

EXPLORING DATA VIDEOS
AS POTENTIAL PERSUASIVE MEDIUM
TO ENHANCE HEALTH-RELATED BEHAVIORS

by

Samar Sallam

A Thesis submitted to the Faculty of Graduate Studies of
The University of Manitoba
in partial fulfillment of the requirements of the degree of

Master of Science

Department of Computer Science

University of Manitoba

Winnipeg

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ABSTRACT

Data Videos (DVs) or short animated infographics that tell stories with data are becoming increasingly popular, and are often used for educational and health promotion purposes (e.g., government promoting mask wearing). While the area is still novel, recent research has confirmed some *advantages* of DVs [17]. With two studies, I explore the underlying factors influencing the potential of health-related Data Videos on influencing their viewers' intentions. Since Data Videos are ideally short in length, they are not expected to cause immediate change in behavior, however I am interested in exploring the effect of watching health-related DVs on the conceptual level (i.e., viewers' intentions or willingness to alter their behavior vs actual behavior change). Specifically, I explore; 1) the influence of DVs on how and whether viewers' *affect* induced by Data Video viewing could be linked to their willingness to alter their health-related behaviors; 2) whether these affective responses are linked to the viewers' *personality traits*; 3) underlying attributes in DVs that contribute to their persuasive potential. The first study explores the influence of watching health-related DVs on the viewers' feelings of anxiety or worry about their health; given their unique personalities. For this study I conducted an online survey with (N=102) participants recruited via MTurk. I further explored if such negative feelings (i.e., feeling worried or anxious) influence peoples' willingness to alter their behaviors. Further, I explored attributes that can aid in improving the persuasive potential of health-related DVs; quantitatively and qualitatively. The second study investigates the effect of including a *solution* to the

health problem presented. A between-subject study on MTurk (N=119) compared the effects of three DVs (DV with no solution, DV with general solutions, and DV with specific/actionable solutions). Results indicated that viewers' negative affect lowered their willingness to improve their health-related behavior. Neurotic people experienced higher levels of negative affects and they are harder to persuade. Providing any kind of solution to the health problem; even a general one, makes the viewers perceive the videos as more useful and less stressful and that leads to higher willingness to behavior change.

ACKNOWLEDGMENTS

First and foremost, I would like to give my biggest thanks and gratitude to Dr. Yumiko Sakamoto for her support in every way possible. I would like to thank my supervisor Dr. Pourang Irani for his support and for giving me the opportunity and honour to be one of his students. I want to thank my committee members Dr. Celine Latulipe and Dr. Jason Leboe-McGowan for their valuable feedback on all stages of my research and for always giving me the time to discuss and enhance my ideas. Thanks to my fellow colleagues in the HCI lab for listening to my ideas and giving me feedback.

I would like to acknowledge the Visual and Disease Analytics program (VADA) for the generous funding and the learning experience.

Finally, I'm most grateful to my parents for their unconditional love and support. Thanks for always believing in me and pushing me forward. Thanks for giving me all the opportunities and experiences that have made me who I am. I am forever indebted to you. A big thank you to my small family, my husband and two girls for taking this adventure with me. My beloved husband Karim, thanks for believing in me and pushing me beyond my limits.

DEDICATED TO MY BELOVED PARENTS, MY DEAR HUSBAND, AND MY
GIRLS.

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ACRONYMS

HCI	Human Computer Interaction
DV	Data Video
PPQ	Persuasive Potential Questionnaire
SP	Susceptibility to Persuasion
GPP	General Persuasive Potential

1 INTRODUCTION

Data Videos (DVs) consisting of motion graphics with visual and auditory stimuli to promote a data story [3], are becoming increasingly popular for communicating data through a story. While this popularity could be naturally attributed to the advancement of technologies (e.g., DVs can be viewed with smartphones and tablets anytime and anywhere), another reason could be, at least partially, due to its capability to target broad audiences on any given topic: They can be designed for presenting societal challenges (climate change, wealth inequality), for advertising products, and more recently for promoting healthy behaviors [17]. Further, they are often very short (shorter than six mins, [35]), and provide data-driven information for the viewers in a *story* or *narrative* format [3]. In contrast to descriptive statistics, static data charts, and/or graphics, the narrative element of DVs can make complex data easier to digest and highlight insights buried under big data which contributes to the appeal of Data Videos as a quick and entertaining source of information over other conventional sources.

I believe that Data Videos provide an added dimension to data representation by their ability to further expand on data viewing through adding an '*actionable intelligence*' component to the viewed data. For example, a very recent Data Video (DV) topic that is dominant on YouTube is COVID-19 with all its underlying topics including sanitization, social distancing, mask wearing, contact tracing,

and finally vaccination. These videos, show statistics and facts provided by different health and research entities and utilize them in a narrative that plays on viewers' affect, and draws data driven conclusions to encourage them to make better decisions. In short, Data Videos provide *actionable insights* supported by research data. A 2020 study examining YouTube videos covering COVID-19 vaccine development, before any vaccine was available, found that such videos are considered one of the major sources of information for many people [9]. Since many turn to Data Videos to search important pieces of information about the pandemic, providing accurate data driven information to guide behaviors (e.g., getting vaccinated) will be an ideal way to communicate with those who are uncertain about the situation. Improving the quality of Data Videos will help viewers understand the outcome of vaccine uptake better.

To my knowledge, despite the recent efforts to expand our understanding of Data Videos [3, 4, 17], there are still no clear guidelines on how to fully utilize these short clips to maximize the viewers' likelihood of taking the best possible action for their health. In this research, I explore DVs targeting common health issues (physical activity, healthy sleep, and healthy diet) with the aim to understand the underlying dynamics or properties that affect their potential ability to influence their viewers' health-related behaviors. Given their limited length, I am only interested in DVs' ability to influence viewers' perception of the topic (i.e., viewers' intentions or willingness to alter their behavior vs. actual behavior change) as opposed to actual behavior change. I chose to focus on health issues because, while behavioral health issues (e.g., improper diet and/or physical inactivity) could be linked to many serious consequences (e.g., cardiovascular diseases, obesity, high blood pressure, and even some types of cancer) [38, 62], they are preventable. As behaviors are normally adjustable, people suffering from behavior-induced health

issues would benefit if they understood how their seemingly minor behaviors underlie potentially serious medical issues. Data Videos have a great potential to help in this area, mainly due to their narrative nature. The storytelling aspect of DVs often arouses emotions in the viewers' minds. Research in advertisement and marketing demonstrates that the extent of such emotional experiences or *affect* plays a significant role in motivating/convincing viewers[51]. For example, to alleviate generally negative affect, changing one's behavior is logical (e.g., one starts exercising after *feeling bad or at risk*). It is important to note that personality differences could underlie individuals' unique affective responses to a persuasive message: indeed, individuals' responses to an affect provoking persuasive message *vary from person to person*[36, 44, 75]. Investigation of viewers' personality traits could lead us to fruitful Data Video Personalization strategies.

To explore the perceptual functions of DVs, this study focuses on three topics; 1) the influence of DVs on how and whether viewers' *affect*, induced by video viewing, could be linked to their willingness to alter their health-related behaviors; 2) whether these affective responses are linked to the viewers' *personality traits*; and 3) underlying attributes in DVs that contribute to their persuasive potential. Study 1 (check Chapter 4) examined viewers' affective reactions to existing health-related DVs. Links between personality traits and negative affect, and between video contents and negative affect were observed. Interestingly, when viewers experienced higher negative affect after watching a DV, they were less convinced that they should adjust their health-related behaviors. When participants perceived the video as useful, they were more convinced. Hence, to boost the persuasiveness of DVs, a means to mitigate negative affect and improve the usefulness of the videos is discussed in Study 2 (check Chapter 5). Study 2, explored the effect of adding a *solution*; to the problem discussed, in an effort to alter both viewers' levels

of negative affect and their perception of the usefulness of the video. The results confirmed my expectation that adding a solution decreases viewers' negative affect and increases the perceived usefulness of the videos. Both of these consequences of providing a solution enhanced the potential of the video to convince its viewers (proved in study 1 and reaffirmed in study 2).

2 RELATED LITERATURE

In this chapter, I discuss previous work investigating the effectiveness of Data Videos as a narrative to communicate data. I further highlight some behavioral theories as well as studies in Human Computer Interaction (HCI)/other related fields, then turn to affect associated with narratives. Furthermore, I discuss how affect could contribute to improving viewers' behaviors. As a factor influencing affective response, I review studies focusing on the importance of the role personality traits play in reacting to a persuasive message, by describing studies and strategies used in the literature on persuasive technologies. Finally, I touch on studies exploring measures to assess the effectiveness and quality of health-related videos.

2.1 DATA VIDEOS AS A NARRATIVE

Data videos are motion graphics that incorporate factual, data-driven information to tell informative and engaging stories with data [3–5]. Data videos are gaining popularity [3–5] in various fields, such as journalism, education, advertisements, mass communication, as well as in political messages/campaigns [27, 37, 45, 68–70]. Due to their narrative nature, Data Videos are recognized as one of the seven forms of narrative visualizations [15, 69]. The power of Data Videos comes mainly from this narrative format. Being the most basic as well as natural way to communicate

[39], stories can convey information in an engaging way that is more natural, seamless, and effective than text or even pictures [30]. A well told story can convey a large amount of information in a way that the viewers find interesting, easy to understand, trustworthy, and memorable [13, 30, 55]. Compared to text or static images, the advantage of audiovisual narrative is the capacity to present a large amount of information in a structured way that imposes less demands on the viewers' time. [30]. According to the Narrative Transportation Theory, Data Videos can transform and immerse the viewer in a totally different world. The locations, characters, and emotion-laden scenarios then generate the opportunity to impact the viewers' own beliefs, emotions, and intentions [34, 55, 56, 74]. Furthermore, a wealth of psychological theories support the persuasive power of narrative. The Extended Elaboration Likelihood Model (E-ELM) argues that as people indulge in the narrative, with all its cues and stimuli, their cognitive processing of the narrative obstructs making counterarguments in response to the presented message [14, 72], making the message more persuasive even for those who are difficult to persuade otherwise [71]. Furthermore, as per the Entertainment Overcoming Resistance Model (EORM), the entertaining aspect of a narrative also plays a role in reducing the cognitive resistance to the message presented, and hence facilitates persuasion [18, 54, 55].

Although Data Videos have great potential for motivating changes in behavior and have become an increasingly relied upon source for accessing information, it was not until recently that empirical investigations of Data Videos have focused on the component features and narrative characteristics that help to determine their capacity to persuade [3, 17]. Baber et al. define narrative as a formal structure that constitutes a "sharable" story or report as opposed to the informal stories which could be "unstructured" and "ambiguous" [7]. Narrative is defined as a

series of connected events that constitute a story [69]. The order in which these events are presented in a Data Video constitutes its narrative structure and affect the understanding and the viewing experience of the video [19]. Amini et al. examined 50 professionally created Data Videos to learn about their narrative structure [3]. In their study, they divided the videos into temporal sections and coded them based on Cohn's theory of visual narrative structure that categorized the narrative into four categories: Establisher (E), Initial (I), Peak (P) and Release (R) [19]. The Establisher is the entry point to the video to introduce its context, the Initial initiates the action, the Peak is where the most important events and the tension happen, and the Release is where the conclusions are drawn [3, 19]. After analyzing and coding the videos based on these categories, the authors found that these categories are ordered differently based on video types: factual videos with multiple facts and information; comic and open ended videos that do not have a conclusion or a take away message; and videos that exhibit multiple problems or those that provide multiple solutions to a single problem. The authors pinpointed some narrative structure patterns that are commonly used in Data Videos. Choe et al. introduced a new class of Data Videos called Persuasive Data Videos or PDVs [17]. This genre of Data Videos incorporates some persuasive elements inspired by and drawn from the Persuasive System Design Model [59]. In their research, the authors studied how incorporating some persuasive elements in a Data Video could improve the potential persuasion level of the video [17]. Their study revealed that their PDVs had higher persuasive potential than regular Data Videos. Amini et al. examined the effect of using pictographs and animation, two commonly used techniques in data videos [4]. They found that the use of such techniques enhanced the viewers' understanding of data insights while boosting their engagement. They concluded that the strength of pictographs can be attributed to Data videos' ability

to trigger more emotions in their viewers, while the animation strengthens the intensity of such *emotions*.

2.2 AFFECT AND DATA VIDEO

This leads us to an important aspect of Data Videos: affect (or any emotional experience). Viewers' preference for multimedia; be it a performing art, internet video, or even music videos, is highly dependent on their arousal level and the intensity of their affect towards the viewed media [8, 73]. Past studies assumed that TV viewers liked to watch shows that elicit positive emotions as opposed to negative emotions [32]. However, later research disagreed with this belief finding that this might be true for real life events but not for TV shows or else people would not watch drama or horror shows that evoke fear, anger, or sad emotions [57]. In a more recent study Bardzell, Bardzell, and Pace examined the intensity and valence of viewers' affect, as well as their ratings of internet videos [8]. The results shows correlation between the affect intensity and the liking of the video [8]. As for the valence (i.e., positive or negative), the study showed that it is not the presence or absence of certain affect, be it negative or positive, that influenced the rating of the video. Rather, it is the *emotional arc* that leaves the viewer emotionally resolved and hence liking the video, even if it started with negative emotions [8].

2.2.1 *The role of affect in attitude and behavior change*

Affect plays an important role in the appeal as well as the persuasive power of media content [1, 11, 48]. According to behavioral theories in psychology, some

of our attitudes have a cognitive base while others have an affective base [43, 61]. *Affective attitudes* emerge from our feelings towards certain topics or ideas. Some attitudes are influenced relatively easily through affect or emotions while others through logic and facts [43, 61]. The Dual Process Model suggests two routes to persuasion; central and peripheral. The central route is the cognitively (or thinking) based route in which the receiver of a message is willing and able to cognitively process the ideas [14, 61]. In contrast, the peripheral route processing is triggered when the receiver lacks the motivation or ability to logically process cues in the message, and decides to agree with the message based on its emotional appeal (e.g., emotions triggered by the look or smell but not by the logic) [14, 48]. For instance, one might purchase a car based on its gas emission, cost, functions, and so on (Central route) or because of the way it looks (Peripheral route). In sum, both cognition and affect are heavily involved in persuasion.

In the field of marketing, as an area focusing primarily on persuading and guiding the viewers to adopt a certain service or commodity, a wide array of studies have focused on the kind of affect evoked by ads [41] and how they affect the viewers' attitudes to improve the persuasive power of ads [12]. However, no research has explored the affective changes induced by Data Videos as a potential persuasive medium.

2.2.2 *Measuring Affect*

When it comes to measuring affect, studies normally fall between two approaches or a mix of both. The first one is the implicit approach to measure affect, which relies on physiological recordings of individuals' biometric responses. The second

approach is the explicit self-reporting of the viewers' or users' affect during their exposure to the stimuli. While modern technologies in the form of sensors and specialized devices that can log biometric changes (e.g., heart rate, breath rate, respiration patterns, skin patterns, electroencephalogram (EEG), and galvanic skin responses or GSR) are very promising [47, 73], they are often invasive, expensive, and the meaning of the data recorded remains unclear [47]. As for the explicit measurement methods, indicators such as final applause to a show, post-show surveys, or interviews are most commonly used. While less costly and invasive, the explicit approach could capture somewhat skewed responses as the viewers' responses are normally affected by their peak emotion and the emotions experienced by the end of the show (i.e., the 'peak-end' effect) [21, 46, 47, 64]. In their study, Latulipe, Carroll, and Lottridge asked participants to record their affect using different forms of sliders.

2.3 PERSONALIZATION IN PERSUASIVE TECHNOLOGY

Recent research indicates that the one size fits all model of persuasive technology is not as effective. Instead, the focus is shifting towards *personalized* persuasive systems which often explore the effect of personalities on persuasion level [6, 16, 22, 40, 43, 44, 75, 78]. The five-factor (or Big Five) model of personality offers five broad personality traits that capture differences in typical patterns of thought and behavior that vary across individuals: Extraversion, Agreeableness, Conscientiousness, Neuroticism, and Openness to Experience. This is the most widely used model for personality assessment across diverse disciplines [24, 29, 43, 52, 67, 75]. Halko and Kientz explored the link between personality traits and people's

perception regarding persuasive technologies that adapt different strategies [36]. They categorized their participants based on the big five personality traits, and studied the effect of eight persuasive techniques. They found correlations between personality traits and the persuasive strategies. For example, their results showed that people who score high in Neuroticism tend to prefer negative reinforcement (i.e., removal of aversive stimuli) in the reinforcement category. As for the social feedback, neurotic people do not prefer cooperating with others to achieve their goals [36].

2.4 MEASURES FOR ASSESSING HEALTH-RELATED VIDEOS

There is no doubt that the content of a video, with its particular visual/auditory elements, animations, graphics, narration style, topic, and so on, contributes to the effectiveness of the message and the video's potential to affect attitude and behavioral change. Various studies have examined ways to assess the quality of YouTube videos tackling health-related issues like exercise and low-fat diet [10, 25], bruxism [28], or general health videos [23, 26, 66]. However, assessing the quality of such videos, as well as providing guidelines for creating them, has been mainly done by experts like health professionals, major health organizations, or even IT researchers [26]. Very few studies have considered the feedback or judgements of the patients or viewers of such videos [26]. Studies that solely examine viewers' judgement are very scarce or almost of no existence according to some researchers [20, 26].

As described above, research supports the potential of Data Videos to effectively convey health-related data through their affective influences. It is naturally ap-

pealing to study affective responses in conjunction with personality traits. This will allow us to explore the means to effectively personalize Data Videos for better communication. It is also useful to examine common video attributes; from the viewers' perspective, in relation to potential attitude change. These findings would contribute in providing general guidelines for Data Video makers who are interested in presenting health information in a way that would be most effective towards attitude modification.

3 RESEARCH OBJECTIVE

¹ This research aims at exploring the potential of data visualization in the form of a short video with narratives (i.e., Data Video or DV); targeting common health issues to influence their viewers. We are interested in exploring viewers' affective reactions to Data Videos, and the underlying links between such affective connections/reactions and viewers' willingness to alter their behaviors based on the videos. The central question we ask is **'how can we improve the persuasive potential of health-related Data Videos, to effectively influence viewers' health-related attitudes**; We plan to propose design guidelines focusing on two dimensions: 1) Data Video narrative and content related attributes, 2) accommodating Data Videos to viewers' unique personalities.

3.1 OVERVIEW

I focused on three common health topics: physical activity, healthy diet, and healthy sleep and started our exploration by collecting DVs on the three topics. I collected more than 100 videos from YouTube by using keywords like 'dangers of not having enough sleep', 'importance of exercise', and 'healthy diet'. A preliminary analysis of the videos showed that most of the videos targeting health

¹ This research was guided and supervised by Dr. Pourang Irani

issues follow a *loss-framed* messaging strategy (i.e., showing the consequences of failing to follow a certain behavior) that play on viewers' feelings of being *at risk* or *worried* about their health. While this choice makes sense based on the *Prospect Theory* that argues that people 'do more to avoid loss or get out of pain than they do for gain'[42, 50]. That is further confirmed in *The Model of Behaviour Change* which suggests that 'feeling worried or at risk is the first step towards attitude change'[34]. Is this actually the case with health-related DVs, and would that apply to all viewers' given their personality differences? This research aims to explore this side of Data Videos, that has not been explored yet. We aim to examine viewers' negative affect experienced by DV viewing in relation to their unique personalities, and towards their willingness to alter their behaviors based on the video. My aim is to provide design guidelines towards the creation of powerful persuasive DVs that consider viewers' unique affective experiences.

3.2 RESEARCH QUESTIONS

I created the below research questions to derive the focus of our research:

- RQ1: Does increasing viewers' negative affect influence their willingness to alter their health-related behaviors?
- RQ2: Do participants personality differences influence their experienced levels of negative affect?
- RQ3: What attributes of Data Videos influence their persuasive potential?
- RQ4: What is the effect of providing solutions in DVs?

- RQ5: Can we Provide design guidelines for effective data videos related to video content?
- RQ6: Can we Provide personalization guidelines for effective data videos?

3.3 APPROACH

To explore our research questions, I conducted two online studies consisting of survey questions and Data Videos as stimuli. Due to COVID-19 pandemic, I used Amazon Mechanical Turk (or MTurk) to recruit our participants, since in person participation was impossible. For the same reason I relied on participants' self reporting of their affect as opposed to using physiological measures. I collected data regarding participants' personality traits, their appraisal of the video content as well as their potential persuasion. Details on the first study are available in Chapter 4, the second study details are discussed in Chapter 5

To answer the first three research questions, I ran the first study with nine existing Data Videos; from YouTube, covering our three topics. The results tell us that when participants' negative affect was high, they were less willing to alter their related health behavior. I also found some personality effect on the perceived levels of negative affect as well as the overall tendency to get persuaded. In terms of video attributes, I found that perceived videos usefulness was a major factor contributing to participants' willingness to alter their behavior. Furthermore a qualitative analysis of the videos, showed that videos that didn't provide solution along with the presentation of the health risks, induced the highest levels of negative affect in the viewers.

Starting with the findings from the first study, I looked at ways to make Data Videos targeting health issues less stressful and more useful, with the ultimate goal to improve their persuasive potential. I explored the effect of providing solution(s) as a means to take the viewers' emotions to a resolution state after the fear inducing messages presented in the video. I started off with an existing video targeting physical activity [77] and created three versions depicting three different solution conditions; 1) no solution, 2) general solution, and 3) detailed solution). The results showed that adding any kind of solution, even a general one, would ease the viewers' negative affect and would also improve the perceived usefulness of the video and both aid in making people more willing to alter the behaviors based on the video.

4 STUDY 1 - EXPLORATION OF AFFECT, PERSONALITY, AND POTENTIAL FOR ATTITUDE CHANGE

¹ To understand participants' affective responses to health-related Data Videos, I conducted a qualitative and quantitative analysis using nine Youtube Data Videos; on physical activity, healthy sleep, and healthy diet, as stimuli. A complete list of the videos is available in Appendix .1. Study 1 explored three main questions:

1. Does increasing viewers' negative affect or anxiety levels lead to higher potential persuasion?
2. What are the predictors of higher persuasion or potential attitude change in terms of personality differences as well as video content?
3. Is there a relationship between participants' personality traits and their affective state after watching DVs?

4.1 STUDY DESIGN

I explored the influence of existing health-related Data Videos on users' willingness to reconsider their health-related behaviors. I focused on three common health-related topics (physical activity, sleep, and diet). I examined participants' affective

¹ Dr. Yumiko Sakamoto helped with the study design and data analysis & Dr. Jason Leboe-McGowan helped with the study design

experiences after watching DVs and whether it is linked to their personality traits. I also examined some factors related to participants' appraisal of the videos' contents in relation to their potential to change their attitude. For this exploration, I developed an online study which contained questions and the Data Videos as the stimuli.

4.2 STUDY ADMINISTRATION

An online study was created using Qualtrics, and administered through Amazon Mechanical Turk (MTurk). To ensure data quality, I recruited reliable MTurk workers with approval ratings higher than 95% and who had completed a minimum of 1000 tasks prior to the study. All participants received monetary compensation (\$2.24 US) in compliance with the study ethics approval and MTurk payment terms. I restricted participant recruitment to the US and Canada to ensure a good command of English while controlling potential cultural influences. The study started with a consent form, provided participants an overview of the objective of the study, and the study instructions. The study consisted of survey questions before and after the presentation of three Data Videos on health-related topics.

4.3 DATA VIDEO SELECTION

I collected Data Videos focusing on three general health-related topics; physical activity, healthy sleep, and healthy diet. My aim was to collect generally *good* Data Videos as my ultimate goal is to create guidelines to produce Data Videos. There are no criteria for quality of Data Videos yet: empirical research in this area

is scarce, so I systematically explored existing Data Videos with guidance from Amini et al.'s study [3]. The Careful video selection process, described below, yielded overall consistency across all the videos used (See Fig. 4.1).

- First, two researchers collected more than 100 Data Videos using relevant keywords such as 'healthy diet', 'dangers of not having enough sleep', 'importance of exercise', etc.
- Videos that contained erroneous information or did not follow the Amini et al.'s Data Video definition were removed: 1) follow a narrative format, 2) have a core topic supported with data, and 3) include at least one data visualization.
- Remaining videos were coded by two researchers for length, source credibility, and information accuracy. To ensure the quality and accuracy of the information provided in the videos, I increased the score of videos produced by professional and reputable health-related organizations, companies, magazines, research centers, and websites (e.g., WHO, Tylenol Official, The Guardian, British Heart Foundation, and UK Mental Health) and with high numbers of views counts (greater than 25,000 views) on YouTube.com or Vimeo.com.
- The final list consisted of nine videos; three on each topic. Videos were checked by three researchers for suitability for the study. See Appendix .1 for the list of Data Videos used.

4.4 DATA COLLECTION INSTRUMENTS

Demographics The survey started with some demographic questions (e.g., age, sex, first language) followed by questions about participants' interest levels on the three health topics (i.e., physical activity, diet, and sleep).

Personality Traits The next section assessed participants' personality traits. The Five Factor Model (Big-Five model) of personality [31] is a comprehensive model that is based on five factors representing the basic dimensions in personality: Openness to experience, Conscientiousness, Extroversion, Agreeableness, and Neuroticism. It has been widely accepted and used as the dominant model for categorizing personality differences [75]. To assess participants' personalities, I utilized a shortened (10 questions) version of the Big-Five Inventory [63] to avoid lengthy survey which could influence the participants' responses especially because it was administered online, see Table 4.1. Note this version of the scale is widely used in personalized technology research [6, 60] that tailor their contents based on the users' personality and in which personality assessment needs to be quick. Although it is relatively short compared to the standard multi-item instruments, the 10-item version has been repeatedly examined and validated. According to Gosling et al. [33] it has "reached an adequate level" in terms of *predictive power* and convergence with full scales in self, observer, and peer responses. ²

Perceptions of Own Health Participants were asked to answer questions about their own diet, sleep, and physical activity in general (e.g., "Generally speaking, I am physically active"), using a 7-point Likert scale (1; Strongly Disagree to 7; Strongly Agree).

² According to Google Scholar search, this 10-item scale has been cited in 3468 articles at the moment of writing; August, 2021

Table 4.1: Big Five Inventory 10-items (BFI-10) developed by Rammstedt [63]

I see myself as someone who ...	
... is reserved (R)	<i>Extraversion</i>
... is outgoing, sociable	
... is generally trusting	<i>Agreeableness</i>
... tends to find fault with others (R)	
... tends to be lazy (R)	<i>Conscientiousness</i>
... does a thorough job	
... is relaxed, handles stress well (R)	<i>Neuroticism</i>
... gets nervous easily	
... has few artistic interests (R)	<i>Openness</i>
... has an active imagination	

(R) = item is reverse-scored.

A Likert scale (1: Strongly Disagree to 5: Strongly Agree) is used.

Table 4.2: Negative Affect Question Items

Please read each statement carefully, and select the appropriate answer that best describes how you feel **right now**.

I feel anxious.
 I am relaxed. (R)
 I am worried.

(R) = item is reverse-scored.

A Likert scale (1: Not at all to 8: Extremely) is used.

Affective State Self-Reports Participants' negative affect, focusing on their worries, anxiousness, and (not being) relaxed, were assessed using three questions, four times; first, once prior to the exposure to any of the videos (for a baseline value) and immediately after viewing each video (i.e., three times), to examine the affective influence of the video. I used an 8-point Likert scale to report the affect level (1 = not at all; 8 = extremely; see Table 4.2), based on Wyvill et al. [79]. I focused on *negative* affect for two reasons. First, health DVs often contain *unpleasant facts* and *threatening messages* which should induce rather negative affect. Second, the model of behaviour change [34] suggests that feeling worried or at risk is the first step towards attitude change (i.e., professionally developed DVs might employ this technique).

Persuasive Potential Questionnaire (PPQ) Study 1 explored the effect of Data Videos at the perceptual level as a preliminary step in investigating Data Videos. Specifically, *I focused on participants' motivation and willingness to change their behavior*. While DVs have great potential in influencing their viewers, they are brief video clips. Hence, I suspect only one exposure to a video (as in this study) might not have a strong enough influence on their viewers' behaviors. Exploring behavior

changes would have been useful; however, it requires a longitudinal study which was not possible due to the enforced pandemic-related restrictions at the time I conducted the study. Therefore, I focus on the DVs' potential for persuasion. To measure the potential of Data Videos, the Persuasive Potential Questionnaire (PPQ) [53] was adopted and adjusted to fit my context. Persuasive Potential Questionnaire (PPQ) is a subjective measurement tool that allows us to assess the potential of a persuasive system. The scale is composed of 15 question items, reported using a 7-point Likert scale (1; Strongly Disagree to 7; Strongly Agree); grouped under 3 dimensions: 1) individuals' susceptibility to persuasion (SP), 2) the general persuasive potential of the system (GPP), which measures the participants' perception of the system's ability to persuade, and 3) the individual persuasive potential of the user (IPP) which measures participants' assessment of the persuasive potential of a system they have been using. I did not include the IPP dimension as this set of questions (e.g., "I think I will use such a program in the future") are irrelevant to my research goal. Thus, I used the first two dimensions of PPQ (See Table 4.3). Since the Susceptibility to Persuasion (SP) dimension measures personal traits that are independent of the system, I asked participants to respond to it prior to the video viewing. Participants responded to the General Persuasive Potential (GPP) questions after the video viewing to report their perception of the potential persuasive ability of each video.

4.5 OVERALL STUDY PROGRESSION

First, participants answered demographic questions (age, sex, education, ethnicity) and SP questions in Table 4.3, followed by the 10-item personality measure (See

Table 4.3: Adjusted Persuasive Potential Questionnaire

SP	1	When I hear others talking about something, I often re-evaluate my attitude toward it.
	2	I do not like to be influenced by others.
	3	Persuading me is hard even for my close friends.
	4	When I am determined, no one can tell me what to do.
GPP	I feel that...	
	5	the video would make its viewer change their behaviors.
	6	the video has the potential to influence its viewer.
	7	the video gives the viewer a new behavioral guideline.

A Likert scale (1: Strongly Disagree to 7: Strongly Agree) is used

Table 4.1) and the three affect-related questions to measure their baseline affective state. Participants then watched three Data Videos; one video from each topic, and answered questions after each. The videos were randomly selected from the sets of three videos per topic (see Figure 4.2). The order in which the topics were presented was also randomized to avoid any priming effect that might occur due to the topic relevance to the participant.

After watching each video (three videos in total):

1. Participants answered the three Affect-related items. This helped us to capture participants' affective state influenced by the video (see Table 4.2).
2. Participants answered three questions regarding their appraisal of the video content (Novelty, Clarity, and Usefulness of the information; e.g., "The information provided by the video was useful to me") using a 7-point Likert scale (1: Strongly Disagree to 7: Strongly Agree). Their overall liking of the video was also assessed.

3. Participants completed the questions for the General Persuasive Potential (GPP) of the video (see Table 4.3).
4. Finally, participants indicated if they had any health issues that would prevent them from following the video's advice.

After completing these four steps for each video, participants were asked to solve a one-minute, 12-piece jigsaw puzzle. This step was created to help participants neutralize their affective state between videos by focusing on a task. After the puzzle, participants repeated the four steps for the next video. In total, each participant watched three videos and did two puzzles (one puzzle between 1st and 2nd video, and another puzzle between 2nd and 3rd video).

4.6 RESULTS

On average, participants took 26 minutes to complete the study. Data-fitting assumptions for each analysis were checked and non-parametric options were used whenever appropriate.

4.6.1 *Participants*

I recruited participants ($N = 102$; 68 Males, 33 Females, and one participant preferred not to say) with ages ranging between 21 and 70 ($M = 37.29$, $SD = 12.01$). 60% of the participants identified themselves as white, 20% preferred not to mention their ethnicity and the rest were Hispanic, Black, Asian, and American. 100 participants reported their first language was English, 83.3% of them had an education level higher than Bachelor's Degree.

4.6.2 *Data Quality Control*

A verifiable (i.e., Gotcha) question was included in the survey. This question was designed to be readily solvable as long as the participants read the question (“How many words do you see in this sentence?”): 78 valid cases remained for the analyses ($N = 78$). When appropriate, I further filtered out responses when participants responded “Yes” to the following question (“I have health issues that prevent me from following the advice provided in the video”) in each of the three topics (i.e., Physical Activity, Sleep, Diet). This choice was made to reduce potential confounds (i.e., the participants might not be willing to change their attitude in response to the video because of their health issues). Four participants responded “Yes” after watching a video related to physical activity, and four different participants responded “Yes” after watching a video related to sleep, and finally, three participants responded “Yes” after watching a video related to diet. A pairwise deletion method was applied to this selection throughout the analyses.

4.6.3 *Data Preparation*

I started off by measuring the reliability of different scales (e.g., GPP, affective response, etc.). I checked inter-item reliability between scale items, and when correlations were high enough (i.e., $.70$) [58], I computed the mean across all items to be used as an index.

Negative Affect Index: To compute the Affective Responses index, first, Chronbach’s Alphas were checked ($.73 \leq \alpha \leq .82$) for participants’ affective responses

(anxious, relaxed, and worried) per topic (Physical Activity, Sleep, and Diet).³ Since the alpha levels satisfied the standard (.70) [58], the mean of these three items was computed for each topic. Then the correlations between these means for each topic were also investigated. They were all significantly correlated ($.810 < r_{hos} < .830$, $ps < .001$; see [2]). This implies that if a participant's affective response was negative from viewing one video, it was likely that they experienced negative affects from viewing other videos as well (i.e., implied underlying *personal tendency*). Thus, the mean across all the topics was used as an index for Negative Affect. *Whenever Negative Affect is mentioned in the analysis, it refers to the Negative Affect Index.*

SP Index: Since Chronbach's Alpha for the four SP items was low (Cronbach = .60), I removed the first item (See Table 4.3) based on its low correlation with other items. Thus, the mean of these three items (2, 3, and 4, see Table 4.3) was used to create an index of SP (Chronbach's Alpha = .79; [58]).

GPP Index: The index for GPP was also created in the same manner. Chronbach's alphas ranged between .81 and .91 per topic. I further checked whether GPP for one topic (e.g., Physical activity) was correlated with the GPP for other topics (e.g., Sleep and Diet). They were significantly correlated with each other ($.555 < r_{hos} < .719$, $ps < .001$)⁴, and the mean of scores across all the topics was used as a GPP index. *Whenever GPP is mention in the analysis, it refers to the overall GPP Index.*

³ One item ("I am relaxed") was reverse coded for the index computation.

⁴ This implied another underlying *personal tendency*; if a participant perceived high levels of general persuasiveness in one video, they perceived higher levels of general persuasiveness in other videos as well

4.6.4 Findings

4.6.4.1 Negative Affect and GPP

I explored whether overall GPP could be predicted by negative affect with a linear regression analysis. Negative affect predicted GPP, $F(1, 76) = 4.056$, $p = .048$, $R^2_{\text{Adjusted}} = .038$, $\beta = -.225$. Participants increased levels of negative affect predicted lower GPP (i.e., harder to motivate the viewers to alter their health-related behavior when they had negative affect after viewing the video).

4.6.4.2 Potential Predictors of GPP

I looked at possible predictors of GPP in terms of personal tendencies (characteristics of viewers) as well as attributes related to the videos' contents (characteristics of Video).

Personality Traits and GPP:

First, I explored the link between personality traits and individuals' susceptibility to persuasion (SP). Correlations between personality traits and SP index were explored instead of regression. This was because, conceptually, personality traits should be related to individuals' Susceptibility to Persuasion but they *both represent an individual's characteristics*. Hence, I did not suspect one can predict the other (i.e., causal direction can be inferred). Agreeableness was positively correlated with SP, $\rho(78) = .26$, $p = .047$. No other links were found. Understandably, the more agreeable participants were, the more susceptible to persuasion they were and vice versa.

To explore possible relationships between personal tendencies and GPP, I ran multiple linear regression analysis with personality traits as predictors of GPP

index using a stepwise method. Neuroticism was the only predictor of GPP, $F(1, 76) = 8.179, p = .005, \beta = -.306$. When individuals are highly neurotic, GPP was lower. Thus, the results suggest that DVs will be less effective at convincing individuals who score high on neuroticism to change health-related behaviors. DVs, due to their brevity (i.e., only one exposure), seems to be most effective when they target highly agreeable individuals who are low on neuroticism.. For those high on neuroticism, repetitive exposure to similar DVs may be required.

Video content Appraisal and GPP

I further conducted a multiple regression analysis to explore how content appraisal variables (i.e., Information Novelty, Information Clarity, Information Usefulness) and personality traits variables could predict GPP altogether. Content appraisals and personality traits are unique in a way as content belongs to the design while the personality traits belong to the target population. Thus, they are conceptually two independent routes to influence the viewers' perception (design itself target selection). I entered GPP as a dependent variable while Big Five traits and the three content appraisal items were entered as predictors, using the stepwise method. Only two predictors remained in the model, which explained approximately 67% of the variability in GPP (1; Information Usefulness, $\beta = .718, p < .001$, 2; Neuroticism, $\beta = -.143, p = .036$), $F(2, 75) = 74.87, p < .001, R^2_{Adjusted} = .657$ (See Figure 4.3). Information usefulness explains 72% of the variation in GPP. When viewers' perceive the information in DVs as useful, it was easier to influence the viewers' attitude. My model shows that consideration of both routes are useful to achieve higher persuasive potential.

4.6.4.3 *Personality Traits and Negative Affect*

To examine the relationship between personality traits and the levels of negative affect, correlations between each personality trait and negative affect were explored. Negative affect was positively correlated with neuroticism, $r_{ho}(78) = .594, p < .001$, and negatively correlated with conscientiousness, $r_{ho}(78) = -.363, p = .001$; no other traits were correlated with negative affect (b in figure 4.4). Highly neurotic people experience higher levels of negative affect by DV viewing, unlike conscientious people who are less sensitive.

4.6.4.4 *Data Videos and Negative Affect*

As seen in Fig. 4.5, each DV induced different levels of negative affect. DVs that induced the highest (Diet₁) and the lowest (Physical Activity ₁ or PA₁) negative affect were examined more closely. Wilcoxon Signed Ranks Tests revealed that viewers' negative affective responses were increased after watching Diet ₁ Video (Pre-video *Mdn* = 3.00; Post-video *Mdn* = 5.00, $p = .001$), but not after the PA₁ Video (Pre-video *Mdn* = 2.00; Post-video *Mdn* = 1.67, $p = .48$). To understand this differential effect, two researchers coded the contents of the videos qualitatively and identified that, Diet ₁ Video included a fear inducing message without any clear solution. As a result, participants' negative affect remained high even after the video (a in Fig. 4.4). I further observed that none of the three DVs that induced the highest levels of negative affect (See figure 4.5) contained concrete solutions (See Appendix .2). Thus, it appeared that not providing solutions was linked to heightened negative affect.

4.7 DISCUSSION

Due to the nature of common health Data Videos which regularly contain fear inducing messages, in this study I explored negative affect (i.e., anxiety, worries, and not being relaxed) in response to those messages specifically about physical activity, sleep, and diet. I observed that DVs without clear solutions to their fear inducing messages kept viewers' negative affect higher. I further found that heightened levels of negative affect predicted a lower viewer willingness to change their behavior. Moreover, the levels of negative affect viewers experienced were linked to their own personality traits: Individuals who score high on neuroticism experience higher levels of negative affect while those who score high on conscientiousness experienced lower levels of negative affect. These findings flag the potential risk of including heavily loss-framed messages (i.e., messages that focus on the consequences of not following a certain behavior) in DVs for highly neurotic individuals who are not only more negatively affected by such messages, but also harder to persuade. While loss-framed messages are commonly included in DVs, and their effect is validated in numerous psychological research, such fear/anxiety inducing messages could potentially backfire in DVs.

4.8 LIMITATIONS AND FUTURE WORK

This study was influenced by current pandemic in several ways. First, I limited to conducting an online survey, which reduced the controllability of my study, and actual behavior changes were not examined. Another limitation is that I only relied on self-reporting questions to capture participants' affective responses.

Future studies with physiological measurements (e.g., heart rate) will be useful in validating my findings surrounding affect. Finally, I investigated negative affect which could be influenced by the pandemic as participants might be experiencing higher anxiety than normal. Future studies focusing on both positive and negative affect conducted in person may be useful to further understand the power of DVs. Furthermore, stimuli used in this study were not created for the purpose of this study. Instead, I selected nine existing videos systematically. While I might have relatively lower control in the stimuli (e.g., voice-over by male vs. female, use of animation, font types), I chose to use existing well accepted data videos to help maximize the generalizability of the results. The general data trends by individual video (Fig 4.1) show that central qualities of the videos were consistent across videos, confirming that the video selection was successful. Future study should verify the effectiveness of providing a solution to the health risks discussed in DVs. Also given the revealed effect of information usefulness on the potential to attitude change, it is worth investigating means to boost the usefulness of DVs.

4.9 CONCLUSION

In corresponding to loss-framed messages commonly found in health-related DVs, I explored participants' negative affect after they watched health-related DVs. Study 1 revealed that, increasing viewers' negative affect or anxiety levels would not aid in convincing them to reconsider their behaviors, rather it was the opposite. When complementing DVs; targeting health issues and which adopt fear inducing messaging style, with *solutions*, viewers' anxiety levels were lowered and they were more willing to reconsider their health behaviors. Creating *useful*

Data Videos is particularly important in boosting the videos persuasive potential, according to my findings. I also observed that individuals who scored high in neuroticism experienced higher negative affect, whereas those who scored high in conscientiousness experienced lower negative affect. Furthermore, highly neurotic people are generally harder to persuade using DVs. In sum, understanding how your DV triggers negative affect might be a key in producing powerful DVs, and personality traits might allow us to get to this key.

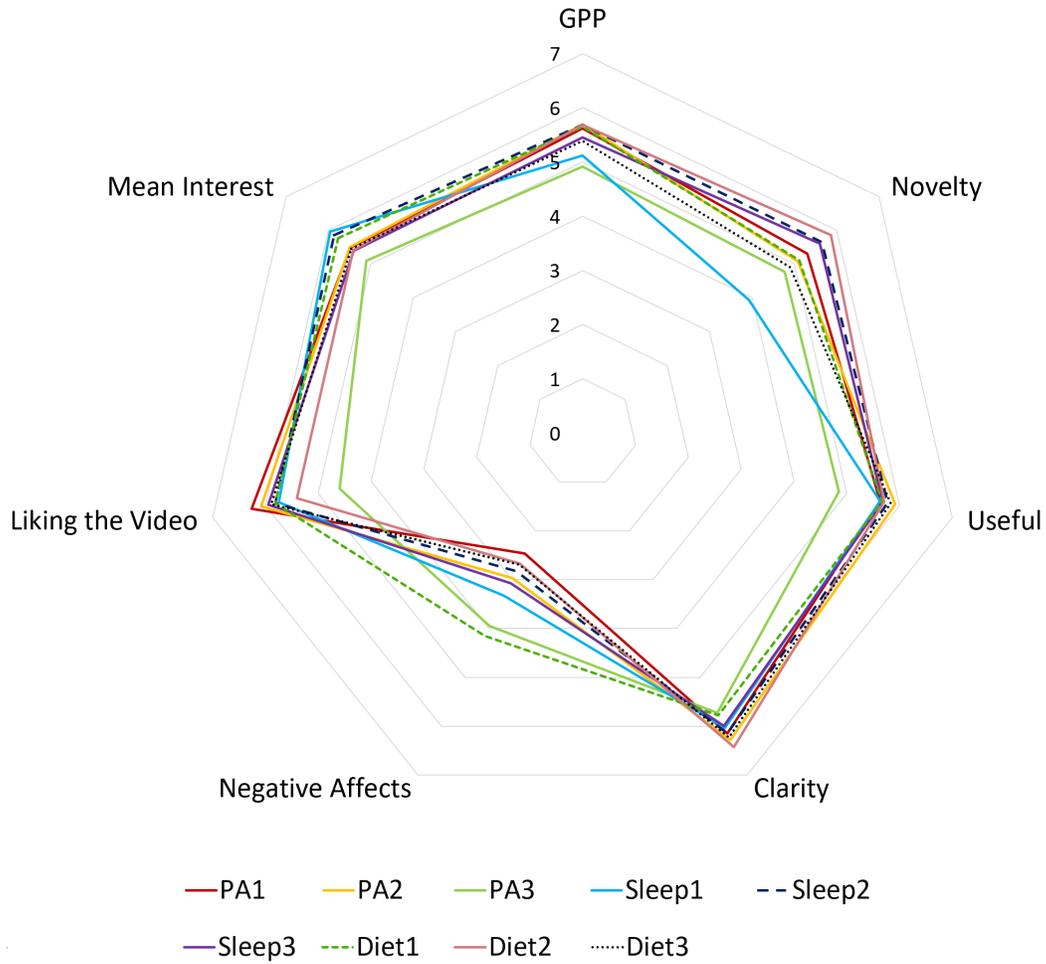


Figure 4.1: General trends by individual video. Overall, selected videos induced generally comparable effects, implying that although I did not create videos for the study, I sufficiently controlled for the basic quality of the videos.

3 Physical Activity videos	3 Sleep videos	3 Diet videos
PA Video 1	Sleep Video 1	Diet Video 1
PA Video 2	Sleep Video 2	Diet Video 2
PA Video 3	Sleep Video 3	Diet Video 3

Figure 4.2: I had 9 videos in total: 3 videos per topic. Each participant watched 3 videos in total, 1 video on each topic. (e.g., Diet Video 2, PA video 1, then Sleep Video 2). Thus, the order of the topic and the selection of the video within each category were randomized.



Figure 4.3: GPP, Negative Affect, Topic Interest and Content Appraisal means per video. Only Usefulness predicted GPP.

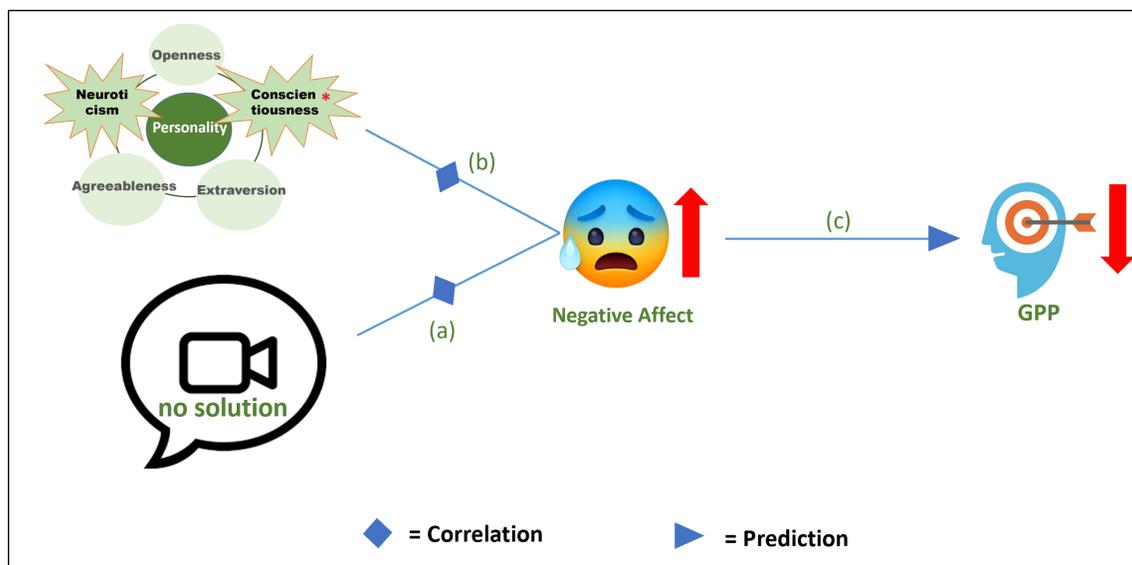


Figure 4.4: Negative affect was correlated with Video Content (a in the figure) and Personality Traits (Neuroticism, Conscientiousness; b in the figure). Finally, Negative Affect predicted viewers' lower willingness to alter their behaviors (c in the figure).

* *negative correlation*

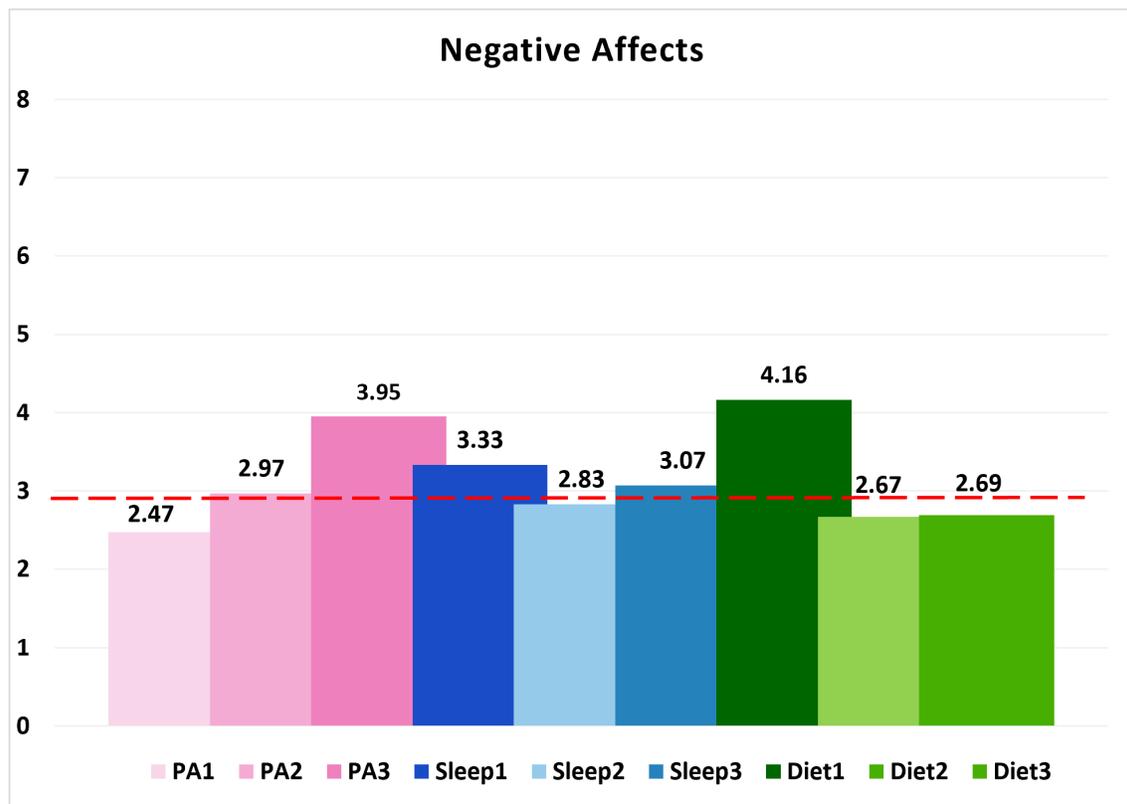


Figure 4.5: Negative Affect by video.(Note PA = Physical Activity). The line indicates the mean across all 9 videos ($M = 2.96$).

5 STUDY 2 - EXPLORING THE EFFECT OF PROVIDING SOLUTIONS IN DVs TOWARDS NEGATIVE AFFECT AND POTENTIAL PERSUASION

1

This chapter describes a follow-up study based on Study 1 findings. Study 1 found an undesirable effect of increased negative affect in DVs: viewers' heightened negative affect was linked to lowered willingness to improve their attitude. This negative affect was then linked to the absence of "clear solutions" to the issues presented in each DV. Additionally, perceived usefulness of the information had a large effect on participants' willingness to change their attitude (it accounted for 72% of the variability in GPP).

Study 2 explores the effect of providing solutions in a DV. I investigated two types of solutions; 1) general/broad solution, and 2) concrete/actionable solution, compared to having no solution at all (baseline). I hypothesized that, by providing concrete solutions, the viewers' anxiety levels can be assuaged as they feel **the issues are resolvable**. This hypothesis is based on Cohn's narrative structure that starts with introducing the problem (*Establisher or 'E'*), followed by a rise in action (*Initial or 'I'*) where the events intensify. In this case, the negative consequences of not being physically active are listed until the *peak or 'P'* is reached [19]. Finally the

¹ Dr. Yumiko Sakamoto helped with the study design and data analysis , Dr. Jason Leboe-McGowan Dr. Celine Latulipe helped with the study design

narrative takes a descending direction towards a resolution to the problem (*Release or 'R'*). This *'well-balanced'* narrative structure is very common in Data Videos [3]. This perspective is consistent with Bardzell, Bardzell, and Pace's findings regarding viewer's liking of internet videos [8]. They found that it does not matter if the video evokes negative or positive emotions, rather it is the *emotional arc* that leaves the viewer emotionally resolved and hence liking the video, even if it started with negative emotions [8]. I anticipated that presenting the issue will increase the level of anxiety, but this will be alleviated once the solutions to the issue are presented since the viewers will know *what needs to be done to avoid the negative consequences*. This reduction in anxiety level might be a key to improving persuasive potential of the videos. I also believe that the effect of providing a solution is twofold. Other than reducing viewers' negative affect, providing solutions or suggestions to the presented problem can aid in improving the perceived usefulness of the video. In turn, the perceived usefulness of the video will then aid in its persuasive potential, as suggested by the results of Study 1.

5.1 STUDY DESIGN AND ADMINISTRATION

In Study 2, I explore the effect of adding solutions; general/broad solution or concrete/actionable solution, on viewers' anxiety levels, as well as their perceived usefulness of the videos, with the goal of improving the persuasive potential of the video. I decided to explore two types of solution in order to get more insights regarding the level of details and specificity for the added solution to achieve optimal effect. I focused on one of the three health topics investigated in Study 1; physical exercise. This was because since COVID-19 pandemic started, many

people were forced to work from home, and not to leave it except for getting their essentials. People were denied access to the gym or banned from participating in any training or group activities. This situation has affected peoples' physical activity levels and hence I decided to focus on this.

Parallel to Study 1 (check Chapter 4), an online survey was created using Qualtrics, and administered through Amazon Mechanical Turk (MTurk) with the same workers' requirement criteria; the number of completed tasks (>1000) and approval ratings on MTurk (>95%). All participants received monetary compensation (\$2.47 US) in compliance with the study ethics approval and MTurk payment terms. Participants in the US and Canada were recruited to help in ensuring that they have a good command of English and also to minimize cultural influence. The study was a between participants design with three conditions (Control/No Solution Condition; General Solution Condition; Concrete Solution Condition). Participants completed survey questions before, after, and interspersed with participants watching a Data Video on physical activity.

5.2 DATA VIDEO DEVELOPMENT

I used an existing DV developed by a credible source, namely, the WHO, titled 'Move for Health' as the basis for my stimuli [77]. The original video starts by stating that modern life has made us less physically active (*Establisher* phase or E in the narrative arc). The video starts listing the dangers of physical inactivity in the *Initial* phase or I (e.g., fourth leading risk factor for mortality worldwide, major cause of severe diseases such as breast and colon cancer, diabetes, heart disease, coronary heart disease, etc.), the video then reaches its *Peak* (P) by referring to office

workers who remain seated for eight hours a day and how that could lead to severe health consequences. Thereafter, the video takes a descending direction by giving some advice and suggestions (i.e., solutions) in the *Release* phase or R). They advise the viewers to stand up and stretch while in the office and then further encourage them to work out and be physically active by stating that physical activity is simple and can be done anytime and anywhere and does not require going to the gym. The author of the video uses walking as an example of simple but important physical activity that is free and easy to practice. The video concludes by providing concrete advice to practice 30 minutes of moderate intensity physical activity 5 days per week, accompanied by images of a variety of suggested activities (e.g., basketball, golfing, hiking, gardening, etc.). This video follows a 'well-balanced' structure, which is one of the most common DV structures according to Amini et al. [3]. I adjusted and used this video as a basis for the three video condition:

1. **Condition 1: Data Video with no solution:** This is used as the control/baseline condition. In the no solution condition, I cut the video right before any suggestions or solutions are provided. Thus, the video ended immediately after the peak where participants experience anxiety. The length of the control video is one minute and 51 seconds (check <https://youtu.be/SrrjanPNEg8>).
2. **Condition 2: Data Video with general/broad solutions:** The difference between control and this video was a very general suggestion/solution added after the peak. This video contained a general solution message, to get up leave the seat followed by a motivational statement saying physical activity is simple and can be done anywhere and anytime. The added solution segment took 39 seconds (general solution video segment available on: <https://youtu.be/AEiHi3GcAW8>).

3. **Condition 3: Data video with actionable/concrete solutions:** This video provided specific actionable solutions in addition to the general advice provided in video 2. Two concrete solution ideas were provided; 1. Walking (from the original video), 2. Brisk walking (content and animation developed and added to the original video). To make the added piece of advice useful and actionable, I explained what brisk walking exactly is and how to distinguish it from other forms of walking or jogging "*Brisk walking is one of the easiest and most effective workouts. Brisk walking = 100 steps per minute or 17 steps per 10 seconds. Just walk fast enough so you can talk but not sing*". These facts about brisk walking are taken from [65]. To avoid any confound effect, three HCI researchers ensured that added content follows the same theme and animation style as the original video and also ensured smooth transitions between different scenes. The added actionable solution took one minute and 24 seconds in length (actionable solution video segment available on: <https://youtu.be/w6gz2PW02VI>).

The three video film images at the bottom of 5.1 show brief summary of the three videos. Appendix .4 summarizes the video viewing experience.

5.3 DATA COLLECTION INSTRUMENTS

Study 2 followed the same scales as study 1 for measuring *personality traits* (Rammstedt and John's 10-item Big-Five Inventory [63]) and *Persuasive potential* (Meschtscherjakov et al.'s Persuasive Potential Questionnaire or PPQ [53]). Additionally, I further measured:

Table 5.1: Physical Activity Negative Affect Question Items

Please read each statement carefully, and select the appropriate answer that best describes how you feel **right now**.

I feel **worried** about my health due to my low physical activity level.
 I feel **nervous** about my physical activity level.
 I feel **anxious** about my physical activity level.

A Likert scale (1: Not at all to 7: Extremely) is used.

Affective state Similar to Study 1, I employed the self-reporting method for measuring participants' negative affect. I adjusted the three questions in Study 1 (see table 4.2) to be focused on physical activity (e.g., I feel worried about my health due to my low physical activity level). Again on 8-points Likert scales (check table 5.1).

Actionability scale Questions assessed participants' perception of the video in terms of its utility or actionability at the personal level (i.e., actionable for me) and in general (i.e., generally actionable). These questions are created based on the 'Reduction' and 'Tunneling' principles from the Primary Task Support and 'Suggestions' from Dialogue Support categories in Oinas-Kukkonen and Harjumaa's model for persuasive systems [59], see table 5.2 for the list of questions testing actionability on the personal level and table 5.3 for the questions testing actionability in general or for others.

Perceived controllability I created four questions to draw information regarding participants' feeling of control over their own health and physical activity level (e.g., I feel that I have control over my physical activity level) using a 7-point Likert scale (1= Strongly Disagree, 7= Strongly Agree). Participants were posed this set of

Table 5.2: Items to measure video actionability on the personal level

Please answer the following questions about how **you** felt about the video.

The video provided solution(s) to the discussed issue.
 The video provided concrete steps to address the problem.
 The video provided me with easy to understand solutions.
 I feel that I can implement the proposed solutions.
 I have the required resources (time, space, etc.) to carry out the suggestions in the video.
 The video provided advice that is unrealistic to me. (R)
 After watching the video, I know exactly what to do.

(R) = item is reverse-scored.

A Likert scale (1: Strongly Disagree to 7: Strongly Agree) is used.

Table 5.3: Items to measure video actionability in general

Please imagine what **general others** would feel about the video.

Generally, the video provided solution(s) to the discussed issue.
 Generally, the video provided concrete steps to address the problem.
 Generally, the video provided easy to understand solutions
 Generally, people would be capable of implementing the proposed solutions.
 Generally, people would have the required resources (time, space, etc.) to carry out the suggestions in the video.
 Generally, the video provided unrealistic advice. (R)
 After watching the video, people would know exactly what to do.

(R) = item is reverse-scored.

A Likert scale (1: Strongly Disagree to 7: Strongly Agree) is used.

Table 5.4: Perceived Controllability Items

Please state your agreement level to the below statements:

I feel that I have **control** over my physical activity level.

I feel that I can **avoid** physical in-activity (*)

I believe that health issues related to physical in-activity are **preventable**.

I believe that I should be able to **manage** health issues by adjusting my physical activity level.

(*) = item is removed in the analysis.

A Likert scale (1: Strongly Disagree to 7: Strongly Agree) is used.

questions before and after viewing the video to investigate the effect of the video on participants' feeling of control as one of the elements in Weiner's attribution theory that underlie people's decisions to adopt a certain behavior [76].

5.3.1 Study Progression

First, participants answered demographic questions (gender, age, education level, and ethnic background) followed by the 10-item personality questions. Participants' baseline anxiety levels were then assessed (pre-anxiety level). Participants also answered some Physical activity related questions regarding: 1) their interest level in physical activity; 2) Their perception of their own Physical activity level ("Generally speaking I am physically active", on a 7-point Likert scale: 1 indicating Strongly Disagree to 7, Strongly Agree); 3) their perceived control over their health and physical activity (baseline). Thereafter, participants were randomly assigned to watch one of the three videos (Control, General Solution, or Actionable Solution). To understand participants' emotional arc, in the two experimental videos with solutions, participants anxiety levels were assessed three times: 1) prior to the

video viewing (i.e., Pre-Video), 2) at the *Peak* point, and after *Release* (i.e., Post video). For the control video, however, it was assessed twice: 1) prior to the video viewing (i.e., Pre-Video) and 2) at the *Peak* point. It was measured only twice simply because the video ended at its Peak point. Check Appendix .4 for a visual representation of the video viewing experience.

After completing the video viewing, participants responded to:

- **Affective State:** questions for a post video anxiety level measure (post anxiety).
- **Perceived Controllability:** questions for a post video figure.
- **Actionability Questions:** two sets of questions to measure their perception of the **utility or actionability** of the video they watched, on the personal and general levels (see table 5.2, table 5.3).
- **Video Content appraisal:** questions to measure participants' perception of the importance, novelty, clarity, usefulness, and relevance of the information provided by the video, as well as their overall liking of the video.
- **Health barriers:** questions to report if they cannot follow the advice provided in the video due to some health issues.

5.4 RESULTS

On average, participants took 15 minutes to complete Study 2. Data fitting assumptions for each analysis were checked and non-parametric options (approaches focusing on median comparisons) were used, when appropriate. Thus, Medians, instead Means, are reported throughout, whenever appropriate. Due to multiple

comparisons, I used the Bonferroni method for adjusting degrees of freedom when needed. Given the three conditions, I considered α level of 0.017 in all pairwise comparisons.

5.4.1 *Participants*

I recruited 119 participants. Participants varied in terms of gender, age and education (see Table 5.5)

5.4.2 *Data Quality Control*

I used the same verifiable question as in study 1 to filter out erroneous responses. I applied a listwise deletion method for cases with wrong responses to this Gotcha question, leaving us with 109 valid cases. I further filtered out responses by participants who answered "yes" to the question "*I have health issues that prevent me from following the advice provided in the video*", also using a listwise method as well. I decided to filter out participants with health barriers to avoid any biases or extreme responses that cannot be explained by the video condition to which they were assigned.. 82 valid cases remained for the analyses ($n = 82$).

5.4.3 *Data Preparation*

As was the case with Study 1 data, for each scale, I first checked inter-item reliability scores within each scale (negatively coded items were reverse coded first) by investigating Cronbach's *alphas*: 1) GPP ($\alpha = .84$), 2) Negative Affects (α

Table 5.5: Participants' Demographic Information

Total Participants= 119	
Gender	Male (66%), Female (30%), Other (4%)
Age	18-34 (39%), 25-49 (40%), 50-64 (18%), over 65 (3%)
Education	High school or equivalent (17%), Bachelor's degree (61%), Graduate de
Gotcha Question	Correct (109 participants) , Wrong (10 participants)
Health Issues	No (82), Yes (27) * after filtering out wrong Gotcha responses

= .95), 3) Actionable on the personal level ($\alpha = .88$), and 4) Actionable for others ($\alpha = .89$). Since all aspects encapsulate items that are highly correlated (i.e., $\alpha \geq .70$ [58]), I created an aggregate index for each.² Similarly, I created an index for each personality domain by aggregating the two applicable items..

Perceived Controllability

Since Chronbach's Alpha for the four Controllability items (pre video perceived controllability) was low (Chronbach's Alpha = .595), I removed the second item from the scale (See Table 5.4) due to its low correlation with other items. As a result, the inter-item reliability was brought up to an acceptable level (Chronbach's Alpha = .706). Thus, the mean of these three items (1, 3, and 4, see Table 5.4) was used to create an index for Perceived Controllability. I used the same set of items to compute the *post video* perceived controllability index (Chronbach's Alpha = .756). Thereafter, I computed the index for the change in perceived controllability after watching the video (controllabilitychange index = post controllability index - pre controllability index).

Negative Affect measures:

In this study I measure participants' negative affect twice or three times based

² Starting this point whenever any of those four aspects is mentioned, it refers to the corresponding index.

on the video condition (circular points on the line chart in figure 5.1 represent times when negative affect was measured). Each time, I measured negative affect using the 3 anxiety questions in table 5.1. After checking for inter-item reliability between the anxiety scale items, I created 3 indices:

1. **pre anxiety:** aggregate of participants' anxiety level *before watching any of the three video conditions.*
2. **peak anxiety:** aggregate of participants' anxiety level *after watching the first segment of the video and before introducing the solutions (i.e., at Peak).*
3. **post anxiety:** aggregate of participants' anxiety level *after watching the second segment of the video in which the solutions are presented (i.e., after release for solution video conditions).*³

As the line graph in figure 5.1 shows, participants in all three conditions experienced an increase in their anxiety levels after watching the first identical segment of the video: 1) no solution condition (pre anxiety: $Mdn = 3.67$, $SD = 2.204$, peak anxiety: $Mdn = 4.33$, $SD = 2.371$); 2) general solution condition (pre anxiety: $Mdn = 2.33$, $SD = 1.805$, peak anxiety: $Mdn = 3.00$, $SD = 2.215$); 3) Actionable solution condition (pre anxiety: $Mdn = 4.00$, $SD = 2.116$, peak anxiety: $Mdn = 6.00$, $SD = 2.212$). Please note that, until this point, the change in anxiety levels cannot be attributed to the video condition because the videos across conditions were identical at this stage of the viewing (segment a in Figure 5.1). After exposing participants in the experimental conditions (i.e., the general and actionable solution conditions) to the second segment of the video, in which the solutions are provided, their anxiety levels started to decline (post anxiety: Condition 2 ($Mdn = 2.67$), Condition

³ For the video with no solution, post anxiety will be the same as peak anxiety as there is no second segment so participants' anxiety levels remain the same.

3 ($Mdn = 5.33$). As for participants in the control condition (i.e., the video with no solution), their anxiety level remained unchanged $Mdn = 4.33$. To be able to measure the changes in anxiety levels across conditions I used two values:

1. **Anxiety increase per condition:** the difference between mean anxiety levels before watching the video (pre anxiety) and after watching the first segment (peak anxiety).
2. **Anxiety decrease/drop per condition:** the difference between mean anxiety levels after watching the second segment (post anxiety) of the video and after the first segment (peak anxiety). See the red circles in Figure 5.1.

For the the analysis, I am interested in the *anxiety drop* values as they can be attributed to the condition effect based on the existence vs. absence of a solution.

5.4.4 Data analysis and Findings

Video condition and perceived actionability

To investigate whether the video manipulation (i.e., adding two different types of solutions or suggestions in the video) succeeded in making the video more actionable, first, I compared medians for both of the "actionability" scales (i.e., actionable on the personal and general levels) across the three conditions. As Figure 5.2 shows, the trends are as anticipated on the personal and general actionability levels. To check if there is a significant difference between the three video conditions in terms of actionability, I conducted a Kruskal-Wallis test. The results showed that there is a significant condition effect on actionability on the personal ($p = .011$) and general ($p = .004$) levels. A Pairwise condition comparison using Mann-Whitney U tests confirmed that participants in the experimental

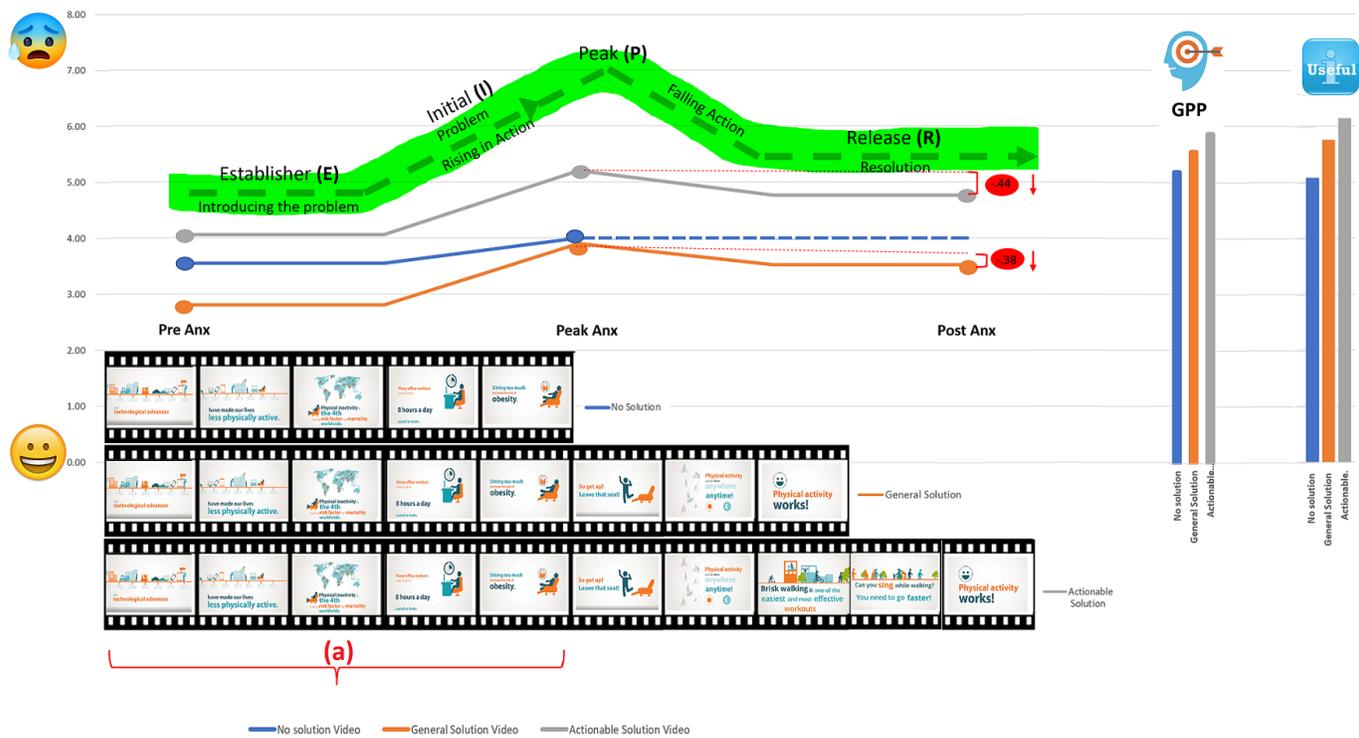


Figure 5.1: The green curve on top represents the common narrative arc. The line charts represent the fluctuation in participants’ negative affect during the video viewing. Each line represents one video condition. The film frames at the bottom summarize the 3 video conditions and show where they end relative to each other and to the narrative arc as well as the affect fluctuation curves. The bar charts represent median GPP and median usefulness by video condition. *note: the green narrative arc curve at the top is just a random representation of the trend and does not follow any scale*

conditions (general & specific solutions) perceived the videos as more actionable compared to participants in the no solution condition. Interestingly, there is no significant difference between the two experimental conditions in terms of perceived actionability (i.e., both of the experimental videos are significantly more actionable than the control video but are not different from each other in terms of actionability). This result indicates that, to improve perceived actionability, video designers can simply add a general solution to the video instead of detailed solutions. This is an interesting finding as adding a concrete solution usually

requires more resources (e.g., detailed information search, more design effort, and more time added to the video).

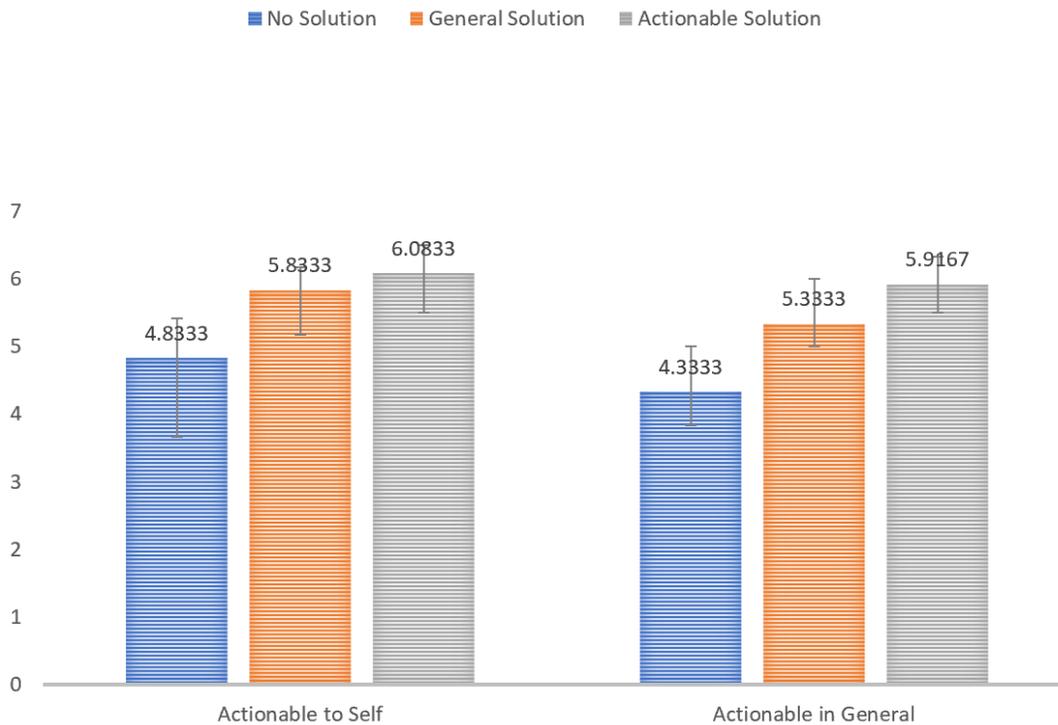


Figure 5.2: Medians of Perceived actionability on the personal and general levels per video condition. Error bars represent 95% CI.

Actionability and usefulness

Next, I explored whether perceived actionability could predict perceived information usefulness. I entered usefulness as a dependent variable while both Actionability indices (i.e., Self specific and General actionability) as predictors using a stepwise method. General actionability explained 66% of the variation in usefulness ($F(1, 81) = 63.03, p < .001, \beta = .664, R^2_{Adjusted} = .434$). Higher general actionability ratings predicted an increase in the perceived usefulness of the video ('a' in Figure 5.3).

Video condition and Usefulness

I also investigated the relationship between the video condition and perceived usefulness. The video condition was entered as a predictor of perceived usefulness in a linear regression. The video condition predicted usefulness ($F(1, 81) = 6.602$, $p = .012$, $\beta = .276$, $R^2_{\text{Adjusted}} = .065$). The more actionable and detailed solutions provided in the video, the more useful participants considered it to be. To examine if there were any differential effect based on the video condition, I ran a Kruskal-Wallis Test. According to K-W Test, there is a significant difference between perceived usefulness among the three video conditions ($p = 0.028$). Subsequent Mann-Whitney U Tests found that, compared to the control video, the video with actionable solution was perceived as significantly more useful ($p = 0.011$). No other significant effects were found.

Usefulness and GPP

Finally, I tested if perceived information usefulness predicts general persuasive potential or GPP as it was the case in Study 1. I entered usefulness as a predictor of GPP in a simple linear regression, information usefulness did predict GPP ($F(1, 81) = 122.97$, $p < .001$, $\beta = .778$, $R^2_{\text{Adjusted}} = .601$). Consistent with the findings in Study 1, information usefulness is a very strong predictor of GPP as it explains 78% of the variability in GPP ('b' in Figure 5.3).

Figure 5.3 summarizes the effect of adding solution to overall GPP.

Actionability, anxiety, and GPP

To explore the effect of Actionable videos (or videos with solution) on easing or reducing participants' levels of Negative affect, I conducted a linear regression with the video condition as a predictor of the level of drop in anxiety. The video condition did predict the drop in anxiety levels ($F(1, 81) = 63.03$, $p = .030$, $\beta = .240$, $R^2_{\text{Adjusted}} = .046$). When the video provided a solution, the anxiety

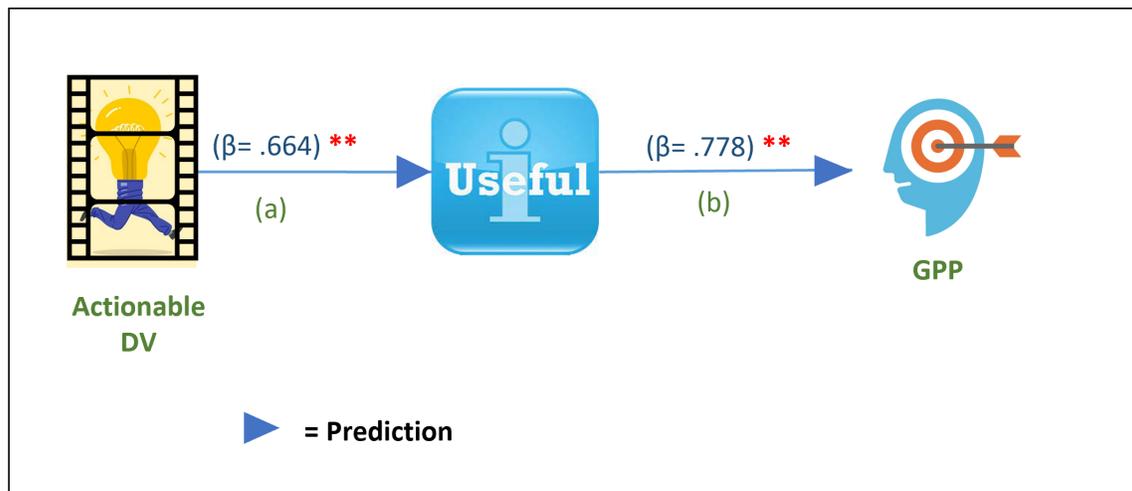


Figure 5.3: Videos with solution are more actionable, actionable DVs predicted usefulness. Usefulness predicted GPP
 ** $p < .001$

levels declined further, meaning that participants experienced more relief at the conclusion of the video. When no solution was provided, unlike the two solution conditions, participants' negative affect remained high after the video ended. A Pairwise comparison using the Mann-Whitney U test showed that there was no significant difference in the drop in anxiety levels between the two experimental conditions (general and actionable solutions). This finding informs us that incorporating any kind of solution in DVs is capable of easing the anxiety that viewers develop from their exposure to the video.

After that, I entered anxiety drop as a predictor of GPP in a linear regression model. Anxiety drop marginally predicted GPP ⁴ ($F(1, 81) = 3.022, p = .086, \beta = .191, R^2 = .036$). Figure 5.4 summarizes the actionability, anxiety, and GPP relationships.

⁴ This marginal effect could be due to smaller N size since I did find a small effect in this analysis. Note $R^2 = .036$ is considered to be a small effect according to Cohen (1988).

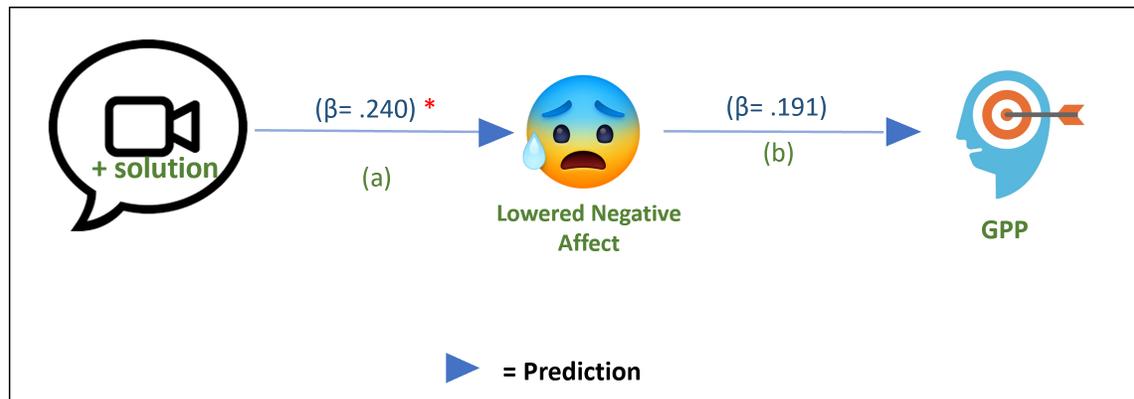


Figure 5.4: The video condition predicted drop in negative affect (a); Video with detailed solutions induced the highest decrease in negative affect while video without solution did not decrease participants' negative affect. The drop in negative affect predicted GPP (b), marginally.

Controllability

I further explored the effect of the three video conditions on viewers' feelings of having control over their own health and activity levels. I used the mean *change in controllability* as opposed to the pre or post controllability values in order to examine the effect of the videos as opposed to participants' personal tendencies. By comparing median controllability change across the three conditions, I found that the video with no solution did not cause a change in perceived controllability ($Mdn = 0$). Videos with solutions, on the other hand, increase participants' feeling of control (video with general solution, $Mdn = .33$; video with actionable solution, $Mdn = 0.5$). Furthermore, a Kruskal Wallis test showed that there is a significant difference in the change of anxiety levels among the three conditions ($p = .005$). To identify the source of the change, I carried out a sequence of Mann-Whitney U tests. M-W U tests showed that: 1) the video with an actionable solution is significantly different from the video with no solution ($p = .001$); 2) the video with

general solution is marginally different from the no solution video ($p = .033$)⁵; 3) there is no difference between the two experimental videos ($p = .258$).

Afterwards, I conducted a linear regression with controllability as predictor of GPP. Regression results confirmed that controllability predicts GPP ($\beta = .214$, $p = .053$, $R^2_{\text{Adjusted}} = .034$). This tells us that adding a solution to the video increased viewers' perception of their controllability over their health which aids in their potential to reconsider their behaviors. While detailed actionable solution is the best, a general solution would also increase the viewers' perceived controllability. However, we should not fail to add a solution. Finally, when viewers' have a perceive high controllability over the health issue, they are more willing to alter their behaviors.

Solution and GPP Lastly, I wanted to determine the effect of providing either a general or actionable solution vs. no solution on overall GPP. For this analysis, I split the data into only two conditions: 1) DV with no solution and 2) DV with solution (combining the data for the general and actionable solution conditions). I entered the solution condition as a predictor of overall GPP in a linear regression model. Adding a solution did predict GPP ($\beta = .242$, $p = .028$, $R^2_{\text{Adjusted}} = .047$). Videos with a solution (general or actionable) are more persuasive than video without a solution.

Underlying personal aspects influencing experienced levels of Negative affect

To understand the dynamics underlying participants' personal tendencies to feel anxious or worried, I examined two factors:

1. **Personality traits and Negative affect** With multiple linear regression using a stepwise method, I explored personality traits as a predictor of overall

⁵ due to multiple comparisons (3 comparisons), I am considering α level of 0.017 according to Bonferroni adjustment

negative affect index (mean of pre, peak, and post anxiety). I was able to replicate the findings from Study 1 in that only Conscientiousness ($\beta = -.388$, $p < .001$) and Neuroticism ($\beta = .358$, $p = .001$), predicted overall negative affect $F(2, 80) = 68.64$, $p < .001$, $R^2_{\text{Adjusted}} = .401$.

- 2. Health perception and negative affect** I also looked at the relationship between people's perceptions about their own Physical activity level and the anxiety levels they reported after watching the "threatening" part of the video (i.e., peak anxiety). I explored perceived activity level as a predictor of peak anxiety levels using linear regression. Health perception predicted negative affect with a negative *beta* ($\beta = -.316$, $p = .004$, $R^2_{\text{Adjusted}} = .088$). When participants perceived themselves as physically active they were less affected by the negative messages.

These findings tell us that highly neurotic people are more negatively affected by fear inducing messages whereas people who were high in conscientiousness are less affected. Also when participants perceived themselves as less physically active, they tend to worry or get more anxious when presented with threatening messages related to physical inactivity.

5.5 DISCUSSION

Study 2 examined the effect of adding a solution (broad or actionable) to health-related Data Videos on the experienced levels of negative affect, as well as the perceived usefulness of the videos. I verified the relationships between negative affect and potential persuasion, as well as information usefulness, and potential persuasion. Investigations concerning personality traits and experienced levels

of negative affect were also conducted. The findings tell us that the inclusion of solutions in data videos targeting health-related issues has two merits. First, I observed that DVs with any kind of solution even a broad one, succeeded in easing participants' anxiety levels, whereas videos without solutions to their fear inducing messages kept viewers' negative affect higher. I further found that heightened levels of negative affect predicted a lower willingness on the part of viewers to change their behavior (check figure 5.4), replicating the findings in Study 1. Second, I found that adding solutions (even a broad/general one) to DVs leaves viewers to perceive them as more actionable or practical, increasing their perceived usefulness. In turn, the perceived usefulness of the video was revealed in the results to be an immense predictor of higher willingness to change the related behavior (check figure 5.3).

Interestingly, the results are consistent with earlier psychological investigations of smoking. For example, one study revealed that fear was effective in *motivating* behavior change, but only when the message informed individuals how to succeed in smoking cessation efforts [49]. However, one very interesting and potentially helpful finding is that there is no significant difference between the general and actionable solution conditions in terms of the reductions in the levels of anxiety, actionability, or perceived controllability. This means that just telling the viewers that there exists a solution, even an obvious one, such as '*just get up and exercises*', is effective at decreasing the viewers' anxiety and giving them a sense of actionability or utility, as well as controllability, thereby aiding in their willingness to change their behaviors. Providing detailed actionable solutions (e.g., what exactly to do, how often, and for how long) is ideally the best, but it requires more effort and resources (e.g., detailed information search, more design effort, more time added to the video). If adding a detailed solution is not possible, DV designers should

choose to add a general solution and strongly avoid having no solution. This aspect of the findings is especially important in the context of DVs that are designed to be short and to the point, so that they maintain the viewers' attention and interest. Maybe what the viewers' need most is an assurance that their well-being is under their personal control. Ultimately, this perception of control may be achieved with a simple and general message such as *'get up and leave the seat, physical activity is simple and can be done any time and anywhere'*. When the target is only a change on the perceptual level, the video need to give the viewers a push or glimpse of hope that the solution is doable or the problem is avoidable, after presenting the health risks. Note, however, when it comes to actual behavior change; which is beyond the scope of this study, the approach might differ.

Although both solution conditions (i.e., general and actionable) were perceived almost the same in terms of actionability and controllability, when it comes to information usefulness, providing a detailed, actionable solution is significantly better. This makes sense because if the video doesn't tell the viewers what exactly to do, or if it just includes very general and obvious solutions (i.e., didn't add to people's knowledge), I do not expect it to be perceived as very useful. Hence, to improve the perceived usefulness of the information in DVs, providing actionable detailed solutions is likely to be essential.

While the results cannot tell us *how* we should design personalized DVs, they flag the potential risk of including heavily loss-framed messages, especially for highly neurotic people. Such individuals tended to be more affected by these types of messages, unlike conscientious individuals, who appear to be more tolerant to threatening information. I also learned that, although people who perceive themselves as highly at risk are most in need to be informed about the threats or dangers of not following the healthy behavior, they should be treated with caution

in terms of the intensity of the loss-framed messages. They experience higher levels of anxiety which can impair the persuasion potential.

5.6 CONCLUSION

This study revealed that, while threatening/fear inducing messages have been proven effective in attitude change, in the context of narrative Data Videos, it is important to complement the video with *solutions*; even a simple and general one, to avoid or reduce the risks conveyed, otherwise exposure to the video could backfire. The results revealed that *unresolved anxiety and worry would hinder the persuasion potential*. I also found that perceived usefulness of DVs was a key to higher persuasion potential and it was also affected by the existence of a solution. In short, to produce effective Data Videos, targeting health issues, the video should follow a narrative arc to balance the anxiety levels with some general solutions or suggestions. I also observed that *individuals who scored high in neuroticism experienced higher negative affect*, whereas *those who scored high in conscientiousness experienced lower negative affect*. In sum, understanding how your DV triggers negative affect in your target viewers might be a key in producing powerful DVs, and personality traits might allow us to get to this key.

6 DISCUSSION

The goal of this research is to extend our knowledge about Data Videos, specifically DVs targeting health-related issues, as a very popular and promising medium for data representation. Data videos are a way to present data in a quick and engaging way that takes advantage of the narrative form with all of its underlying attributes. Since the power of narrative is attributed largely to its ability to emotionally influence the viewers, I examined viewers' affective reactions in response to loss-framed messages that are commonly adopted in DVs targeting health issues. I also looked at personal tendencies influencing viewers' affective experiences, as well as some general video attributes. My ultimate goal is to provide design guidelines that allow designers to fully utilize the narrative aspect of Data Videos to effectively convince viewers to reconsider their behaviors based on the information in the video. The conducted studies provide guidelines to improve the persuasive potential of Data Videos targeting health issues in two directions: 1) the content and narrative structure of the videos and 2) personality-tailored guidelines.

6.1 DATA VIDEO CONTENT

Narrative Structure: The results of the two studies tell us that to increase the persuasive potential of health related data videos that normally follow a loss-

framed messaging style (i.e., messages that show the consequences of failing to take certain actions), designers should make sure to follow a *'narrative arc'* or a *'well-balanced'* narrative structure. Presenting the problem and all the threats associated with it should be followed by *solution(s)* or suggestions(s) to leave the viewers emotionally resolved and balance the level of negative affect they experienced from the messages they received earlier in the video.

Usefulness: I demonstrated in the first study and affirmed, once again, in the second study that the perceived usefulness of the video was a very strong predictor of viewers' potential to be persuaded. Providing a solution after presenting fear inducing messages, or following a narrative arc, causes the videos to be perceived as more useful and, hence, more persuasive.

Results from both of the studies assure the importance of providing solutions to problems presented in data videos to make them more persuasive. The more interesting finding was related to the type of solution that ought to be provided. While detailed actionable solutions that provide very specific advice are the optimal approach, results from study 2 showed that providing a simple general solution is equally effective at reducing anxiety levels and increasing the perceived usefulness of Data Videos. In short, *adding a short and general solution in Data Videos targeting health issues is a key to create useful and persuasive videos without significantly compromising the length of the video.*

6.2 DATA VIDEO PERSONALIZATION

As for my contributions in terms of personalization of DVs, my findings confirm that when watching DVs targeting a health issue, *different people react differently to*

affect provoking messages based on their underlying personality traits. Highly neurotic people are more affected by threatening messages, whereas highly conscientious individuals have higher tolerance for receiving such messages. Neurotic people are also harder to persuade by watching DVs. Accordingly, designers should be extra cautious when targeting neurotic people in terms of the amount of threat contained in their messages or else their videos may backfire. People who perceive themselves as more vulnerable to the health issue discussed in the video are more sensitive to the threatening messages. Designers should also be careful with the amount and severity of the negative messages when targeting those individuals. After all, DVs are short clips and designing them tailored to fit their target audience can be a key to achieving persuasion and motivating positive behavior change.

7 SUMMARY AND FUTURE WORK

Given the recent rapid advancements in computing technology, smart wearable and handheld devices (e.g., smartphones, tablets, smart watches, etc.) became available to everyone. These devices have made it easier for us to lookup, fetch, and glance information in no time. Consequent changes in data visualization techniques accompanied these technological advancements to provide as much information in a limited display space and also in a short period of time to cope up with the fast paced life styles. Data Videos or short data-driven motion graphics are relatively new form of data representation that emerged with recent advancements in technology and social media. Data Videos are gaining popularity and their viewing rates are skyrocketing in almost all fields, hence they constitute a very promising medium for data representation that is worth exploring. I focused on Data Videos targeting health issues. I explored viewers' affective reactions in response to loss-framed messages in DVs targeting health issues. I looked into how these affective reactions are linked to the viewers' unique personalities as well as their potential to consider changing their related health behaviors. I found that heightened levels of anxiety or worry, would not aid in persuasion, rather it was the opposite. I further found that people differ in their response to the threat or fear inducing messages in health DVs. Neurotic people experience higher levels of negative affect compared to conscientious people who are less affected

by DVs' threatening messages. Furthermore, neurotic people are generally harder to persuade. As for the content of DVs, I found that when viewers' perceived the presented content as useful, they were more willing to reconsider their behaviors based on the video.

One key finding that my studies revealed is that the narrative structure of the videos really matters. While Study 1 revealed that heightened negative affect backfires in improving persuasive potential, Study 2 showed that, when used properly (i.e., reduced towards the end of the video), negative affect are quite useful. It is ok for DVs to list the threats or negative consequences of an unhealthy behavior as long as that is balanced out with a solution or suggestion at the end to relieve the viewers' tension. The more interesting finding is that while a specific detailed solution would be the optimal, providing a general solution would work as good in easing viewers' negative affect and hence boost the persuasive potential of the video. Moreover, adding a solution would not only aid in easing viewers' negative affect, it would also aid in boosting the usefulness of the videos' content which would aid to a big extent (according to my findings) in enhancing the persuasive potential of the video.

7.1 LIMITATIONS AND FUTURE WORK

Due to the COVID-19 pandemic, I was not able to conduct any of the studies in the laboratory setting: instead, I used MTurk. Although MTurk gave us the opportunity to recruit participants in a short period of time at a relatively low cost, it compromised the controllability of the study. For the same reason, I only relied on participants' self-reporting of their affective responses, and was not able to use

any physiological measurements to verify their reported affect. Future studies with physiological measurements will be useful to validate the findings. Furthermore, the studies were limited to negative affective responses focusing on anxiety. I acknowledge that the current time of the pandemic might have affected our results, as participants may be experiencing higher levels of general anxiety than usual. Moreover, the investigation of positive affect would also be useful. Examining positive affect such as excitement or hope, along with negative affect, will improve the model further. These studies shed light on the importance of useful content in Data Videos. Future studies should investigate constructs of usefulness in the content of Data Videos. Finally, and as mentioned earlier, the studies looked at the potential to attitude change as opposed to actual behavior change . A longitudinal study to explore people's actual change in behavior is worth investigation.

7.2 FINAL WORD

While Data Videos are very limited in length, given their popularity and high viewing rate they constitute a very promising medium for data representation. I believe that DVs have not reached their potential yet as we do not have clear guidelines on how to fully utilize them, and use them to their full potential. This research identified some rules that we can apply for health-related Data Videos production so we utilize them to efficiently improve our related behaviors. This research is just one of the first steps, but further investigation of Data Videos are needed indeed.

.1 APPENDIX A

Table .1: List of the Data Videos used in the study, by topic

Title	Source	Duration	# Views	URL
Physical Activity				
Morning Exercise = Mental Health	Kram Gallery	2:12	373,174	https://www.youtube.com/watch?v=3ZBXldCxZEA
The Importance of Intensity in Physical Activity	DocMikeEvans	3:20	97,728	https://www.youtube.com/watch?v=0Mn8Tq5Eyao
What Happens To Your Body When You Stop Exercising	Tech Insider	2:08	6,339,611	https://www.youtube.com/watch?v=hQz_V9Dr8IU
Diet				
Sugar is Killing Us	Sikuvideo	3:23	1,228,701	https://www.youtube.com/watch?v=Yda8Rt0cVFU
What would happen if you didn't drink water?	TED-ED	4:36	9,027,233	https://www.youtube.com/watch?v=9iMGFqMmUFs
Why eating fat won't make you gain weight	Tech Insider	4:43	346,114	https://www.youtube.com/watch?v=470619aXIt0
Sleep				
Understanding the Importance of Sleep	Tylenolofficial	1:25	28,524	https://www.youtube.com/watch?v=NwJ_Xwr2irI
The benefits of a good night's sleep	Ted-Ed	5:30	3,445,468	https://www.youtube.com/watch?v=gedoSfZvBgE
What causes insomnia?	Ted-Ed	4:47	1,930,075	https://www.youtube.com/watch?v=j5Sl8LyI7k8

.2 APPENDIX B

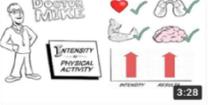
Video	Summary	Negative Consequences	Concrete Solution	# of Infographics
Physical Activity				
	The video is focusing on the importance of starting the day with physical activity. Benefits of exercising in the morning as: - mental capacity for handling stress triples - the brain produces chemicals (BNF and Endorphins) that clears the mind, helps in making positive decisions, minimize the discomfort and the feeling of pain and promotes the feeling of pleasure - helps with a faster metabolism, more energy and sense of accomplishment.	✗	✓	1
PA1: Morning Exercise = Mental Health				
	- Narrator is Dr. Mike Evans (which adds credibility and authority to the video). - Video is about the importance of intensity in physical activity and they define it as "stuff that gets your heart pumping" - They state that we need to perform 150 minutes of Moderate to Vigorous Physical Activity weekly. - Exercise reduces heart disease and cancer, and improves mental health and the overall quality of our lives. - Research has shown that higher the intensity, the better the results. "Interval training is good to improve performance in a short amount of time. Tips to know the intensity of the activity: 1. low intensity activity: if you are not sweating or not experiencing breath reate change. 2. Moderate activity: you feel out of breath but can still hold a conversation 3. Vigorous activity: you can't talk"	✗	✓	4
PA2: The Importance of Intensity in Physical Activity				
	- The video is talking about changes and risks to the body over time as we stop exercising. - The video is reporting changes that can happen over weeks to months. - The video is tracking the increase in the time needed to finish a 5k run (starting at 20 min when physically active, increase of 1 min after 2-3 weeks and 3 minutes longer after 5-7 weeks). - The video is also showing the decrease in the level of VO2 max that is responsible for delivering oxygen to generate energy for muscles as the no exercise period increases. As VO2 max decreases, muscle cells become smaller and the fat cells are become bigger.	✓	✗	8
PA3: What Happens to Your Body When You Stop Exercising				
Diet				
	- The video is talking about the dangers of sugar. - Scientists are saying sugar is toxic. It turned out that sugar is not only not healthy but it is dangerous. - High fructose in sugar can harm the body in various ways and causes lots of health issues. - However it is not easy to cut down on sweets as high fructose corn syrup are now added to foods that you never expect. - A recent study found the 80% of food in America contain added sugar. - At the end, the video is suggesting that the solution is to educate consumers not to buy products with added sugar which will affect the sales of such products.	✓	✗	3
Diet1: Sugar is Killing Us				
	- The video is about the role of water in the human body and how much do we need to drink to stay healthy. - Water cushion and lubricate joints, regulate temperature and nourish the brain and spinal cord. - Each day our bodies lose 2-3 liters of water through sweat, urine and bowel movements and even from breathing. We need to drink water to compensate for this loss. - The amount of daily water intake we need ranges between 2.5-3.7 L for men and 2-2.7 L for women depending on the weight and environment. - Benefits of being well hydrated: lower the chance of stroke, manage diabetes, reduce the risk of certain types of cancer	✓	✓	11
Diet2: Why eating fat won't make you gain weight?				
	- This video is focused on the benefits of good fats and how they are not associated with weight gain while carbs are the real issue. - Research shows that low fat diets do not aid in weight loss or reducing the risk of disease compared to high-fat diet and the refined carbs might be the real issue. - Good fats are very important for the body to function properly. - Monounsaturated fats are found in olive oil and avocados and they reduce inflammations and levels of LDL or bad cholesterol in the blood. - Polyunsaturated fats are found in fish are very useful; Omega-3 fatty acids decrease blood pressure and increase DHL or good Cholesterol and protects against heart disease. - Studies showed that full fat dairy is healthier than reduced fat as full fat dairy is found to be associated with a lower risk of type 2 diabetes	✓	✓	8
Diet3: Why eating fat won't make you gain weight?				
Sleep				
	This video is short and to the point. It explains the importance of getting good sleep, how much sleep do we need and the dangers of not getting enough sleep. Almost half of the video is dedicated to listing annoying and worrying threats of inadequate sleep (e.g. you will look older, you will get fat, you will develop cardiovascular disease, etc.)	✓	✗	3
Sleep1: Understanding the Importance of Sleep				
	- The video is talking about the importance of sleep for memory consolidation. - It starts by putting the viewers in an imaginary situation where they have a test in 8 hours followed by a piano recital and you are not feeling ready yet. You can drink a cup of coffee and spend some time studying and practicing but the narrator assures that it is better to put everything away and sleep. - The video contains a lot of scientific informations and terms and refers to several scientific studies related to the brain and the process of memory consolidation.	✓	✓	3
Sleep2: The benefits of a good night's sleep				
	- The video focuses on insomnia, its symptoms, reasons and provides some solutions. - unlike healthy sleepers, during their sleep, insomniac experience high metabolism which exhausts their bodies and brain making them wake in a state exhaustion, stress and confusion. - Insomnia's chemical mechanisms are similar to anxiety attacks found in people experiencing depression and anxiety and accordingly suffering from insomnia increases the risk of suffering from depression and anxiety.	✓	✓	6
Sleep3: What causes insomnia?				

Figure .1: List of all videos with summary description and some video attributes.

.3 APPENDIX C

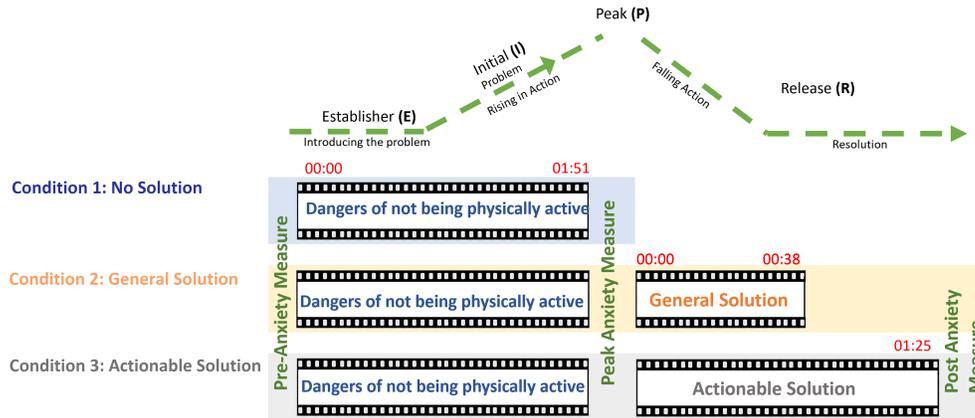


Figure .2: Participants were randomly assigned to one of the three video conditions:

1. In the *No Solution* condition, Participants watched one video segment that covered the dangers of not being physically active then answered the Affective state questions.
2. In the *General Solution* Condition, Participants watched 2 video segments; the first segment covered the dangers of not being physically (identical to condition 1), then they answered the affective state question, finally they watched the second video segment that introduced a general solution.
3. In the *Actionable Solution* Condition, Participants watched 2 video segments; the first segment covered the dangers of not being physically (identical to condition 1), then they answered the affective state question, finally they watched the second video segment that introduced an actionable solution

Below are the video links:

1. Dangers of not being Physically active or No solution condition video: <https://youtu.be/SrrjanPNEg8>
2. General Solution video segment: <https://youtu.be/AEiHi3GcAW8>
3. Actionable solution video segment: <https://youtu.be/w6gz2PW02VI>

.4 APPENDIX D



Informed Consent

Department of Computer Science

Dr. Pourang Irani
 Winnipeg, Manitoba
 Canada R3T 2N2
 (204) 474-8995
 FAX: (204) 269-9178

Please read this Informed Consent carefully before you decide to participate in the study.

Purpose of the research study: The goal of our study is to explore efficient ways to present data using new technology devices. Although a number of wearable devices have been emerging in the consumer market, there are many questions remained unanswered. In our project, we plan to explore questions such as: How can we best deliver collected data to users in a video format?

Research Project Title: "Improving data presentation on wearable devices"

Researchers: Dr. Pourang Irani (irani@cs.umanitoba.ca), Dr. Yumiko Sakamoto (yumiko.sakamoto@umanitoba.ca), and Samar Sallam (sallams@myumanitoba.ca).

This consent form, a copy of which will be left with you for your records and reference by clicking "Click here to download the Consent Form", is only part of the process of informed consent. It should give you the basic idea of what the research is about and what your participation will involve. If you would like more details about something mentioned here, or information not included here, you should feel free to contact the researchers above. Please take the time to read this carefully and to understand any accompanying information.

Research Procedure: This project focuses on the experiences of video viewing. First, you will be asked to complete a brief general questions asking about your background and personality, then watch three video clips and answer about your experience of watching each of these videos, including your affects. The video clips were taken from Youtube and they focus on health related topics (Sleep, Diet, Workout; between 1:26 and 5:25 mins). If you are interested in following up on the outcome of this study, you can send an email to the researcher listed above. Participation in this study is voluntary and will take up to 30 minutes. You will receive \$2.24 for your participation. Aside from this incentive, you will get a chance to learn about facts related to Sleep, Workout, and Diet. You will also have the opportunity to learn how computer science studies are conducted. Please note that there are no known risks associated with your participation. All information you provide is completely confidential. Data collected during this study will be used for academic research and publication purposes in anonymous form. For example, the results from this study will be shared in journal articles, conference presentations, and students' theses. All the data will be stored in a device in a locked file cabinet in Dr.Irani's office (E2-580 EITC at University of Manitoba, Canada) with a lockable door. The identity information and the consent forms will be destroyed as soon as the data analysis and publication are complete (but no later than December, 2020). The data will be retained for a period of a maximum one year after publication of the results to which only researchers listed in this form will have access.

Please note, once you participate, you will not be able to withdraw your data as there is no way to identify your data.

Figure .3: Study 1 Consent Form

We plan to report the results in presentations or written products such as theses and journal articles. However, neither your name nor any other identifying information will be used in any of them: We will ensure that none of the report will include identifying features, and the data will be accessed only by the researchers listed on this form. By signing this consent form, you agree that you understand this and that we may use the data collected from this experiment.

Clicking below "I consent to participate in this study" indicates that you have read this consent form and understood to your satisfaction the information regarding participation in the research project, and agree to participate. In no way does this waive your legal rights nor release the researchers, sponsors, or involved institutions from their legal and professional responsibilities. You are free to withdraw from the study at any time and/or refrain from answering any questions you prefer to omit, without any prejudice or consequence, and you will still receive the \$2.24. That is, even when you decide to withdraw from the study after signing this consent form, you can still keep the money. Your continued participation should be as informed as your initial consent, so you should feel free to ask for clarification or new information throughout your participation.

The University of Manitoba may look at your research records to see that the research is being done in a safe and proper way. This research has been approved by the Joint-Faculty Research Ethics Board. If you have any concerns or complaints about this project you may contact any of the above-named persons or the Human Ethics Coordinator (HEC) at 474-7122 or email: humanethics@umanitoba.ca. A copy of this consent form has been given to you to keep for your records and reference.

Yes, I consent to participate in this study.

[Click here to download the Consent Form.](#)

No, I do not consent.

Figure .4: Study 1 Consent Form



Department of Computer
Science

Dr. Pourang Irani
Winnipeg, Manitoba
Canada R3T 2N2
(204) 474-8995
FAX: (204) 269-9178

Informed Consent

Please read this Informed Consent carefully before you decide to participate in the study.

Purpose of the research study: The goal of our study is to explore efficient ways to present data using new technology devices. Although a number of new tools have been emerging in the consumer market, there are many questions remained unanswered. In our project, we plan to explore questions such as: How can we most effectively present data in a display?

Research Project Title: “Improving data presentation”

Researchers:

Dr. Pourang Irani (irani@cs.umanitoba.ca), Dr. Yumiko Sakamoto (umsakamo@umanitoba.ca).

This consent form, which you can download as a PDF for your records and reference, is only part of the process of informed consent. It should give you the basic idea of what the research is about and what your participation will involve. If you would like more details about something mentioned here, or information not included here, you should feel free to contact the researchers listed above. Please take the time to read this carefully and to understand any accompanying information.

Research Procedure: This project focuses on the experiences of processing data by using animated infographics on a display, and the study will be conducted via Amazon Turk, which led you to this consent form. First, you will be asked to watch a short Video Clip (approximately 2 minutes). Subsequently, you will be asked to complete a survey containing sections asking you about your background, and experience of watching the video clip. The session will not take any longer than 10 minutes.

Once your session is over, please feel free to e-mail researchers who will provide additional feedback on this research project and give you the opportunity to ask any other questions you might have. If you are interested in following up on the outcome of this study, you can provide your email in this consent form or can alternatively send an email to the researcher listed above.

Participation in this study is voluntary and will take up to approximately 10 minutes. You will receive \$ 2.47 US for your participation. Aside from this incentive, you will get a chance to explore new advancements in data presentation and infographics by interacting in new ingenious

Figure .5: Study 2 Consent Form

ways. You will also have the opportunity to learn how computer science studies are conducted. Please note that there are no known risks associated with your participation. All information you provide is completely confidential. Data collected during this study will be used for academic research and publication purposes in anonymous form. For example, the results from this study will be shared in journal articles, conference presentations, and students' theses. All consent forms and names and numbers linking data with consent forms will be stored separately from the data in a locked file cabinet in Dr. Irani's office (E2-580 EITC) with a lockable door, at the University of Manitoba, Canada. The identity information and the consent forms will be destroyed as soon as the data analysis and publication are complete (but no later than August, 2020). The data will be retained for a period of a maximum one year after publication of the results to which only researchers listed in this form will have access. If for any reason, you require withdrawal of your data collected during the study, please feel free to contact any of the researchers listed in this form at any time during your participation or within the first two weeks after your participation. As a result of a request for withdrawal of your data, we will destroy your data and it will no longer be used in any future reports or publications. **When you contact us to withdraw from the study, please give us the ID code that you obtained in the survey.**

We plan to report the results in presentations or written products such as theses and journal articles. However, neither your name nor any other identifying information will be used in any of them: We will ensure that none of the report will include identifying features, and the data will be accessed only by the researchers listed on this form. By signing this consent form, you agree that you understand this and that we may use the data collected from this study.

Your signature on this form indicates that you have read this consent form and understood to your satisfaction the information regarding participation in the research project, and agree to participate. In no way does this waive your legal rights nor release the researchers, sponsors, or involved institutions from their legal and professional responsibilities. You are free to withdraw from the study at any time and /or refrain from answering any questions you prefer to omit, without any prejudice or consequence, and you will still receive the \$ 2.47 US. That is, even when you decide to withdraw from the study after signing this consent form, you can still keep the compensation.

Your continued participation should be as informed as your initial consent, so you should feel free to ask for clarification or new information throughout your participation.

The University of Manitoba may look at your research records to see that the research is being done in a safe and proper way. This research has been approved by the Joint-Faculty Research Ethics Board. If you have any concerns or complaints about this project you may contact any of the above-named persons or the Human Ethics Coordinator (HEC) at (1) 204-474-7122 or email: humanethics@umanitoba.ca.

Figure .6: Study 2 Consent Form

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