Acta Psychologica 190 (2018) 199–216

Contents lists available at ScienceDirect

Acta Psychologica

journal homepage: www.elsevier.com/locate/actpsy

Unpacking decision difficulty: Testing action dynamics in Intertemporal, gamble, and consumer choices

Jiuqing Cheng[a,*], Claudia González-Vallejo[b]

[a] Department of Psychology, University of Northern Iowa, Cedar Falls, IA 50614, United States of America
[b] Department of Psychology, Ohio University, Athens, OH 45701, United States of America

ARTICLE INFO

Keywords:
Action dynamics
Decision difficulty
Conflict
Wavering
Trajectory
Numeracy

ABSTRACT

The study examined the two-factor structure of decision difficulty proposed by Cheng and González-Vallejo (2017) in new domains, and the role of numeracy in relation to these factors. Using the measurement methodology of 'mouse' (cursor) movements, participants' temporal and spatial measures were recorded when making decisions in the domains of intertemporal, gamble, and consumer choices. Task manipulations designed to affect difficulty included the sign of the payoffs (gains vs. losses), the similarity of the attribute values being compared, and attribute importance. A psychometric analysis of the measures revealed three orthogonal components, two of which, *conflict* and *wavering*, described decision difficulty. The *conflict* component was most affected by changes in the sign of the payoffs of intertemporal and gamble choices, with greater means observed in the loss than in the gain context. By contrast, the *wavering* component was most affected by changes of the similarity between the options' attributes, with greater means when the options were more similar. The study also found that choosing the long-term advantageous options in an intertemporal choice task; choosing the riskier gain and safer loss in a gamble choice task; and choosing the more expensive/better-quality hotel in a consumer choice task demonstrated greater *conflict* and/or *wavering*. The study further found that numeracy, or the degree to which individuals are able to use and interpret numbers, was negatively related to the *conflict* component. Taken together, the study demonstrated that decision difficulty varied with contextual changes, and action-dynamic measures reflected different facets of decision difficulty.

1. Introduction

Decision making is not always easy. For example, when planning a trip, a hotel that provides excellent amenities (e.g., cleanliness, transportation, entertainment, etc.) is desirable, but superior services usually come with a higher price tag. Consumers have to make trade-offs between quality and price and this is usually difficult to do (Chatterjee & Heath, 1996; Luce, Payne, & Bettman, 1999; Tversky & Shafir, 1992). In addition to the inherent dilemma of making trade-offs, decision difficulty may be impacted by the characteristics of the decision context, the emotionality of the situation, and the uncertainty of both information and preferences (Broniarczyk & Griffin, 2014; Coupey, Irwin, & Payne, 1998). For instance, it is much easier to make trade-offs when buying breakfast beverages than deciding when and how to pay student loans (Kristof, 2009). We focus on understanding decision difficulty using an online measurement approach based on cursor movements. We advance a dimensionality characterization of decision difficulty and also explore the unique challenges that dealing with numerical information brings.

Researchers have commonly referred to decision difficulty as a subjective feeling (Hanselmann & Tanner, 2008) and many studies have employed self-report to measure it (e.g., Chatterjee & Heath, 1996; Hanselmann & Tanner, 2008; Thompson, Hamilton, & Petrova, 2009; Zhang & Mittal, 2005). Self-report is usually retrospective with participants rating the difficulty of the decision after making it. Subtle feelings that may occur at the moment of making a decision, however, may not be reliably recalled with retrospective self-reports.

Others researchers have inferred maximum difficulty from decision deferral (Dhar, 1997; Dhar & Nowlis, 1999; Dhar & Sherman, 1996). Decision deferral may be caused by demanding more time to search for better options, or more time to solve the conflict inherent in the decision (Anderson, 2003). More generally, researchers have used response time as a proxy for difficulty assuming that more difficult decisions require more time to process (Chabris, Laibson, Morris, Schuldt, & Taubinsky, 2008; McClure, Laibson, Loewenstein, & Cohen, 2004).

Previous research has also advanced a multifaceted conception of difficulty. For example, Luce et al. (1999) and Broniarczyk and Griffin

* Corresponding author.
E-mail address: jiuqing.cheng@uni.edu (J. Cheng).

https://doi.org/10.1016/j.actpsy.2018.08.002
Received 15 September 2017; Received in revised form 16 July 2018; Accepted 8 August 2018
0001-6918/

(2014) identified important sources of decision difficulty at the levels of cognition (e.g., calculation and ease of understanding information) and emotion (e.g., subjective discomfort such as anxiety over potential losses). Similarly, Anderson (2003) listed a series of different sources of difficulty that result from reasoning and emotional aspects. The notion that decision difficulty is multidimensional has been discussed conceptually, but tested empirically only recently. The current study assumes this multidimensional conceptual framework and advances a measurement approach to study decision difficulty during decision episodes following the work of Cheng and González-Vallejo (2017).

1.1. Goals of the present study

Decision difficulty is generally viewed as a cost that can negatively impact final choices, thus the importance of better understanding the factors that affect it. Across three experiments and different decision domains (i.e., intertemporal choice, gamble choice and consumer choice), the study advances knowledge of the multidimensional nature of decision difficulty. In particular, we distinguish between two psychological dimensions of decision difficulty. Conflict is conceived as the internal state that results from making trade-offs (i.e., increase the chances of winning but receive a smaller payoff). Wavering is viewed as a state of decision uncertainty reflecting similarity of the options' utilities (i.e., uncertainty regarding which options are more valuable). Although these constructs are assumed distinct, they can certainly coexist.[1]

The current study advances novel results expanding the initial decision difficulty distinction made by Cheng and González-Vallejo (2017) to decision making with risky options and consumer products. Furthermore, the study addresses individual differences in the ease of using numerical information as a separate source of decision difficulty. Low numerate people have difficulty in processing numerical information (Reyna, Nelson, Han, & Dieckmann, 2009), and thus are likely to experience greater decision difficulty when making decisions that demand numerical comparisons. In combination, the experiments present unique contributions to the literatures on decision difficulty, psychometric analyses of action dynamic measures, and numeracy. We first provide a brief review of the action dynamic methodology and measures in order to facilitate understanding of the hypotheses. An analysis of the results of prior studies leads to theoretical bridges that provide the basis for specific predictions.

1.2. Action dynamic measures

The measures based on cursor movement that were used by Cheng and González-Vallejo (2017) are termed action dynamics. This measurement methodology finds its root in process-tracing methods (Johnson, Payne, Bettman, & Schkade, 1989). Process-tracing methods track information-search prior to making a decision and use search patterns as measures of decision-making processing and strategies. Typically, a process-tracing method presents participants with options described by their attributes, all of which appear in computer grids in a hidden form, and attribute values are revealed in response to clicking on a value-option combination (Johnson et al., 1989).

More recently, dynamic measures generated from cursor or hand movements serve as proxies for cognitive activities taking place while making judgments and decisions (Freeman & Ambady, 2010; Gallivan & Chapman, 2014; McKinstry, Dale, & Spivey, 2008; Spivey, Grosjean, & Knoblich, 2005; Taylor & Ivry, 2013). The measures resulting from the action-dynamic methodology provide continuous and dynamic trajectories prior to a final choice, and similar to process-tracing patterns, researchers using action-dynamic measures assume that the responses reveal aspects of decision processing (e.g., Gallivan & Chapman, 2014; Koop & Johnson, 2011, 2013; Taylor & Ivry, 2013). To facilitate the understanding of trajectory tracking, Fig. 1 illustrates a hypothetical trajectory of a participant making an intertemporal choice; the figure is from Cheng and González-Vallejo (2017, p112).

A participant starts a choice trial by moving the cursor to the center-bottom of the frame to click the start button (the frame is smaller than the screen, and participants cannot move the cursor outside this frame). After clicking, the start button disappears and two options appear on the left and right sides at the top of the screen. Under each option, there is a "Select" button. Participants move the cursor from the start point to a "Select" button to complete the choice. Once selected, the two options disappear and the start button appears again to start the next trial. The computer program records the trajectory that participants make from the start button to the selected option. The trajectory includes temporal and spatial measures discussed in Table 1.

1.3.1. Action dynamic measures and decision difficulty

Table 1 presents several measures used in previous studies with their descriptions. Some of the studies employed action-dynamics to examine choice behavior (Koop & Johnson, 2011, 2013; Koop, 2013; Dshemuchadse et al., 2013; Cheng & González-Vallejo, 2017; Koop & Criss, 2016). Other studies focused on learning behavior (Dale et al., 2008; Spivey et al., 2005), and deception behavior (Duran et al., 2010). Freeman and Ambady (2010) provide a review of action-dynamic software and relevant metrics. While studies in Table 1 all employed action dynamic measures, their research topics were diverse. The present study focuses on decision making, and hence we narrow our review to studies that addressed decision difficulty.

Koop and Johnson (2013) asked participants to make selections between gamble options such as "You have 80% chance of winning $60" and "You have 90% chance of winning $50". Results showed that participants had more deviant trajectories when choosing a risky gain over a safe one (e.g., greater values of Distance, X-flips and AAD), but the pattern was reversed (and less pronounced) when the amounts were losses possibly because such choices went against a basic tendency toward selecting the safe option in gains, and the risky option in losses as described in prospect theory (Kahneman & Tversky, 1979).

Previous studies also found that decisions were more difficult when the options were more similar. For instance, Dhar (1997) found longer decision deferral, and greater self-reported difficulty when consumer products were similar. Consistently, in a study of intertemporal choices, Dshemuchadse et al. (2013) found that the curvature of the trajectory (the area between the trajectory and the hypothetical straight line between the start point and the chosen option) was larger when the subjective value of the options was similar. This finding was assumed to depict greater decision difficulty as a function of greater similarity. Koop and Johnson (2013) also found that the trajectories were more deviant (as measured by MAD and AAD, see Table 1) when choosing between two similar than dissimilar pictures.

Taken together, trajectory patterns from cursor movement are informative about online decision difficulty, but as this review demonstrates, there is a variety of measures used in different studies without a clear mapping between psychological constructs and measures. Hence, we advance a conceptual differentiation of two facets of decision difficulty based on the various indices, namely *conflict* and *wavering*.

1.3.2. Conflict and wavering are distinct aspects of decision difficulty

A goal of the current work is to investigate whether the various dynamic measures can be grouped into meaningful indices that support the distinct aspects of decision difficulty. Cheng and González-Vallejo (2017) used a correlational approach with data from an intertemporal choice task and found that that Idle time (i.e., time while not in movement) was positively associated with AAD (i.e., the average absolute distance from the straight path). Motion time (i.e., time while moving) was positively related to Distance (i.e., total distance traveled),

[1] For ease of presentation, we refer to both the constructs and the measures by the names of *conflict* and *wavering* in what follows.