulated that individuals have a need to maintain an optimal level of physiological arousal. According to this approach, when the level of physiological arousal would get lower than a critical level the individual would be motivated to do something to increase arousal, leading to behaviors that appear to be intrinsically motivated. This does not suggest, however, that arousal must be maintained at an exact level all the time, but rather that there is a certain range of optimal arousal. Accordingly, if the level of arousal falls under that range, boredom will result, while if the level of arousal exceeds the optimal range the result is distress. Similar views were maintained by other theorists, for example Fiske and Maddi (1961, as cited in Deci & Ryan, 1985), who expanded this theory by postulating that the optimal level of arousal is not static but varies throughout the day. According to their views the optimal level of physiological arousal depends on the individual's degree of wakefulness and therefore varies with the stage of a person's sleep-wakefulness cycle.

Yet another way of explaining intrinsic motivation comes from various theories concerning psychological incongruity, which are all concerned with the question as to what extent people avoid versus approach incongruous cognitions or inputs (Deci & Ryan, 1985). Cognitive dissonance theory (Festinger, 1957, as cited in Kaplan and Oudeyer, 2007), for example, maintained that the driving force behind behavior is to close the gap between how we think that things ought to be and how they currently are, i.e. to reduce psychological incongruity. In similar lines, Kagan (1972, as cited in Kaplan and Oudeyer, 2007) claimed

that a main force behind human behavior is to reduce incompatibility between different cognitive structures, between structures and experience or between structures and behavior. The theories by Festinger and Kagan were criticized based on the observation that much of human behavior actually seems to be aimed at increasing uncertainty. Instead, Hunt (1965, as cited in Kaplan and Oudeyer, 2007) and others (e.g. Berlyne, 1960, as cited in Kaplan and Oudeyer, 2007) saw people as striving for an optimal level of incongruity where a certain amount of novelty, a certain amount of incongruity between what is experienced and what is the standard level of stimulation, is experienced as rewarding.

Still another group of researchers focused on competence and self-determination as a basis for intrinsic motivation. An early and influential theorist representing this approach was White (1959, as cited in Kaplan & Oudeyer, 2007), who saw the drive approach of physiological needs as too narrow and instead assumed a need for competence or effectance to be at the root of intrinsic motivation. He used the terms competence and effectance to refer to the satisfaction derived from exercising and extending one's capabilities (White, 1959, as cited in Deci & Ryan, 1985). This approach was later developed by Deci and Ryan (e.g. 2000b) to what is called self-determination theory (SDT). Within SDT the driving forces for intrinsically motivated behavior are assumed to be three basic psychological needs, the needs for competence, autonomy and relatedness. When people have an opportunity to meet these three needs their actions are likely to be based on intrinsic motivation.

Finally, the last category of approaches explaining intrinsic motivation focuses on emotions, either as initiators or as accompanying features of intrinsically motivated behavior. Izard (1977, as cited in Deci & Ryan, 1985), for example, proposed that ten distinguishable human emotions can be identified and that each of them is involved in the motivation of behavior. Out of these emotions, interest-excitement is proposed to be the foundation of intrinsically motivated behavior. Csikszentmihalyi (1975, as cited in Deci & Ryan, 1985), on the other hand, viewed intrinsically motivated behavior as characterized by enjoyment. Therefore, according to this approach intrinsically motivated activities are the ones where the reward is the enjoyment of the activity itself.

2.1. *Self-determination Theory*

Self-determination theory is the main empirically validated motivational theory that has considered intrinsic motivation (for a review of the evidence base of SDT, see Ryan & Deci, 2000b). Much of the research that will be reviewed in this essay is conducted from the perspective of SDT and a few concepts from SDT will be used throughout the essay. Because

of these reasons a short introduction to SDT will be given here, mainly focusing on the concepts of psychological needs and on the continuum of motivational styles.

SDT, according to Ryan and Deci (2000b), is concerned with the optimal functioning of human beings and the conditions that foster such functioning. Three basic psychological needs have been identified as essential factors for facilitating optimal functioning. These needs are autonomy, competence and relatedness (for a review, see Ryan & Deci, 2000b). Autonomy, according to Deci and Ryan (1985), refers to the person's experience of having freely chosen to engage in a behavior, which is also what is meant by self-determination in SDT. Competence, on the other hand, refers to the individual's perceived ability in relation to a specific task. Finally, relatedness refers to having a sense of belonging and experiencing some degree of social support. According to Ryan and Deci (2000b), intrinsic motivation is seen in SDT as an evolved property of human beings. Therefore SDT is not concerned with what causes intrinsic motivation but with the conditions that sustain or diminish it. Central to these conditions, as indicated by a substantial amount of research, (for a review, see Ryan & Deci, 2000b), is whether or not they support the fulfilment of people's needs for autonomy, competence and relatedness. As an example of research in support of this, studies by Deci (1975, as cited in Ryan & Deci, 2000b) have shown that positive feedback on performance increased intrinsic motivation while negative feedback on performance diminished it, and studies by Vallerand and Reid (1984, as cited in Ryan & Deci, 2000b) found that these effects were mediated by perceived competence. Furthermore, studies by Fisher (1978, as cited in Ryan & Deci, 2000b) and Ryan (1982) have shown that the positive effect of competence on intrinsic motivation is present only when the person experiences a sense of autonomy. Finally, studies on infants and their mothers have shown that higher levels of exploratory behavior in infants is predicted by security and maternal support (e.g. Frodi, Bridges & Grolnick, 1985, as cited in Ryan & Deci, 2000b), supporting the notion that relatedness is a factor that enhances intrinsic motivation. Indicated by these and other studies (Deci & Ryan, 2000b) is that when individuals' basic psychological needs are met they tend to be intrinsically motivated, whereas when these needs are not met, levels of intrinsic motivation tend to be low.

2.1.1. Organismic integration theory.

So far in this essay, intrinsic and extrinsic motivation have been referred to as the only two kinds of motivation that exist. However, according to Ryan and Deci (2000b), SDT acknowledges that a continuum of types of motivation exists between extrinsic and intrinsic motivation. Organismic integration theory (OIT), a sub-theory within SDT, describes these

different types of motivation (for a detailed description of OIT, see Ryan & Deci, 2000b). As described by the authors, the types of motivation on the continuum, moving from more extrinsic to more autonomous, are called external, introjected, identified, integrated and intrinsic regulation.

According to the authors (Ryan & Deci, 2000b), external motivation refers to when one is doing something solely to attain a specific goal or reward. In introjected regulation the person has taken in the regulation to a certain extent but mainly acts on it to maintain or enhance self-esteem, e.g. to avoid guilt or to enhance pride. Both of these types of motivation are varieties of external regulation and have in studies often been combined to form a controlled motivation composite. The word controlled here refers to that these types of motivation are characterized by an experience of having to do something, such as having to go to work in order to attain a decent living standard (external regulation) or having to go to church in order to preserve feelings of worth (introjected regulation), as opposed to doing these things based on an experience of choice. Next on the continuum is identified regulation, where the person has consciously accepted the goal or regulation as personally important. This is followed by integrated regulation, where the regulations are fully assimilated to the self so that they are in congruence with one's values and needs. Both of these more autonomous regulations are still considered extrinsic since they are done to attain certain outcomes and not because of the satisfaction derived from the activity itself. Together with intrinsic motivation they have in some studies been combined to form an autonomous motivation composite. Empirical evidence has been provided in support of the motivation continuum (Ryan & Connell, 1989; for a review of additional support for OIT, see also Ryan & Deci, 2000b).

3. Benefits of Intrinsic Motivation

There is a wealth of studies from a variety of areas that point to multiple benefits from acting based on intrinsic motivation. Some of these areas are persistence, creativity, conceptual learning and well-being. The aim of this chapter is to review some of the research that suggests that intrinsic motivation has these benefits.

3.1. Persistence

Many studies point to a positive relationship between intrinsic motivation and persistence, a continued engagement over time in a certain activity or towards a specific goal. This relationship has been found in areas such as exercise (for a review, see Wilson, Mack &

Grattan, 2008), high-school attendance (for a review, see Guay, Ratelle, & Chanal, 2008), and weight control (e.g. Silva et al., 2010).

For example Ryan, Frederick, Lepes, Rubio, & Sheldon (1999) examined the relationship between motivation and exercise adherence in two studies (Study 1 had 40 participants and study two had 155 participants). In two exercise-groups, one where the participants practised tae-kwon-do and one where they practiced aerobics, the reasons for exercising were measured. Intrinsic motivation was measured in terms of competence and enjoyment (in study two also in terms of relatedness) and extrinsic motivation in terms of appearance and fitness motives. Adherence was measured in terms of drop-out, where drop-out was defined as no attendance during the first three weeks of the study, and in terms of attendance, defined as the total number of exercise hours during the 10-week period. In study one, competence and enjoyment were only measured in the beginning of the study, while in study two they were measured also after each exercise session. In both of these studies initial intrinsic motivation was positively related to higher levels of adherence. In study two, ongoing experiences of competence, enjoyment and relatedness were also positively related to adherence.

Evidence from the field of weight loss comes from a longitudinal randomized-controlled trial by Silva et al (2010), who examined the mediating effects of motivational orientation on exercise adherence and weight loss. 211 overweight or obese women participated in a 1-year intervention designed to facilitate weight loss and regular exercise. The intervention group attended 30 sessions that were focused on integrating exercise and eating habits conducive for weight maintenance. The program was especially focused on increasing autonomous regulation with regards to exercise and weight control. The control group received 29 sessions of general health education. Follow-up measurements were done 1 and 2 years after the interventions ended. Exercise adherence and weight loss was significantly higher for the intervention group as compared to the control group at both follow-up occasions, and these effects were predicted by autonomous motivation. External and introjected regulations did not have any significant effects on these outcomes.

Further evidence comes from the school setting, for example from Alivernini and Lucidi (2011), who conducted a longitudinal study concerning the relationship between students' self-determined motivation and intention to drop-out of high-school. 426 students of grades 9-13 completed self-report questionnaires concerning academic motivation, academic achievement and intentions to persist versus drop out. The measurements were done at the end of the first and third school terms during the period of the study. The students' official grades in several subjects were obtained at the end of the second school-term and their

socioeconomic status assessed at the beginning of the study. The results showed that higher level of self-determination was negatively related to drop-out intentions, even after controlling for the effects of academic achievement and socio-economic status.

3.2. Creativity

Many studies have found a positive relationship between intrinsic motivation and creativity (for a review, see Hennessey & Amabile, 2010). According to Hennessey and Amabile (2010), most researchers today agree that the two essential components of creativity are novelty (i.e. the development of a novel idea, product or problem solution) and value (i.e. that these developments are of value to the individual and/or larger social group). However, as described below creativity has been defined and measured differently in different studies.

Amabile (1983, as cited in Hennessey & Amabile, 2010) proposed the following intrinsic motivation principle of creativity: Intrinsic motivation is conducive for creativity while extrinsic motivation generally is detrimental. In an example of a study that provides support for this principle, Amabile (1985) examined the effects of intrinsic and extrinsic motivation on creative writing. 72 young adults who had an active involvement in creative writing each wrote 2 poems in individual laboratory sessions. Before they wrote the second poem they got to fill in a questionnaire, one group with questions focusing on intrinsic reasons for writing and one group with questions focusing on extrinsic reasons. The control group did not fill in any questionnaire in-between the two poems. There were no differences between the conditions for earlier involvement in writing or on creativity of the first poems written. However, participants in the external motivation condition displayed significantly lower levels of creativity in the second poem as compared to the other two groups. Creativity was measured through subjective ratings by 12 poets with a high level of interrater reliability.

Support for this principle also comes from correlational studies. In a sample of 290 Korean high-tech employees from 46 companies and their supervisors Shin & Zhou (2003) found that intrinsic motivation of employees partially explained their creativity. In this study employee creativity was rated by their supervisors by means of Zhou and George's (2001) 13-item scale with items such as "comes up with new and practical ideas to improve performance" and "comes up with creative solutions to problems" (Shin & Zhou, 2003, p. 706). In another study, Dewett (2007) attempted to link several common creativity antecedents, intrinsic motivation, and one's willingness to take risks to employee creativity. Survey data was gathered from 165 research and development employees and their supervisors in a large U.S. organization. Employee creativity was rated by their immediate supervisors on a scale with

six items adapted from George & Zhou (2001, as cited in Dewett, 2007) and Scott and Bruce (1994, as cited in Dewett, 2007), asking how characteristic various creative behaviors, such as novel and practical work-related ideas, are of the particular employee. Results showed that intrinsic interest in one's work is an important antecedent of employee creativity.

Much of the research in support of the Intrinsic Motivation Principle of Creativity comes from experimental studies that have focused on how different kinds of controlling events negatively affect intrinsic motivation and creativity. Among these are expected reward, expected evaluation, surveillance, competition, and restricted choice (Hennessey & Amabile, 2010). Typically, creativity has been measured in these studies by means of the Consensual Assessment Technique (Hennessey & Amabile, 1999), a way of assessing creativity based on the independent subjective evaluations of individuals familiar with the domain in which the products were made. Throughout the years there has been a debate concerning the existence of these negative effects of rewards and other extrinsic factors on intrinsic motivation and creativity (Hennessey & Amabile, 2010). This debate will be discussed in more detail in the chapter concerning the undermining effect.

3.1.3. Conceptual Learning

A large amount of research suggests that intrinsic motivation is conducive for conceptual learning (for a review, see Guay et al., 2008). Conceptual learning is a form of learning where the person has formed a deeper understanding of the material and is able to question its underlying meaning and relate it to other concepts (Vansteenkiste, Simons, Lens, Sheldon, & Deci, 2004). Conceptual learning has been assessed for example by asking the participants questions such as what they thought was the main point of the text (Grolnick & Ryan, 1987), or by asking them to rate items such as "I studied the text by associating the things I read with what I already knew" (Vansteenkiste et al., 2004, p. 249). It is a deeper form of learning than simple rote learning, the latter being a superficial memorization of information without any intention to discover the underlying meaning (Gow, Balla, Kember, & Hau, 1996, as cited in Jakubowicz, 2010).

An early example of a study examining the relationship between intrinsic motivation and conceptual learning comes from Benware and Deci (1984), who in a randomized-controlled study examined the effects of an active vs passive learning orientation on intrinsic motivation and quality of learning. The 40 college students that participated in the experiment were instructed to study a text about the functions of the brain. One group was to be examined on the contents of the text (passive learning condition) while the other group was to teach the

material to another student (active learning condition). The active learning group reported higher intrinsic motivation and had higher conceptual learning scores than the passive learning group, while there was no difference between the groups in rote learning. The effects were not a result of differences in time spent with the learning material since both groups reported having studied the same amount of time.

Grolnick & Ryan (1987) added to the generalizability of these results through a study with younger children instead of college students. In this study, using a randomized-controlled design, they examined the effects of motivationally relevant conditions and individual differences on learning and emotional experience. In individual laboratory sessions, 91 fifth-grade children were asked to read a text from a grade-level social studies book. The children were divided into three different conditions. One of the groups (noncontrolling-directed condition) was told that they would receive some questions on the text, though it would not actually be a test and they would not be graded on it. They were also told that they should read the text in whatever way was best for them. Another group (controlling-directed condition) was told that they would be tested and the test would be graded so that the experimenter could see if they were learning well enough. They were also told to work as hard as they could. The third group (nondirected condition) were only told that they would receive some questions about their experiences of reading the text. For this group, nothing was said about questions regarding the context of the text or concerning how they should read it. Rote learning was assessed by asking the participants to recall as much of the text as possible by using a free-recall paradigm, while conceptual learning was assessed by asking the participants to answer, in essay form, what they thought was the main point of the text, or what the author was trying to say. The non-controlled group and the non-directed group experienced greater interest and had higher scores on contextual learning as compared to the controlled group. Both of the directed groups had higher rote learning scores than the non-directed group, however, the degree of retention concerning rote learning was higher for the noncontrolled-directed group at an 8 (+/-1) day follow-up. Overall, more self-determined regulatory styles predicted higher scores for conceptual learning across conditions. This study also supports the connection between intrinsic motivation and hedonic well-being through the finding that the non-controlled and non-directed groups experienced less pressure than the controlled group.

Another set of studies by Vansteenkiste and colleagues (2004) looked at the same phenomena in a different context, namely that of goal-framing, and they also added to the generalizability of the results using several different samples, different kinds of goals,

different kinds of learning activities and a different culture (Belgium) than the previously mentioned studies (U.S.A.). They conducted three field experiments in order to investigate whether framing a learning activity in the context of intrinsic (vs extrinsic) goals and in an autonomy-supportive (vs controlling) learning climate would enhance learning, performance and persistence. In the first study, 200 college students studying to become preschool teachers learned text material concerning recycling and pro-ecological behavior. Half of the students had the activity framed within the context of an intrinsic goal of contributing to the community, while for the other half the activity was framed within the context of an extrinsic goal of attaining monetary benefit. Half of the participants in each of these groups were placed in either an autonomy-supportive or a controlling condition. The manipulation of these conditions was done through differences in the wording of phrases in the instructions, for example "if you choose" or "you might" (autonomy supportive condition) or "you should" or "you have to" (controlling condition). The other two studies had the same basic design while using different extrinsic and intrinsic goals (image vs growth and health), different categories of students (high school students and college students majoring in marketing) and learning of physical exercises instead of text material). In all of these three studies both experimentally manipulated variables gave main effects on depth of processing, test performance and persistence. When both intrinsic goals and autonomy support were provided together the interaction resulted in even higher deep processing and test performance. Autonomous motivation significantly mediated the main effects.

3.1.4. Well-being

A large number of evidence points to a positive relationship between intrinsic motivation and both hedonic as well as eudaimonic well-being. Hedonic well-being is commonly defined as the existence of a high level of positive affectivity, low level of negative affectivity, subjective evaluations of one's overall life satisfaction, and satisfaction with important domains of life, such as work (Diener, 2000). Whereas hedonic well-being emphasizes positive subjective feelings and mental states, eudaimonic well-being, on the other hand, is generally defined as optimal activity of a person, activity that fulfils one's human potential (Ryan, Huta, & Deci, 2008). Engagement, meaning in life, and goal-directed virtuous activities are commonly included in the concept of eudaimonic well-being (Ryff & Keyes, 1995).

Evidence for a positive relationship between intrinsic motivation and both hedonic as well as eudaimonic well-being comes from many different areas, for example from the context of

school (for a review, see Guay et al., 2008). In one of many studies from that context, Vallerand, Blais, Brière, and Pelletier (1989) found that students with higher autonomous motivation reported higher degrees of hedonic well-being in terms of satisfaction at school, greater enjoyment of academic work, and more positive emotions in the classroom.

Another area where the relationship between intrinsic motivation and well-being has been studied is in relation to the kinds of goals that people value and pursue. In three studies, Kasser and Ryan (1996) examined how the importance placed by the participants on intrinsic and extrinsic goals related to their eudaimonic and hedonic well-being. Eudaimonic well-being was measured by means of a self-actualization scale by Jones & Crandall (1986, as cited in Kasser & Ryan, 1996), while hedonic well-being was measured by means of, among others, a scale of vitality by Ryan & Frederick (1994, as cited in Kasser & Ryan, 1996), the Center for Epidemiological Studies - Depression Inventory (Radloff, 1977), and Hopkins Symptom Checklist - Anxiety Subscale (Derogatis, Lipman, Rickels, Uhlenluth, & Covi, 1974, as cited in Kasser & Ryan, 1996). What they found was that intrinsic goals were positively related to both kinds of well-being and negatively related to depression while the opposite was true for extrinsic goals. Both college and adult samples were used in these studies and the results were not dependent on gender, age or income level, suggesting a high level of generalizability of the results. These results have been replicated in many studies, also in other countries such as Russia (Ryan, Chirkov, Little, Sheldon, Timoshina, & Deci, 1999) and Germany (Schmuck, Kasser & Ryan, 2000), further adding to their generalizability. A limitation to these studies is that they employed a correlational design, which does not permit drawing causal conclusions (Kasser & Ryan, 1996).

The hedonic well-being derived from actually attaining one's goals is also related to the kind of goals one attains. A longitudinal study by Sheldon and Kasser (1998) showed that attaining intrinsic goals enhanced hedonic well-being while attaining extrinsic goals did not have a significant effect. Hedonic well-being was measured by means of, among others, the Satisfaction With Life Scale (Diener, Emmons, Larsen, & Griffin, 1985), the Center for Epidemiological Studies - Depression Inventory (Radloff, 1977), and the Positive Affect/Negative Affect Scale (Watson, Tellegen, & Clark, 1988). Similar findings come from several cross-sectional studies (e.g. Ryan et al., 1999).

Intrinsic motivation has been shown to have a positive relationship with the fulfilment of the basic psychological needs for autonomy, competence and relatedness (see e.g. Ryan & Deci, 2000b). Several studies have found that hedonic well-being is higher on days when need fulfilment is above the daily baseline of the individual (for a review, see Howell, Chenot, Hill,

& Howell, 2011). This applies to both life satisfaction and positive and negative affectivity, as measured by among others a daily survey using questions adapted from the Satisfaction With Life Scale (Diener et al, 1985) and from the Positive and Negative Affect Schedule - Expanded Form (Watson & Clark, 1994, as cited in Howell et al, 2011).

4. The Undermining Effect

In previous chapters it has been shown that intrinsic motivation has a variety of benefits and that, according to SDT, these benefits can be maximized through supporting the conditions that enhance intrinsic motivation, these conditions being the fulfilment of the three basic psychological needs. However, a common way of attempting to enhance motivation today is through the use of rewards, a method that, according to SDT, not always harmonizes with the fulfilment of these needs. In fact, many studies have found that when people get rewarded for a behavior that is intrinsically motivated their degree of intrinsic interest in the behavior tends to diminish. This phenomenon is often referred to as the undermining effect (e.g. Deci et al., 1999). The amount of research that has investigated this phenomenon is quite substantial, as illustrated by the fact that a metareview of research on the topic (Deci et al., 1999) included 128 studies. A typical way of studying this phenomenon, as described in the metareview, is as follows: Two groups are engaged in a specific activity, such as e.g. drawing, puzzle-construction, or word games, out of which one of the groups is rewarded for participating in the activity and the other group is not. The session is followed by a free-choice period where the participants get to do whatever they want, including continued engagement in the previous activity. Intrinsic motivation for the target activity is then assessed in terms of amount of time spent with the activity during the free-choice period. If the reward-group spends less time with the target activity during the free-choice period, as compared to the non-rewarded group, an undermining effect is assumed to have taken place. In most studies, measures of intrinsic motivation are also acquired through single or multiple item self-report measures assessing either interest in or enjoyment of the target activity, or both.

An early example of this kind of study comes from Lepper, Greene, & Nisbett, (1973) who examined this effect in a preschool setting. Their aim was to find out if the intrinsic interest of a person in an activity would be diminished as a result of engaging in the activity as an explicit means of attaining an extrinsic reward. Children with a high intrinsic interest in drawing during baseline observations were placed in one of three experimental conditions. In

the reward condition, the children were told that they would get a certificate as a reward for their drawings. In the unexpected reward condition the children got the certificate after drawing without knowing about it in advance, whilst in the no-reward condition they did not get any reward. The children in the reward condition showed significantly less interest in drawing 1-2 weeks after the experiment compared to the two other groups.

Similar findings, as reported in the meta-review by Deci and colleagues (1999), come from studies with different categories of participants (ranging from preschool to college), different rewards (ranging from dollar bills to marshmallows), different kinds of activities (ranging from construction puzzles to word games), and with rewards being contingent on different factors (such as performance at, completion of and engagement in the test). However, the undermining effect has been found to occur only as a result of tangible rewards and not as a result of verbal rewards, and also, only as an effect of expected rewards and not as an effect of unexpected rewards. Furthermore, it can be noted that the participants of almost all of these studies have either been children or college students, which limits the generalizability of the results to adults.

4.1. Critical Perspectives on the Undermining Effect

As has been demonstrated above, evidence shows that extrinsic rewards can diminish intrinsic motivation. However, throughout the years there has been debate concerning the undermining effect. Even though most researchers today agree that an undermining effect exists there are differing views considering the circumstances during which it appears and concerning how difficult or easy it is to avoid it (Hennessey & Amabile, 2010). This debate has mainly taken place between two different streams of psychology, the social-psychological perspective and the behaviorist perspective (Hennessey & Amabile, 2010). This section will briefly review the standpoint of the two camps in this debate.

Most researchers coming from a social-psychological perspective, as reviewed by Hennessey and Amabile (2010), maintain that in most cases rewards are detrimental for intrinsic motivation. More specifically, they argue that rewards diminish intrinsic motivation when they lead people to feel controlled by the situation. However, they also recognize that there are certain conditions when rewards actually can enhance extrinsic motivation without having subsequent negative effects on intrinsic motivation. More specifically, they maintain that rewards can increase intrinsic motivation when they affirm competence, impart useful information in a supportive manner, or make it possible for people to do things that they already were intrinsically motivated to do (Hennessey & Amabile, 2010). These positive

effects of rewards seem to be most likely to occur when initial levels of intrinsic motivation are high (Amabile, 1993, as cited in Hennessey & Amabile, 2010).

Some researchers from the behaviorist tradition, on the other hand, claim that intrinsic motivation can easily be enhanced by rewards and that the undermining effect only appears during very limited conditions (e.g. Eisenberger and Cameron, 1996). For example, according to the meta-analytic review by Eisenberger and Cameron (1996) rewards, when given based on task performance or task completion, do not diminish intrinsic interest. The only reliable detrimental effect of rewards on intrinsic motivation occurs when rewards are given at one single occasion with no regard for quality of performance or task completion. The authors also point out that the detrimental effect of performance-independent reward has not been found in the few studies where rewards have been given repeatedly followed by several sessions with no reward.

Another question of relevance for this debate is the issue of individual differences in motivational orientation. Reiss (2005), for example, has suggested that people might react differently to external and internal motivators depending on differences in personality. A study by Bateman and Crant (2003) presents preliminary evidence for this proposition. In a correlational study with data from 833 respondents of different occupations, he found that perceived control and job satisfaction were strongly and positively predicted by extrinsic rewards when extrinsic values were high, while the correlation was less strong when extrinsic values were low. Extrinsic values here refers to the extent of personal value individuals place on specific rewards such as “Being able to meet my income goals” or “The recognition I can earn from other people” (Bateman & Crant, 2003, p. 14), as measured by the 30-item Work Preference Inventory (Amabile, Hill, Hennessey, & Tighe, 1994). On a related theme, Silverstein (2010) has argued that people with motivational impairments (such as people with schizophrenia) are more likely to experience motivational benefits from rewards rather than acquiring detrimental effects on their already low levels of motivation.

In conclusion, most researchers today do agree that there is an undermining effect. However, while many researchers from the behaviorist tradition claim that it is a limited and easily avoidable phenomenon, most researchers that take a social-psychological perspective argue that extrinsic rewards generally undermine intrinsic motivation and that positive effects of rewards on intrinsic motivation only appear during specific conditions. The debate concerning these issues still continues and, as has been suggested by Hennessey & Amabile (2010), while the research and theories of both of these philosophical camps becomes more refined, the gap between them may eventually narrow.

In summary, what has been demonstrated so far is that intrinsic motivation has various benefits and that most researchers today agree that extrinsic rewards at least during certain conditions undermine intrinsic motivation. However, several questions concerning intrinsic motivation still lack definitive answers. Can we really distinguish between intrinsic and extrinsic motivation in a meaningful way? Does motivational orientation lead to different responses in relation to different kinds of motivational events? Is the undermining effect a real phenomena or not? Psychological research has at least so far failed to provide conclusive evidence concerning these questions. Can neuroscience provide additional evidence that will help solve these issues? This is what will be explored in the next chapter.

5. Neuroscientific Perspectives on Intrinsic Motivation

Neuroscientists have only recently started explicitly exploring the phenomenon of intrinsic motivation and the amount of studies on the topic is so far highly limited. In this chapter, the six studies that, to the author's best knowledge, have more or less explicitly explored this topic will be reviewed. All of these studies have investigated the phenomenon from somewhat different perspective. Some of them have studied task-specific intrinsic and extrinsic motivation while others have looked at intrinsic and extrinsic motivation as personality traits. The methodology for measuring intrinsic motivation also differs between studies, as will be clarified for each respective study. However, before reviewing the studies on intrinsic motivation, a brief overview of the neural basis of extrinsic motivation will be given to provide a possibility to compare possible differences and similarities between these two kinds of motivation. It should also be noted that while this essay focuses on the neuroimaging studies that have explicitly explored intrinsic motivation, studies exist which have explored phenomena considered to be highly related to intrinsic motivation, such as curiosity (e.g. Kang et al., 2009) and exploratory behaviour (e.g. Voss, Gonsalves, Federmeier, Tranel, & Cohen, 2011). These studies are, however, outside the scope of this essay.

5.1. The Neural Basis of Extrinsic Motivation

Extrinsic motivation, as has been clarified previously in this essay, is generally viewed as the motivation to attain specific external rewards, such as money or food. Therefore, in this section, extrinsic motivation and reward motivation will be treated as synonymous concepts.

In the 1950's it was found that rats would engage in excessive self-stimulation if they have unlimited access to electrodes implanted in the medial forebrain bundle (Walter, Abler, Ciaramidaro, & Erk, 2005). The medial forebrain bundle is a part of dopaminergic reward pathway beginning in the midbrain ventral tegmental area and projecting to the ventral striatum, including the nucleus accumbens. Studies with self-stimulating rats, along with further research, revealed that incentives trigger dopamine release in the brain, and eventually lead to the understanding that the neurotransmitter dopamine plays a crucial role in reward motivation (Reeve, 2009). The involvement of the dopaminergic reward pathway in reward behaviour has been subsequently demonstrated in a wealth of human and animal studies (Walter et al., 2005).

For a long time, it was thought that dopamine is responsible for generating the subjective well-being that stems from the reception of rewards (Walter et al., 2005). However, later research has found that dopamine is responsible for generating the sense of wanting something rather than the sense of liking something (Berridge & Robinson, 2003). Studies have for example found that activation of the human accumbens-striatal dopaminergic system correlates better with subjective assessments of wanting a specific reward, such as food or drug, than with subjective assessments of pleasure (Volkow et al., 2002, as cited in Berridge & Robinson, 2003; Leyton, Boileau, Benkelfat, Diksic, Baker, & Dagher, 2002, as cited in Berridge & Robinson, 2003). Hence, a distinction is made in neuroscience between wanting something, which is related to the neural basis of motivation, and liking something, which is related to the neural basis of pleasure, even though these two functions are closely related to each other (Berridge & Robinson, 2003).

A large number of human neuroimaging studies have investigated the neural basis of reward motivation. In a typical experiment the subjects of the experiment will have their brain activity scanned in an fMRI scanner while they are led to understand that they will soon receive the reward that is specified in the experiment. Typically, activation during the reward condition is contrasted to the no-reward condition within the same subjects and sometimes also to the negative reward condition. In case of a taste reward, for example, the participants are presented with a visual cue signalling that they will soon receive a pleasantly tasting stimulus, an unpleasant taste or a neutral taste (e.g. O'Doherty, Deichmann, Critchley, & Dolan, 2002). In case of monetary rewards the participants are usually engaged in a task where they can either win or lose money depending on if they respond correctly or not according to the rules of the task (e.g. Elliott, Friston, & Dolan, 2000; Delgado, Nystrom, Fissell, Noll, & Fiez, 2000). Many studies have also measured activation during the receipt of

reward, but as this essay is concerned with the neural basis of motivation (wanting) and not with the neural basis of pleasure (liking), what is reported here pertains to findings concerning the anticipation of reward.

Some of the structures that have been most consistently found to be activated in the kind of experiments that have been described above are the amygdala, the ventral striatum/nucleus accumbens and the orbitofrontal cortex (OFC) (Walter et al., 2005). Accordingly, these structures are viewed as some of the core elements of the human reward system (Walter et al., 2005). They have been found to be related to primary reinforcers, such as pleasant sensory stimuli and drugs, as well as more abstract rewards, such as winning money and gaining symbolic rewards (Elliott, Newman, Longe, & Deakin, 2003). Similar patterns of activation have in several studies been found to be related to cognitive feedback, defined as receiving information concerning one's performance in relation to the task at hand (e.g. Daniel & Pollmann, 2010; Aron, Shohamy, Clark, Myers, Gluck, & Poldrack, 2004), and social rewards, such as receiving positive evaluations of one's personality from others (e.g. Izuma, Saito, & Sadato, 2008; Spreckelmeyer et al., 2009).

These structures are involved in reward-processing in different ways. Many studies have found activity in the orbitofrontal cortex to be correlated with the reward value of stimuli, indicating that the OFC is involved in coding for reward valence, i.e. how positive or negative the specific reward is perceived to be (Walter et al., 2005). For example, activation in the OFC has been found to vary in response to different levels of monetary reward (Elliott et al., 2000) and in response to different levels of attractiveness of cars (Erk, Spitzer, Wunderlich, Galley, & Walter, 2002). The amygdala, on the other hand, appears to be coding for the intensity of rewards (Walter et al., 2005). For example, in one study that attempted to separate between responses to reward valence and intensity, it was found that the amygdala reacts to reward intensity independent of reward valence (Anderson et al., 2003). Yet another part of the brain that is important in reward motivation, the striatum, seems to be involved in processing information about the predictability of rewarding stimuli and in coding for reward salience, salience here defined as the quality of a stimulus that is both unexpected and that evokes an attentional-behavioural switch. (Walter et al., 2005). The role of the striatum in reward prediction has been shown for example by Berns, McClure, Pagnoni, & Montague (2001), who found that mildly pleasant stimuli did not elicit activity in the striatum when their occurrence was predictable but only when it was unpredictable. Evidence for the role of the striatum in coding for reward salience, on the other hand, comes for example from a study by Zink, Pagnoni, Martin-Skurski, Chappelow, & Berns (2004), who found that the striatum was

not active when money was obtained passively but only when money could be obtained by behaving in a certain way.

Other regions that have been identified as part of the brain's reward system include the dorsolateral prefrontal cortex and medial prefrontal cortex, especially the anterior cingulate cortex, and it can be briefly mentioned that the role of these regions is assumed to be to integrate reward information with action and decision-making (Walter et al., 2005).

5.2. The Neural Basis of Intrinsic Motivation

Three studies have, to the best of the authors knowledge, so far explicitly explored the differences in neural activation between an intrinsic motivation and an extrinsic motivation condition (Lee, Reeve, Xue, & Xiong, 2009; 2012; Lee & Reeve, 2012). All of these three fMRI studies had a similar experimental setup. In all of them, subjects were exposed to sentences depicting different familiar activities (e.g. writing a paper) combined with different reasons for participating in the activities. The reasons were either intrinsic (e.g. studying for fun), extrinsic (e.g. studying for a grade) or neutral (e.g. studying because it is time). In the first two studies (Lee et al., 2009; 2012), subjects were instructed to read the sentences and decide whether they want to participate in the activities or not (through pressing a button), whereas in the third study (Lee & Reeve, 2012) they were instructed to imagine participating in the activities.

All of these studies compared activations between the intrinsic and extrinsic motivation condition and found differences between the conditions, even though these differences varied between studies. In the first study (Lee et al., 2009), unique activations in the intrinsic motivation condition were found in the right inferior parietal lobe, left superior temporal gyrus and bilaterally in the anterior precuneus, whereas unique activations in the incentive motivation condition were found in the left nucleus accumbens and the left anterior cingulate gyrus. In the second study (Lee et al., 2012), results showed higher levels of activation in the right insular cortex in the intrinsic motivation condition and higher levels of activation in the posterior cingulate cortex in the extrinsic motivation condition. Furthermore, in the second study reaction times for making the choice of participating or not in the activities were significantly higher in the intrinsic motivation condition as compared to the two other conditions. Finally, in the third study (Lee & Reeve, 2012) the results showed more activation in the anterior insular cortex during the intrinsic motivation condition (even while imagining the same activity as in the extrinsic motivation condition but for an intrinsic reason) and more activation in the angular gyrus during the extrinsic motivation condition.

The authors explain these findings based on earlier research showing that these areas are related to functions that are associated with intrinsic motivation and extrinsic motivation respectively. In relation to the first study, the anterior precuneus (intrinsic motivation condition) is associated with assessments of self-relevance, while the nucleus accumbens and the anterior cingulate gyrus (extrinsic motivation condition) are related to the expectation of rewards and the making of decisions based on evaluation of rewards respectively. With respect to the second study, the insular cortex (intrinsic motivation condition) has in studies on addiction and craving been suggested to be related to hedonic feelings engendered by bodily need satisfactions, while the posterior cingulate cortex (extrinsic motivation condition) is known to have a role in the evaluation system associated to subjective value informed by social knowledge. Finally, concerning the third study, the anterior insular cortex (intrinsic motivation condition) has been found to be related to the sense of agency, while the angular gyrus (extrinsic motivation condition) has been found to be related to the sense of loss of agency.

Thus, all of these three studies suggest that there are differences between the neural basis of intrinsic motivation and the neural basis of extrinsic motivation.

5.3. Motivational Orientation Modulates Neural Response to Reward

The three studies mentioned above focused on the neural basis of task-specific motivation. However, a few recent studies have also looked at motivational orientation (intrinsic vs extrinsic) as a personality trait. The two such studies that, to the best of the author's knowledge, exist up to date will be reviewed here.

Linke and colleagues (2010) employed a probabilistic reversal learning task to explore whether differences in motivational orientation would lead to differences in neural response to reward and punishment. The task used in the experiment was a form of a gambling task. In order to assess extrinsic and intrinsic motivation towards gambling, the 33 participants completed the Gambling Motivation Scale (Chantal, Vallerand, & Vallieres, 1994, as cited in Linke et al., 2010). Then, in an fMRI scanner, the participants were engaged in a task were they got to choose from two different playing cards and depending on if they chose the right card they either won or lost money (ranging from 0.10 to 1.00 euros per answer). Which card was correct was based on a specific rule that the participants reasonably should be able to figure out after a few trials. The rule was changed every now and then and in order to continue earning money the participants needed to figure out how the rule had changed. The results from this study showed that persons with higher levels of extrinsic motivation

displayed increased neural response to reward in prefrontal regions, in the parietal and temporal cortex as well as the amygdala and striatum. Conversely, between intrinsic motivation and activation in these regions in response to reward, a negative relationship was observed.

In another experiment that explored the impact of motivational orientation on neural response to reward Daniel and Pollmann (2010) used an information-integration category learning task. 16 subjects performed two tasks in an fMRI scanner. In these two tasks different kinds of stimuli (lines or circles) were presented with different kinds of background structures. The participants were instructed to figure out the pattern according to which they should respond based on the visual and auditory feedback they received from their responses. For one of these tasks the participants received a monetary reward of 0.20 euros for each percentage of correct answers, while for the other task only the visual and auditory feedback was given. After the testing session, intrinsic and extrinsic motivation of each participant was measured by means of a questionnaire based on the postexperimental scale of the Intrinsic Motivation Inventory (Ryan, 1982; McAuley, Duncan & Tammen, 1989, as cited in Daniel & Pollmann, 2010). Consistent with implications of earlier studies (Daniel & Pollmann, 2010), monetary reward and cognitive feedback lead to similar activations in dopaminergic structures of the brain. However, one structure, the nucleus accumbens, showed higher activation during anticipation of monetary reward compared to the anticipation of cognitive feedback. Furthermore, this activation was predicted by extrinsic motivation during anticipation of monetary reward and by intrinsic motivation during anticipation of cognitive feedback.

In conclusion, both of these studies found that differences in motivational orientation lead to differences in neural response in relation to monetary reward. A difference between these two studies, however, was that one of them focused on neural activation during the anticipation of rewards while the other focused on neural activation during the reception of reward. While monetary reward was the only factor that was explored in both of the studies, one of the studies also reported similar findings for cognitive feedback.

5.4. The Neural Basis of the Undermining Effect

The five studies that are mentioned above represent early attempts to use neuroimaging in order to answer the questions of whether it really is possible to distinguish between intrinsic and extrinsic motivation and whether motivational orientation modulates people's responses to motivational events. This section aims to answer the question of whether neuroscience can provide any evidence concerning the existence or non-existence of the undermining effect.

To this date, only one study has explicitly investigated the neural basis of the undermining effect. This study, by Murayama and colleagues (2010), used a stopwatch (SW) task that had been found in pilot studies to be inherently interesting and moderately challenging for japanese university students. The task of the participants was to stop a stopwatch within 50 ms of the 5-s time point. In the control task the participants were instructed to wait until the stopwatch stopped and then to press the button (watch-stop (WS) task). The 28 participants were randomly assigned to two groups and both groups participated in two scanning sessions where the SW and the WS tasks were pseudorandomly intermixed. The experimental group received a monetary reward of 2.20 dollars for each successful trial during the first scanning session. The participants in the control group were not informed concerning any performance-based rewards and simply received a sum equivalent to the participants in the experimental group merely for participating. After the first, rewarded, session with the task there was a 3 min free-choice period where the participants were allowed to continue engaging in the SW or WS tasks on a computer or to do anything else. The amount of times participants played the SW task during the free-choice period was used as a measure of intrinsic motivation for the task. This was followed by another session with the SW and WS tasks in the scanner with the difference that this time there was no performance based rewards, which the participants were informed about in advance. Finally, after the second scanning session there was another 3 min free-choice period. As can be seen, the experimental design closely resembled the classical free-choice paradigm for investigating the undermining effect.

An undermining effect was found in this study, with a significantly smaller amount of times played on the stop-watch task during the free-choice period for the reward group as compared to the control group. The effect was found during both free-choice periods. This effect was accompanied by a decrease in activity in the anterior striatum and in prefrontal areas during the second scanning session as compared to the first. According to Murayama and colleagues (2010), these neuroimaging results suggest that when performance-based reward no longer is promised people do not experience subjective value in succeeding in the task and they are not motivated to show cognitive engagement in the task. They base this conclusion on evidence from previous studies suggesting that activation in the anterior part of the striatum is modulated by the individual's personal belief in influencing the outcome. As further support for their conclusion they refer to previous studies showing that the midbrain, which has strong anatomical connections with the anterior striatum, is responsive to both cognitive feedback and monetary reward feedback. Additionally, as yet more support for their reasoning, they point out that the lateral prefrontal cortex (LPFC) is the center for the

preparatory cognitive control to attain goals and that this role of the LPFC has been shown to be modulated by task value.

In conclusion, the only study so far that has explored the neural basis of the undermining effect did find a decrease in activity in the anterior striatum and the prefrontal areas that was related to the undermining effect.

6. Discussion

As has been discussed in this essay, there are many controversies concerning the topic of intrinsic motivation. First, there is no clear agreed upon definition of the concept but different researchers within the various perspectives in psychology have conceptualized the concept differently. According to SDT, the most used theoretical framework in the study of intrinsic motivation, intrinsic motivation is the kind of motivation that is present when a person is pursuing an activity for the inherent satisfaction that is provided by engagement in the activity. This is arguably a rather vague definition and the question arises as to how it can be measured in a reliable way. In SDT research a number of different approaches in measuring intrinsic motivation have been used, from self-report measures of engagement and interest in the activity, to observation of free-choice engagement in the activity when no rewards or other extrinsic motivators are present. However, it can be argued that since so many different kinds of measures are used in different studies it is questionable if the studies are actually examining the same phenomenon (i.e. intrinsic motivation) or a number of different phenomena (e.g. enjoyment, interest, free-choice behavior). Moreover, as discussed below, all of these measures have some problematic features that makes the use of them as measures of intrinsic motivation questionable.

Csikszentmihalyi (1975, as cited in Deci & Ryan, 1985) defines intrinsic motivation as behavior that is characterized by enjoyment, and enjoyment is also commonly used as a measure of intrinsic motivation in research based on SDT (see e.g. Deci et al., 1999). However, it can be argued that not all intrinsically motivated behaviors are characterized by enjoyment. For example, jogging might not necessarily be characterized by enjoyment while engaging in the activity but the behaviour might still be freely chosen without the existence of extrinsic rewards. Accordingly, it could be argued that what is studied when self-report measures of enjoyment are used is enjoyment or liking a specific activity and not necessarily intrinsic motivation. The same line of reasoning can be applied to the use of interest as a

measure of intrinsic motivation as subjective evaluation of interest in jogging might not necessarily be high despite the activity being intrinsically motivated.

Another common way of measuring intrinsic motivation is the observation of free-choice behavior. This measure reflects the general understanding of intrinsic motivation as something which is present when people engage in behaviors for the inherent satisfaction that the behavior gives them. However, reinforcement learning can often influence behavior a long time after the reinforcer is removed (Delamater, 2004). It can be argued, then, that free-choice behavior can as well be a result of earlier reinforcement learning, rather than a result of intrinsic motivation. Accordingly, what is measured through the usage of the free-choice paradigm might merely be free-choice engagement in a certain behavior and not necessarily intrinsic motivation.

These methodological problems of course apply to research concerning the beneficial effects of intrinsic motivation. In addition, apart from these methodological problems it can also be questioned whether intrinsic motivation is always beneficial. A workaholic, for example, might be highly intrinsically motivated, while the outcomes of this kind of behavior have been shown to be related to lower levels of well-being and poorer health (e.g. Shimazu & Schaufeli, 2009). The possibility of non-adaptive behaviors that are intrinsically motivated suggests that the concept of intrinsic motivation needs to be further elaborated. Vallerand and colleagues (2003) have distinguished between two types of passion (defined as a strong leaning toward an activity that people like and find important and to which they dedicate time and energy), namely obsessive and harmonious passion. According to him, obsessive passion is characterized by an experience of having to engage in an activity, while harmonious passion is characterized by an experience of freely choosing to engage in the activity. Obsessive passion has been found to be related to high levels of negative affect and persistence in activities which lead to negative outcomes, while harmonious passion has been found to be related to high levels of positive affect, low levels of negative affect and disengagement in activities which lead to negative outcomes (Vallerand et al, 2003). Maybe a similar distinction could be made for obsessive and harmonious intrinsic motivation, in order to make the concept of intrinsic motivation more precise.

As to research on the undermining effect, additional methodological aspects need to be considered.

First, Eisenberger and Cameron (1996) have pointed out that in studies where rewards have been given repeatedly followed by several sessions with no rewards, no undermining effect has been found. However, such a result can be explained by traditional learning

paradigms without necessarily introducing the concept of intrinsic motivation. For example, in operant conditioning, the frequency, amount or strength of a certain behavior can be modified when it is repeatedly associated with a certain reward (Coon & Mitterer, 2010). When such a reinforced behavior is repeated many times but now in the absence of the reinforcer a gradual decline of the formerly reinforced behavior takes place, a process known as extinction (Delamater, 2004). Thus, the undermining effect may well be an occasion or form of extinction learning.

Second, many studies have rewarded behavior without any consideration of performance or task-completion, while in other studies rewards have been contingent on these two factors (Deci et al., 1999). It could be argued that what was investigated in the former studies was not actually the undermining effect but rather a form of learned helplessness, that is, a perceived lack of being able to control the outcome of a situation (Maier & Seligman, 1976), as has also been suggested by Eisenberger and Cameron (1996). Aversive effects of non-contingent approval have been demonstrated earlier by for example Eisenberger, Leonard, Carlson and Park (1979), who found that when children received non-contingent approval on a training task they learned slower on a subsequent task as compared to children who had received contingent approval or performed the task without approval. Hence, it could be argued that the results of studies that used non-contingent rewards can be viewed as additional evidence for the theory of learned helplessness, rather than evidence for an undermining effect.

Furthermore, questions have also been raised concerning the generalizability of the undermining effect (Bateman & Crant, 2003). More specifically, it has been speculated that extrinsic rewards might lead to different outcomes depending on individual differences in motivational orientation, i.e. in how much value a given individual places on specific rewards. As has been discussed previously, a study by Bateman and Crant (2003) indicates that this might be the case. To the author's best knowledge, however, only one study has examined this matter, and as such, the question still remains unresolved.

Thus it is clear that psychological research has not been able to provide conclusive answers to a number of questions concerning intrinsic motivation, these questions being: What can actually be considered intrinsic motivation and whether and to what extent is it different from extrinsic motivation, does motivational orientation lead to different responses in relation to different kinds of motivational events, and is the undermining effect a real phenomenon or not? Next, recent findings from neuroimaging research will be discussed in light of these questions.

Considering the question whether we can really distinguish between intrinsic and extrinsic motivation, the first three studies to explicitly explore the neural basis of intrinsic motivation do indeed report differences in activation between these two kinds of motivation conditions as compared to each other (Lee et al, 2009; Lee et al, 2012; Lee & Reeve, 2012). More specifically, in all these studies taken together, higher activation in the intrinsic motivation conditions were found in the right inferior parietal lobe, the left superior temporal gyrus, bilaterally in the anterior precuneus, the right insular and the anterior insular cortex, while in the extrinsic motivation conditions more activations were found in the left anterior cingulate gyrus, the posterior cingulate cortex and the angular gyrus. According to the authors, all these areas have in earlier studies been found to be related to functions that are usually associated with intrinsic and extrinsic motivation respectively. It could be argued that these results provide preliminary evidence for a neural distinction between intrinsic and extrinsic motivation.

As described above these studies conceptualized intrinsic motivation either as self-reported desire about whether and to what extent one wants to engage in different activities (Lee et al, 2009; Lee et al, 2012) or as mental imagery of carrying out certain activities (Lee & Reeve, 2012). In psychological research, however, motivation has mainly been studied in terms of one's emotional experience during a certain activity, i.e. interest or enjoyment, or in terms of behavior, e.g. does providing a reward for a behavior change the behavior. Since the ways of studying motivation are so different between these two fields it can be questioned whether they actually are studying one and the same phenomenon. Based on the distinction between wanting and liking (Berridge & Robinson, 2003) it could be argued that what is studied here are actually three distinct phenomena: wanting (desire), liking (interest or enjoyment) and behavior. This confusion of concepts provides challenges for comparing psychological and neuroscientific research on motivation.

As to the question concerning individual differences in motivation and its effect on rewards, preliminary evidence is provided by the two studies reviewed above. In the study by Daniel and Pollmann (2010), activation in nucleus accumbens (NAcc) in response to monetary reward was predicted by the participants' levels of extrinsic motivation, whereas NAcc activation in response to cognitive feedback was predicted by levels of intrinsic motivation. In the study by Linke and colleagues (2010), activation in several brain structures in response to monetary reward was predicted by extrinsic motivation, whereas for intrinsic motivation a negative relationship between activation in the same structures in response to

reward was found. These studies together indicate that responses to reward are modulated by individual differences in motivation.

Considering the debate regarding the positive and negative effects of using rewards, based on the findings reported above and the study mentioned earlier by Bateman and Crant (2003), an area worthy of investigation could be whether the effects of rewards on intrinsic motivation are also modulated by motivational orientation. Instead of looking at the effects of rewards in general, it can be argued that a more fruitful approach would be to design studies in a manner that would make it possible to differentiate between the effects of rewards on persons with high levels of intrinsic versus extrinsic motivation, and between persons that have high versus low levels of motivation in general.

Considering the existence of the undermining effect in general, the only neuroimaging study so far to explicitly explore this phenomenon reported that the undermining effect is accompanied by a decrease in activity in the anterior striatum and the prefrontal areas (Murayama et al, 2010). That there are notable changes in brain activity related to the undermining effect could be taken as support for the existence of an undermining effect. However, the reasons for the changes in activation, as well as the reasons for less engagement in the target activity after being rewarded for it, might be other than the undermining effect. For example, studies have shown that losses and disadvantages have greater impact on preferences than rewards and benefits (Tversky & Kahneman, 1991). Removing a reward could arguably be viewed as a loss or disadvantage, and hence it is also not surprising that this has an effect on preferences concerning the behavior that earlier was rewarded. If that is the reason for less engagement in the target behavior during the free-choice period, then it could as well be argued that what was studied was the neural basis of loss aversion.

In sum, it has been pointed out that the neural distinction between wanting and liking might provide some clues concerning the usefulness of dividing motivation into the two categories of intrinsic and extrinsic. It might be that what is referred to in psychological research as intrinsic motivation has more to do with enjoyment (liking) than with motivation (wanting). As such, psychological research might benefit from being informed by recent developments in neuroscience and hence develop ways of studying and conceptualizing motivation that incorporate the distinction between wanting and liking.

7. Conclusion

The aim of this essay has been to give an overview of the topic of intrinsic motivation based on both psychological and neuroscientific research. In particular, the essay has focused on the benefits of intrinsic motivation on multiple outcomes and on the effects of rewards on intrinsic motivation. Research that has found beneficial effects of intrinsic motivation on persistence, creativity, conceptual learning and both hedonic as well as eudaimonic well-being has been reviewed. The possibility of non-adaptive intrinsically motivated behaviors (e.g. workaholism) has been addressed, suggesting that the concept of intrinsic motivation needs to be further elaborated to distinguish between adaptive and non-adaptive intrinsic motivation. Evidence for an undermining effect of extrinsic rewards on intrinsic motivation has been put forth. It has been pointed out that there has been considerable debate concerning the undermining effect, most researchers agreeing on its existence while different research traditions disagreeing on how difficult or easy it is to avoid it and on the circumstances during which it appears. Alternative explanations for the undermining effect have been suggested, such as learned helplessness and loss aversion. Conceptual and methodological issues have been discussed, high-lighting potential problems of measuring intrinsic motivation based on enjoyment, interest, and free-choice behavior.

Neuroscientific research has been presented, reaching the conclusion that while the first neuroimaging study to explicitly explore the undermining effect has demonstrated changes in brain activity related to the undermining effect (decreased activity in the anterior striatum and the prefrontal areas), other neuroscientific and psychological studies have indicated that people react differently on rewards depending on individual differences in motivational orientation. Preliminary evidence for the neural basis of intrinsic motivation has been presented (more activity in e.g. the anterior insular cortex and less activity in e.g. the angular gyrus and the posterior cingulate cortex as compared to extrinsic motivation), while also arguing for that the concept of intrinsic motivation might be based on a confusion between two neurally distinct phenomena, namely those of wanting and liking. Recommendations have been made for psychological research to make use of neuroscientific findings in order to make its research more precise. To further our knowledge concerning both positive and negative effects of extrinsic rewards, studies that take into account individual differences in motivational orientation and differences in general levels of motivation have been suggested.

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