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Psychological factors in discounting negative impacts of nuclear waste

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ABSTRACT

The aim of this paper is to examine discounting of negative consequences of nuclear waste from both content-related and methodological perspectives. To test whether discounting depends on the issue at hand, we compare discounting judgments between nuclear and hazardous wastes. Further, we investigate psychological factors underlying discounting. From a methodological perspective, we investigate participants' sensitivity to extensive timescales. Data from an online experiment ($N = 314$) reveal two psychological discounting factors: The more participants belief that societies will be able to adapt to future challenges, the stronger they discounted negative future consequences. The more emotionally involved participants feel about the future the less they discounted. Seriousness judgments were higher for the issue of nuclear than for hazardous waste. The results also indicate that participants are sensitive to different extensive timescales. We discuss the implications of our findings for future research on discounting of negative long-term impacts of technologies.

1. Introduction

Extensive timescales are one essential characteristic of many environmental problems such as climate change and the disposal of high-level nuclear waste. The long-term dimension poses a challenge for assessing possible impacts of these environmental problems in natural scientific research but also calls for social scientific research (Flüeler, 2006; Scholz, 2011). If we want to understand the impact of such long-term environmental problems on social systems and vice-versa, it is imperative to gain a thorough understanding of how people comprehend and deal with the long-term dimension. The temporal dimension may, for example, influence people's willingness to make sacrifices for future generations. Research on time in the social sciences, however, rarely includes timescales that surpass the expected lifespan of a human being (see e.g., Table 1 in Chao, Szrek, Pereira, & Pauly, 2009; Frederick, Loewenstein, & O'Donoghue, 2002; Liberman, Sagristano, & Trope, 2002; Tsukayama & Duckworth, 2010). One exception is a study by Chapman (2001) investigating inter- and intragenerational discounting rates and taking into account timescales of up to 900 years.

The discounting paradigm was originally conceptualized as a tool for comparing the value of investments that can be made today or in the future. Because of its simplicity and its resemblance to the compound interest formula it soon became a popular approach in "decisions involving tradeoffs between costs and benefits at different times" (Frederick et al., 2002, p. 351). It assumes that the utility of a consequence decreases with increasing temporal distance. Discounting a certain utility, e.g., $100, means that $100 is of less utility later in time than sooner in time. If A and B both receive $100 but A receives $100 now and B receives the same amount of money in one year, A could make a financial investment with the money and be better off financially in one year compared to B who would then have just received $100. Thus, receiving $100 in one year is of less value than receiving it today. The same logic is applied to negative consequences. Losing $100 today has a higher negative value than losing it in the future, as it may be invested for some time until it is lost. Having its origins in economics (Frederick et al., 2002) and in investment decisions (Ott, 2003), the discounting paradigm soon became common as well for other social sciences like psychology and also for studying non-monetary decisions involving different timepoints such as health risks and environmental risks.

In the domain of environmental risks discounting has been applied for the issues of nuclear waste storage, soil pollution, greenhouse effect, water pollution, and coastal degradation (for an overview, see Gattig & Hendrickx, 2007). This implies that everything (e.g., the loss of a species) can be monetized, a position which initiated critical reflection (e.g., Hellweg, Hofstetter, &

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Hungerbühler, 2003; Ott, 2003). One can distinguish between different discounting approaches (Baum, 2009): a prescriptive one, where discounting rates are based on ethical considerations (e.g., Stern, 2007), and a descriptive one where discount rates are based on observations of, e.g., the financial market (e.g., Nordhaus, 2007). One example of the descriptive approach considers public judgments. Hence, some studies do not necessarily apply the discounting paradigm as an economic tool, but more so to examine the public's perception of long-term decisions.

An often-reported finding of such studies is that a substantial portion of participants refuses to discount; they are so-called "non-discounters". Studying discounting in the context of greenhouse effect, Nicolaij and Hendrickx (2003) report that about 50% of participants did not discount. Typically, in discounting studies, researchers use a within-subjects design with temporal delay as the repeated factor. This makes the manipulation of temporal delay quite conspicuous (Hendrickx & Nicolaij, 2004) and could, therefore, promote non-discounting. However, also in between-subjects designs, where different participants make judgments on different temporal delays, a common result is that no effect of delay manipulation is found (Böhm & Pfister, 2005; Hendrickx & Nicolaij, 2004). This indicates that overall, participants tend toward non-discounting, even when they are not aware of the manipulation of temporal delay. This high share of non-discounters seems to be "typical for the environmental domain" (Gattig & Hendrickx, 2007, p. 30). This could be because ethical considerations (e.g., social justice and the equitableness of outcomes) are particularly relevant in this domain (Böhm & Pfister, 2005). Another explanation for this effect considers that discounting studies in the environmental domain are about negative outcomes and that low discounting rates in this domain can be explained by the fact that losses are discounted less than gains (Hardisty & Weber, 2009).

Also for the issue of nuclear waste, Svenson and Karlsson (1989) report that about 30% did not discount negative consequences over a time period of 2 million years. Social science studies about the public's understanding of the long-term dimension of nuclear waste are rare and the discounting approach is predominantly applied. In survey studies, for example, participants were asked to judge the seriousness of a leak at a nuclear waste repository for different points in time up to one million years (Drottz-Sjöberg, 2010) or two million years (Svenson & Karlsson, 1989). Research on the psychological factors underlying discounting negative consequences of nuclear waste, however, is so far lacking.

The aim of this paper is to examine discounting of negative consequences of nuclear waste. We thereby take a critical look from both content-related and methodological perspectives by means of a psychological experiment. More specifically, we aim (i) to explore the cognitive and motivational factors underlying discounting as well as (ii) to identify methodological challenges in assessing discounting judgments.

It is important to note that the timescales involved in nuclear waste disposal, are much larger compared to timeframes in financial economics (where the discounting paradigm was developed). Due to involved uncertainties and ignorance, we therefore did not apply a measure of discounting in the classical sense (e.g., monetary values) but rather asked participants about the perceived seriousness of a leak at a waste repository occurring at five different future timepoints. These seriousness judgments serve in the following as an indicator for discounting judgments.

1.1. Challenges of discounting research from a content-related cognitive and motivational perspective

Discounting negative consequences over time is sometimes interpreted as a devaluation of the future in general. However, discounting functions are also influenced by the issue at hand and by the knowledge and experiences people have of the issue. For example, focus groups in which Swiss participants discussed different waste types, demonstrated that nuclear waste was perceived as much more dangerous, and also triggered more negative reactions (such as fear) in participants compared to hazardous waste (GFK, 2010). One potential reason for this is that people have at least some personal experience with certain types of hazardous wastes such as batteries or fluorescent tubes, which is obviously not the case for nuclear waste. In addition, from a socio-historic perspective, nuclear waste is strongly associated with nuclear power and even nuclear weapons. Early studies on risk perception by Slovic (1987) indicate that nuclear waste is perceived as more dreadful and more unknown than other risks (e.g., the heavy metal mercury, which is classified as hazardous waste). Discounting judgments for the issue of nuclear waste therefore include several types of information (discounting because less value is assigned to a negative consequence in the future; discounting according to knowledge about and perception of the issue, and so on), and hence cannot be interpreted in a straightforward manner.

This problem of interpretation is of paramount importance in discounting research. Frederick et al. (2002) conclude their critical review on time discounting by claiming that we need more information about the factors behind discounting or not discounting: "To better understand the pattern of correlations in implied discount rates across different types of intertemporal behaviors, we may need to unpack time preference itself into more fundamental motives […]" (Frederick et al., 2002, p. 392). The authors provide a list of factors potentially driving discounting, namely that future consequences may confer less utility, or uncertainty, inflation, opportunity costs, changing tastes, increasing wealth and so on. Nicolaij and Hendrickx (2003) empirically explored psychological factors underlying discounting. One of their conclusions is that such discounting factors are highly domain specific (Nicolaij & Hendrickx, 2003). We also argue that the temporal dimension itself is important for identifying psychological discounting factors. The issue of nuclear waste includes timescales of up to one million years (e.g., Nagra, 2002). As the history of mankind demonstrates, tremendous societal transitions are possible within much shorter timescales (see e.g., Grin, Rotmans, & Schot, 2010; Scholz, 2011). Therefore the expected ability of future societies to adapt to challenges could be an important driver for discounting negative future consequences. This so-called adaptive capacity (Smit & Wandel, 2006) represents an important aspect of the concept of resilience and vulnerability. In contrast to the term risk, vulnerability includes a dynamic component (Scholz, Blumer, & Brand, 2012) and, thus, seems especially suitable for the study of long-term phenomena.

Previous studies which used the discounting paradigm for investigating the temporal dimension of nuclear waste (Drottz-Sjöberg, 2010; Svenson & Karlsson, 1989) have not specifically explored the psychological factors underlying discounting the negative consequences of nuclear waste. Studying these is one aim of this study. We approach this aim via two different strategies within an experimental design.

First, participants judged the seriousness of negative consequences of either nuclear waste or of hazardous waste at five future timepoints. We chose to compare nuclear waste and hazardous waste on the basis of a previous study characterizing and comparing both waste types (Flüeler, 2010). Both waste types have current practical relevance and are subject to public discourse. Currently, Switzerland has five nuclear power plants at four sites that produce about 40% of total electricity. Switzerland does not yet have a deep geological repository for either low-level or high-level