HEALTH PSYCHOLOGY OPEN

Intervention Study

Health Psychology Open
January-June 2020: 1–9

DOI: 10.1177/2055102920905627
journals.sagepub.com/home/hpo
SAGE

Influence of high versus low readability level of written health information on self-efficacy: A randomized controlled study of the processing fluency effect

Tsuyoshi Okuhara[1], Hirono Ishikawa[2], Haruka Ueno[1], Hiroko Okada[1], Mio Kato[2] and Takahiro Kiuchi[1]

Abstract

We investigated the relationship of processing fluency of written information about exercise to participants' perceived interest, safety, self-efficacy, outcome expectation, and behavioral intention regarding the exercise. We randomly assigned 400 men and women aged 40–69 years to control or intervention conditions. Perceived self-efficacy of performing the exercise in the intervention group (i.e. easy to read) was significantly higher than that in the control group (i.e. difficult to read) ($p = 0.04$). Easy-to-read written health information may be important not only for making written health information comprehensible but also for increasing readers' self-efficacy for adopting health-related behaviors.

Keywords

health behavior, patient education handout, processing fluency, readability, written health information

Introduction

Written health information offers advantages in reusability and flexibility of delivery online and offline, and can be effective for patient education (Piredda et al., 2016). However, some users may not obtain optimal benefits from written health information because of limited health literacy, which can restrict the degree to which individuals have the capacity to obtain, process, and understand basic health information and services needed to make appropriate health decisions (Nielsen-Bohlman et al., 2004). In the field of health literacy, accessibility and appropriateness of health communication are generally considered in terms of readability (Beaunoyer et al., 2017; Nielsen-Bohlman et al., 2004). Readability can affect the reader's ability to access, comprehend, and utilize health information (Blanck and Marshall, 2011; Klare, 2000; Mcinnes and Haglund, 2011). However, two previous reviews reported that public health information and patient education handouts are often written at a level of readability that is too high for most intended recipients (Daraz et al., 2018; Rudd et al., 2000). Such incompletely processed information may be ineffective for encouraging health behaviors. Accordingly, it is important for written health information to be readable and able to be processed fluently.

A growing body of cognitive science research has demonstrated the considerable impact of the presentation of material on cognitive processes. These studies range from the investigation of "framing effects" (i.e. how different formulations of a problem lead to differences in decision-making; Tversky & Kahneman, 1981), to the investigation of the processing fluency effect (i.e. how the perceived fluency of information impacts on judgment; Claypool et al., 2015). Previous studies of processing fluency have reported that easy-to-read text generates more favorable reader attitudes (Claypool et al., 2015) compared with text that is more difficult to read (Reber and Greifeneder,

[1]The University of Tokyo, Japan
[2]Teikyo University, Japan

Corresponding author:
Tsuyoshi Okuhara, Department of Health Communication, School of Public Health, The University of Tokyo, 7-3-1 Hongo, Bunkyo-ku, Tokyo 113-8655, Japan.
Email: okuhara-ctr@umin.ac.jp

2017). Processing fluency is defined as the inferred subjective ease with which individuals can process new external information, and has become an increasingly popular concept over the past decade in psychology (Alter and Oppenheimer, 2009). Any cognitive task, such as reading written health information, can be experienced along a continuum from effortless to highly effortful. This cognitive effort produces a corresponding metacognitive experience of processing information ranging from fluent to non-fluent. Human judgment is influenced by information content as well as by the metacognitive experience of processing that information (Schwarz, 2004; Tversky and Kahneman, 1973). Previous studies have shown that various types of processing fluency (e.g. perceptual, linguistic, retrieval, and imagery fluency) have a uniform effect on liking, safety, confidence, and trust judgment, as discussed below (Alter and Oppenheimer, 2009).

Perceived fluency of stimuli influences how positively or negatively recipients evaluate those stimuli. Studies of processing fluency have reported that people and products with fluently processed names and labels are liked more than dysfluent counterparts (Gmuer et al., 2015; Laham et al., 2012). The concept of liking is included in perceived interest (Schraw and Lehman, 2001). Previous studies have proposed that recipients' perceived interest in a behavior is one of the variables that predict their adoption of the behavior (McGuire, 1985, 2001, 2013). In addition, several studies have reported that products such as medications and food additives are judged to be safer when their names are fluently processed (Dohle and Siegrist, 2011; Song and Schwarz, 2009). Perceived safety is one of the barriers to health behaviors, such as exercise (Lees et al., 2005; Sohal et al., 2015), representing an important variable when promoting a specific behavior.

Perceived fluency of stimuli also influences confidence judgments; individuals are more confident in performing a task when they have fluently processed written health information describing the task (Alter and Oppenheimer, 2009). For example, one study used identical instructions for an exercise printed in an easy- or difficult-to-read font, revealing that participants estimated that an exercise would take less time and feel easier to do when the font was easy to read (Song and Schwarz, 2008). Accordingly, recipients may perceive higher confidence in performing a behavior described in written health information when they process it more fluently. Individuals' perceived confidence to undertake a behavior is called self-efficacy and predicts health behaviors (Bandura, 2004).

Furthermore, individuals are more likely to believe that statements are true when they have been fluently processed (Alter and Oppenheimer, 2009). Reber and Schwarz (1999) manipulated the visibility of statements (e.g. "Osorno is in Chile") by changing the contrast of the text and background on a computer screen. Participants were more likely to believe that the statements were true when they were easy to read than when they were difficult to read against the background. When health professionals create written health information, it is typically intended to communicate the effect of a health behavior to recipients. If recipients of the information believe that the statement about the effect of the health behavior is true, and expect a rewarding outcome from the behavior, they are more likely to adopt the behavior (Bandura, 2004).

If perceived fluency of written information influences recipients' perceived interest, safety, self-efficacy, and outcome expectation, and, accordingly, behavioral intention regarding the health behavior described in presented information, this could have important implications for promoting health behaviors using written information offline and online. However, despite its relevance, the processing fluency effect has attracted little attention in health promotion (Okuhara et al., 2017a). In addition, knowledge is currently scarce regarding the relationship of recipients' perceived fluency of processing written health information to their perceived interest, safety, self-efficacy, outcome expectation, and behavioral intention regarding the health behavior described. This study aimed to elucidate this relationship, enabling the application of the processing fluency effect to health promotion. We focused on linguistic fluency, such as readability, because of the importance of public health communication. We hypothesized that participants' perceived interest, safety, self-efficacy, outcome expectation, and behavioral intention regarding a health behavior would be higher when the written information was fluently processed (i.e. easy to read) compared with when the information was less fluently processed (i.e. difficult to read).

Methods

Participants and design

Participants were recruited from people registered in a survey company database in Japan. E-mails were sent to registered users who responded to screening questions about their sex, age, and ability to exercise. In Japan, the proportion of individuals diagnosed with or suspected of having lifestyle-related diseases such as hypertension and diabetes is reported to increase at the age of 40 and over (Ministry of Health, Labor and Welfare, 2017). Physical activity is associated with a lower risk of chronic diseases (Marques et al., 2018). However, the proportion of people with exercise habits in Japan is relatively low, with a rate of 24 percent for men aged 40–49, 27 percent for men aged 50–59, 43 percent for men aged 60–69, 16 percent for women aged 40–49, 24 percent for women aged 50–59, and 30 percent for women aged 60–69 (Ministry of Health, Labor and Welfare, 2017). In this study, eligibility criteria were used to select men and women aged 40–69 years. Individuals who indicated that they could not perform exercise, or replied "I do not want to answer if I

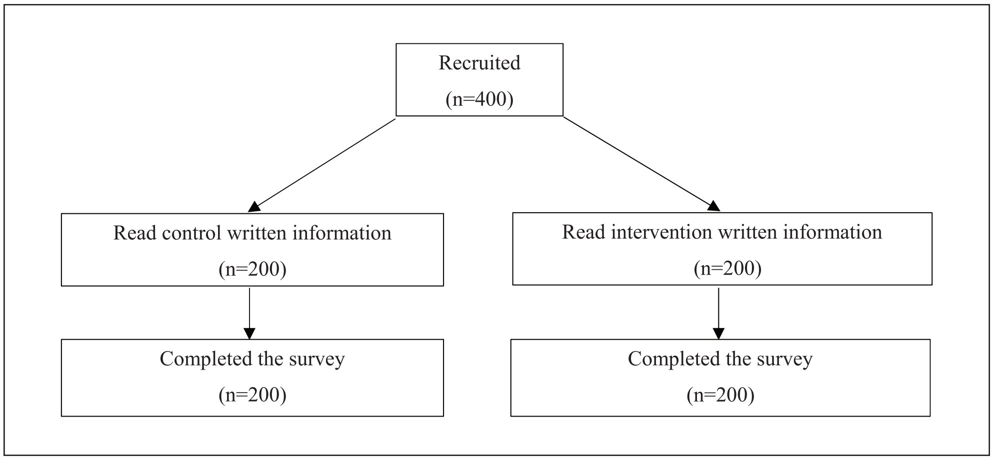

Figure 1. Participant flow.

can exercise or not," were excluded. Recipients who were eligible and consented to participate were invited to complete a web-based survey. A total of 400 participants completed the survey in November 2018. When participants consented to participate in the study via the website, they were randomly assigned either to a group that received "intervention" written information or "control" written information using an algorithm included in the survey program. Because the required sample size of each group was 200 participants, recruitment stopped when the number of participants in each group had reached 200 (see Figure 1). The study was registered as a University Hospital Medical Information Network Clinical Trials Registry (UMIN-CTR) Clinical Trial (Unique trial no. 000034269) on 12 November 2018. The methods of this study adhered to CONSORT (Consolidated Standards of Reporting Trials) guidelines. The protocol was approved by the ethical review committee at the Graduate School of Medicine, University of Tokyo (No. 2018065NI). All participants gave written informed consent in accordance with the Declaration of Helsinki.

Control written information

We obtained explanatory sentences about anaerobic exercise from the websites of the Ministry of Health, Labor and Welfare (2008), and information about the effects of anaerobic exercise from the websites of the Japan Foundation for Aging and Health (2016). We combined these sentences to produce control written information containing a total of 776 Japanese characters. Appendix 1 in Supplementary Material shows the control information used in this study, which was translated into English for this report.

Intervention written information

With reference to the Patient Education Materials Assessment Tool (PEMAT; Shoemaker et al., 2013), the first author revised the control written information and created the intervention written information. Technical language was revised to everyday language; long sentences were shortened; information was ordered into a logical sequence; informative headers were added to each section; underlining was used to draw attention to key points. The content was identical between the control and the intervention information. The intervention information contained a total of 683 Japanese characters. Appendix 2 in Supplementary Material shows the intervention information, translated into English for this report.

Measures

Pre-existing interest in exercise for health. At the start of the survey, participants were asked about their interest in exercise for health on a scale from 1 to 6 ranging from "1: absolutely not interested," "2: not interested," "3: slightly interested," "4: rather interested," "5: interested," to "6: absolutely interested." Participants then read the intervention or control information about anaerobic exercise on the website.

Perceived fluency (i.e. subjective readability) and outcome measures. After reading the information, participants were asked to evaluate the following aspects: (1) subjective ease of reading the information about anaerobic exercise; (2) whether they were interested in anaerobic exercise; (3) whether they believed that anaerobic exercise is safe; (4) whether they believed that they can perform anaerobic exercise; (5) whether they believed that anaerobic exercise is effective for prevention of lifestyle-related disease; (6) whether they had a desire to attempt anaerobic exercise; and (7) whether they had a desire to make anaerobic exercise part of their daily routine. All seven of these aspects were based on those examined in previous studies (Guenther, 2012; Novemsky et al., 2007; Oppenheimer, 2006; Song and Schwarz, 2008). All participants were asked about these aspects using scales ranging from 1 to 6 from "1: strongly disagree," "2: disagree," "3: disagree a little," "4: agree a little," "5: agree," to "6: strongly agree." Aspect 1 served both as a measure of fluency (i.e. subjective readability) and as a manipulation check to verify the difference in perceived fluency of processing between the control and intervention materials. Questions 2 and 3 served as measures of perceived interest and safety, respectively. Question 4 served as a measure of self-efficacy. Question 5 served as a measure of outcome expectation. Questions 6 and 7 served as measures of intention to try a behavior and continue a behavior, respectively. Questions 2 to 7 served as outcome measures in the study.

Socio-demographic measures. In addition, participants were asked how much they initially knew about anaerobic exercise on a scale ranging from 1 to 4 from "1: never heard of it," "2: heard of it but did not know about its content," "3: heard of it and knew about its content somehow," to "4: knew it well." Participants were also asked about their experience of anaerobic exercise on a scale of 1–3 ranging from "1: no experience," "2: have experienced in the past," to "3: currently do." Participants were asked about their exercise habits in general on a scale from 1 to 3, ranging from "1: no exercise habit," "2: continue to exercise for more than 30 minutes per session twice a week for less than 1 year," to "3: continue to exercise for more than 30 minutes per session twice a week for more than 1 year." This amount of exercise is recommended by the Ministry of Health, Labor and Welfare (2017) in Japan. Finally, participants were asked about their academic background. The survey company presented token gifts to all participants on completion of the study.

Objective readability. To measure objective readability of control and intervention written information, we used a validated measure of Japanese readability called the Japanese text readability measurement system (jReadability), which was created for learners of the Japanese language (Lee and Hasebe, 2013). This measure calculates readability based on the average length of sentences, the difficulty level of words, and the proportion of grammatical parts of speech and types of characters per sentence (Lee, 2011). Scores range from 0.5 to 6.4. A high score indicates that the text is relatively easy to read: 5.5–6.4, very easy; 4.5–5.4, easy; 3.5–4.4, neutral; 2.5–3.4, a little difficult; 1.5–2.4, difficult; and 0.5–1.4, very difficult to read.

Sample size

A previous randomized controlled study (Okuhara et al., 2018), which examined processing fluency effect of written health information, showed an intermediate effect size between small and medium ($\phi = 0.184$). Based on the effect size in that study (Okuhara et al., 2018), we estimated a similar intermediate effect size between small and medium (Cohen's $d = 0.28$) in this study. Thus, we conducted a power analysis to detect an effect size (Cohen's d) of 0.28 at an alpha error rate of 0.05 (two tailed) and a beta error rate of 0.20. The power analysis indicated that 200 participants were required in each of the intervention and the control group.

Statistical analysis

Descriptive statistics were used to examine participants' socio-demographic information, their prior interest in exercising for health, their knowledge and experience of anaerobic exercise, and their exercise habits. For manipulation checks, we compared perceived fluency of processing written information between groups using two independent-samples t tests. To test our hypothesis, we compared perceived interest, safety, self-efficacy, outcome expectation, and behavioral intentions between groups using two independent-samples t tests. We conducted a sub-group analysis including only participants who had no experience of anaerobic exercise. In addition, we calculated Spearman's rank correlation coefficients between perceived fluency and outcome measures in the intervention group. These data analyses were conducted using SPSS Statistics for Windows, Version 21.0 (IBM Corp., Armonk, NY, USA).

Trial registration

The study was registered with UMIN-CTR (Unique trial no. 000034269) on 12 November 2018.

Results

Participant characteristics

As shown in Table 1, 52 percent of participants were male. The mean age was 55 years. Of the participants, 48 percent had an educational attainment level beyond college graduation. A total of 79 percent of participants were interested in exercise for health before reading the written information, while 32 percent had knowledge of anaerobic exercise before reading the written information. In addition, 42 percent of participants had experience of anaerobic exercise, and 36 percent had exercised habitually.

Manipulation check

The objective readability score calculated by jReadability was 1.1 for the control written information and 2.4 for the intervention written information. Participants' perceived fluency of processing the written information in the intervention group was higher than in the control group (mean

Table 1. Participant characteristics.

	Control (n = 200)	Intervention (n = 200)	Total (n = 400)
Sex—men (%)	50.5	52.5	51.5
Age (years), mean (SD)	55.4 (8.5)	54.7 (8.3)	55.0 (8.4)
Highest education (%)			
Less than high school	0.5	0.5	0.5
High school graduate	33.5	28.0	30.8
Some college	17.5	24.0	20.8
College graduate	43.5	41.0	42.3
Graduate school	5.0	6.5	5.8
Advance interest in exercise for health (%)			
Absolutely not interested in	3.0	2.5	2.8
Not interested in	3.5	5.5	4.5
Rather not interested in	13.0	14.5	13.8
Rather interested in	33.5	32.0	32.8
Interested in	32.5	29.5	31.0
Absolutely interested in	14.5	16.0	15.3
Advance knowledge of anaerobic exercise (%)			
Never heard of it	31.0	31.0	31.0
Heard of it but did not know its content	40.0	35.0	37.5
Heard of it and knew its content somehow	26.0	26.0	26.0
Knew it well	3.0	8.0	5.5
Experience of anaerobic exercise (%)			
No experience	61.5	55.0	58.3
Have experience in the past	24.5	22.5	23.5
Currently do	14.0	22.5	18.3
Exercise habit (%)			
No exercise habit	68.0	60.5	64.3
Less than 1 year	5.0	8.0	6.5
More than 1 year	27.0	31.5	29.3

SD: standard deviation.

(standard deviation) = 4.25 (1.01) vs 3.89 (1.14)). This difference was significant (p = 0.001).

Comparison of outcomes between groups

As shown in Table 2, participants' perceived self-efficacy in the intervention group was higher than that in the control group (mean (standard deviation) = 4.25 (1.09) vs 4.04 (0.99)). This difference was significant (p = 0.040). The observed effect size was small (Cohen's d = 0.20). Perceived outcome expectation in the intervention group was higher than that in the control group (mean (standard deviation) = 4.45 (1.01) vs 4.28 (0.97)), although this difference did not reach significance (p = 0.087). Perceived interest, safety, intention to try exercise, and intention to make exercise part of daily routine in the intervention group were higher than those in the control group, although these differences were not significant. In the sub-group analysis including only participants who had no experience of anaerobic exercise, participants' perceived self-efficacy in the intervention group was slightly higher than that in the control group (mean (standard deviation) = 4.03 (1.03) vs 4.01 (0.94)), although this difference was not significant.

Correlation between perceived fluency and outcome measures

Table 3 shows correlations between perceived fluency and outcome measures in the intervention group. Correlation coefficients ranged from 0.26 to 0.40 (p < 0.001 for all).

Discussion

This study investigated the relationship of participants' perceived fluency of processing written information about anaerobic exercise to their perceived interest, safety, self-efficacy, outcome expectation, and behavioral intention regarding the exercise. We focused on the linguistic fluency of the written health information. Both objective and subjective ease of reading of the written information were higher in the intervention group than those in the control group. Although the jReadability score of the intervention written information was 2.4, because the jReadability

Table 2. Comparison of outcomes between control and intervention groups.

Measure	Control ($n = 200$)		Intervention ($n = 200$)		p	Effect size (d)
	Mean	SD	Mean	SD		
Interest	4.13	1.09	4.18	1.14	0.654	0.05
Safety	4.08	0.94	4.16	1.03	0.417	0.08
Self-efficacy	4.04	0.99	4.25	1.09	0.040	0.20
Outcome expectancy	4.28	0.97	4.45	1.01	0.087	0.17
Intention to try	4.07	1.04	4.22	1.15	0.187	0.14
Intention to make a habit	4.03	1.09	4.10	1.18	0.538	0.06

SD: standard deviation.

Table 3. Correlation between perceived fluency and outcome measures in the intervention group ($n = 200$).

Measure	Correlation coefficient	p
Interest	0.38	<0.001
Safety	0.26	<0.001
Self-efficacy	0.30	<0.001
Outcome expectancy	0.40	<0.001
Intention to try	0.27	<0.001
Intention to make a habit	0.30	<0.001

measure is a tool for learners of the Japanese language rather than expert speakers, this result does not indicate that the intervention written information was difficult to read for native Japanese speakers such as participants in this study. Importantly, participants' perceived fluency of processing the written information in the intervention group was significantly higher than that in the control group. These findings indicate that the intervention written information was successfully designed to be more fluently processed than the control information.

Analyses comparing the control and intervention groups indicated that perceived self-efficacy in the intervention group was significantly higher than that in the control group. Thus, our hypothesis was partially supported by the study results. The findings suggested that participants may have misread the ease of processing the written information as bearing on the ease of executing the described behavior; as a result, perceived self-efficacy was significantly higher in the intervention group. Perceived fluency and outcome measures in the intervention group exhibited a weak correlation. This indicates that, as perceived fluency of processing written information increases, recipients' perceived interest, safety, self-efficacy, outcome expectation, and behavioral intention may also increase. However, although perceived interest, safety, outcome expectation, and behavioral intention in the intervention group were also higher than those in the control group, the differences were not significant. The results of the sub-group analysis were in accordance with this finding.

The reasons for these null results should be considered in comparison with previous studies of the processing fluency effect using written health information (Okuhara et al., 2018; Song and Schwarz, 2008). Our results were partially consistent with the results of Song and Schwarz (2008) who used identical instructions for an exercise printed in an easy- or difficult-to-read font. In their study, participants estimated that the exercise would take less time and feel easier when the font was easy to read. Accordingly, participants may have perceived higher self-efficacy when the font was easy to read because of the perceived speed and ease of the exercise, although the study did not measure perceived self-efficacy. In contrast to this study, Song and Schwarz (2008) demonstrated that intention to make the exercise part of daily routine was also significantly higher when the font was easy to read. The differences between the present findings and the results of Song and Schwarz (2008) may be related to the differences in experimental manipulation between the studies. Song and Schwarz (2008) manipulated perceptual fluency using Arial (easy to read) and Brush font (difficult to read). However, it is difficult to imagine that healthcare professionals would create health information in a difficult-to-read font such as Brush font. Thus, the manipulation using Arial and Brush font investigated by Song and Schwarz (2008) may be considered to be primarily of academic interest rather than contributing directly to health promotion. The study by Song and Schwarz (2008) may constitute an explanatory study in laboratory conditions (Torgerson and Torgerson, 2008). In contrast, this study used existing texts created by public institutions as a control information condition, which had been already published online for general audiences. We improved the linguistic fluency of the text, such as the difficulty of words and length of sentences, to create an intervention information condition. We adopted this manipulation for the aim of contribution to health promotion as well as scholarly pursuit because difficult-to-read health information should be revised to improve readability, as proposed in previous studies (Berland et al., 2001; Rudd et al., 2000). Thus, this study may constitute a pragmatic study (Torgerson and Torgerson, 2008). Because of this pragmatic manipulation, the contrast between the control and intervention information conditions in this study may have been less distinct than that between the laboratory manipulations used by Song and Schwarz (2008). Accordingly, perceived fluency in this study may have exerted a smaller impact on participants' responses compared with Song and Schwarz (2008).

In addition, the previous randomized controlled study (Okuhara et al., 2018) we referred to for sample size calculation in this study modified control text based on written information about cancer screening to create an intervention information condition, manipulating perceptual fluency (i.e. legibility), retrieval fluency (i.e. reducing amount of information), and imagery fluency (i.e. having recipients imagine future behavior and events) in addition to linguistic fluency (i.e. readability). For example, the intervention information in the previous study increased the amount of white space, enlarged font sizes, and used graphs and pictures and a story about a patient, in addition to using plain language (Okuhara et al., 2018). This previous study demonstrated that the cancer screening rate of the intervention group was significantly higher than that of the control group (Okuhara et al., 2018). Specifically, processing fluency significantly influenced participants' actual behavior in the previous study (Okuhara et al., 2018). Compared with the manipulation of linguistic fluency only and the null results of this study, the previous study (Okuhara et al., 2018) may indicate that improving not only linguistic fluency but also several types of fluency is more effective for encouraging a health behavior than improving a single type of fluency. However, in reality, health professionals cannot always enhance multiple types of fluency. For example, health professionals may only be able to improve the linguistic fluency of texts when they send a text message to a mobile phone, or when writing information on small pieces of paper with limited space.

The importance of readability of written health information has primarily been discussed in terms of consideration of recipients' health literacy (Nielsen-Bohlman et al., 2004). Some guidelines have been published to develop easier to read and understand health materials such as the PEMAT (Shoemaker et al., 2013), the CDC Clear Communication Index (Centers for Disease Control and Prevention, 2015), and the CDC Simply Put (Centers for Disease Control and Prevention, 2009). In addition, health professionals can use readability analysis tools to make texts more readable. For Japanese, the jReadability (Lee and Hasebe, 2013) tool uses color coding to show the readability level as well as the difficulty level of each word. Users can then improve their text's readability by simplifying difficult words. For English, readability assessment tools used in healthcare settings include the Flesch Reading Ease scale, the Flesch–Kincaid Grade, the Gunning Fog Index, the Fry Readability Graph, and McLaughlin's SMOG grading (Centers for Disease Control and Prevention, 2009; Friedman and Hoffman-Goetz, 2006). When written health information is assessed as difficult to read using these tools, health professionals can revise it using plain language, and active voice, as well as short words and sentences (Centers for Disease Control and Prevention, 2009; Friedman and Hoffman-Goetz, 2006). Health professionals can create readable and fluently processed written health information using such guidelines and tools, in consideration of recipients' health literacy.

It is particularly important to pay attention to readability of written health information in Japanese, because the language includes complex kanji (logographic Chinese characters), and health information written in Japanese often includes technical terms and kanji idioms that may be more difficult to read and understand than other types of information. Nevertheless, few studies have examined readability of the Japanese language in the health context. Although previous studies have examined the readability level of health information written in Japanese (Okuhara et al., 2016, 2017b, 2017c), no previous study has investigated the impact of readability on judgments in the health context. This is the first study to examine the impact of readability on recipients' perceived interest, safety, self-efficacy, outcome expectation, and behavioral intention regarding a health behavior in terms of perceived fluency of processing written health information. The present findings suggest that Japanese health professionals may be able to enhance recipients' self-efficacy to adopt a health behavior by creating readable and fluently processed written health information.

Several limitations of this study should be considered. First, the study adapted outcome measures from previous studies, whereas the measures of prior knowledge and experience of anaerobic exercise, and exercise habits were developed for this study. The present results should be interpreted with caution because these measures have not been validated and outcome scores may not have appropriately reflected participants' responses. Specifically, the pre-existing scales of self-efficacy for exercise asked participants to rate their confidence regarding exercise when faced with commonly cited barriers such as weather, pain, and being busy (Resnick and Jenkins, 2000; Wilcox et al., 2005). However, the question of self-efficacy in this study did not specify any constraints on the behavior. Second, this study assessed a behavioral intention rather than an actual behavior. The estimation of the mean intention–behavior correlations ranges from approximately 0.40 to 0.60 (Hagger et al., 2002; Sheeran, 2002). These gaps between intention and behavior should be considered when interpreting the study results. Third, this study assessed behavioral intention rather than actual behavior. The gap between intention and behavior should be considered when interpreting the study results. Fourth, it is unclear to what extent the present findings are generalizable to populations other than the Japanese participants in this study. Fifth, we calculated the sample size by referring to an effect size of a previous study (Okuhara et al., 2018). However, the manipulation methods and content of the written information in the previous study (Okuhara et al., 2018) were different from those used in this study. Because previous studies of processing fluency in healthcare setting are scarce, it was difficult to find an optimal previous study to refer to for the calculation of sample size. The effect size we adopted from the previous study (Okuhara et al., 2018) and the estimated sample size may have not been appropriate. Therefore, we conducted a post hoc power analysis using means and standard deviations of perceived self-efficacy in the intervention and control groups. The analysis showed that the power ($1-\beta$ error probability) was small (0.26). Each of these factors should be considered when interpreting the study results.

Conclusion

The present findings revealed that participants' perceived self-efficacy of performing an exercise for health in the intervention group (i.e. participants who were given easy-to-read information) was significantly higher than that in the control group (i.e. participants who received information that was more challenging to process). Although perceived interest, safety, outcome expectation, and behavioral intention in the intervention group were also higher than those in the control group, these differences were not statistically significant. The results of this study indicate that creating fluently processed (i.e. easy to read) written health information may be important not only for making health information comprehensible but also for increasing self-efficacy to adopt a health behavior.

Acknowledgements

The authors thank Benjamin Knight, MSc from Edanz Group (https://en-author-services.edanzgroup.com/) for editing a draft of this manuscript.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Ethical approval

The protocol was approved by the ethical review committee at the Graduate School of Medicine, University of Tokyo (No. 2018065NI).

Funding

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This study was supported by a Japan Society for the Promotion of Science KAKENHI grant (Nos 16K01752 and 19K10615). The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

Informed consent

All participants gave written informed consent in accordance with the Declaration of Helsinki.

Supplemental material

Supplemental material for this article is available online.

References

Alter AL and Oppenheimer DM (2009) Uniting the tribes of fluency to form a metacognitive nation. *Personality and Social Psychology Review* 13: 219–235.

Bandura A (2004) Health promotion by social cognitive means. *Health Education and Behavior* 31: 143–164.

Beaunoyer E, Arsenault M, Lomanowska AM, et al. (2017) Understanding online health information: Evaluation, tools, and strategies. *Patient Education and Counseling* 100: 183–189.

Berland GK, Elliott MN, Morales LS, et al. (2001) Health information on the internet: Accessibility, quality, and readability in English and Spanish. *Journal of American Medical Association* 285: 2612–2621.

Blanck AW and Marshall C (2011) Patient education materials from the layperson's perspective: The importance of readability. *Journal for Nurses in Professional Development* 27(2): E8–E10.

Centers for Disease Control and Prevention (2009) Simply Put: A guide for creating easy-to-understand materials. Available at: https://www.cdc.gov/healthliteracy/pdf/Simply_Put.pdf (accessed 1 October 2019).

Centers for Disease Control and Prevention (2015) The CDC Clear Communication Index. https://www.cdc.gov/ccindex/index.html (accessed 1 October 2019).

Claypool H, Mackie D and Garcia-Marques T (2015) Fluency and attitudes. *Social and Personality Psychology Compass* 9: 370–382.

Daraz L, Morrow AS, Ponce OJ, et al. (2018) Readability of online health information: A meta-narrative systematic review. *American Journal of Medical Quality* 33(5): 487–492.

Dohle S and Siegrist M (2011) On simple names and complex diseases: Processing fluency, not representativeness, influences evaluation of medications. *Advances in Consumer Research* 39: 451–452.

Friedman DB and Hoffman-Goetz L (2006) A systematic review of readability and comprehension instruments used for print and web-based cancer information. *Health Education and Behavior* 33: 352–373.

Gmuer A, Siegrist M and Dohle S (2015) Does wine label processing fluency influence wine hedonics? *Food Quality and Preference* 44: 12–16.

Guenther RK (2012) Does the processing fluency of a syllabus affect the forecasted grade and course difficulty? *Psychological Reports* 110: 946–954.

Hagger MS, Chatzisarantis NL and Biddle SJ (2002) A meta-analytic review of the theories of reasoned action and planned behavior in physical activity: Predictive validity and the contribution of additional variables. *Journal of Sport and Exercise Psychology* 24: 3–32.

Japan Foundation for Aging and Health (2016) Training: What is anaerobic exercise? Available at: https://www.tyojyu.or.jp/net/kenkou-tyoju/shintai-training/musanso-undou.html (accessed 1 October 2019).

Klare GR (2000) The measurement of readability: Useful information for communicators. *ACM Journal of Computer Documentation* 24: 107–121.

Laham S, Koval P and Alter AM (2012) The name-pronunciation effect: Why people like Mr. Smith more than Mr. Colquhoun. *Journal of Experimental Social Psychology* 48: 752–756.

Lee JH (2011) The utility of corpora for composing reading comprehension questions for large-scale tests. *Teaching Japanese* 148: 84–98.

Lee JH and Hasebe Y (2013) The Japanese text readability measurement system. Available at: http://jreadability.net/ (accessed 1 October 2019).

Lees FD, Clark PG, Nigg CR, et al. (2005) Barriers to exercise behavior among older adults: A focus-group study. *Journal of Aging and Physical Activity* 13: 23–33.

McGuire WJ (1985) Attitudes and attitude change. In: Lindzey G and Aronson E (eds) *Handbook of Social Psychology: Special Fields and Applications, Vol. 2* (3rd edn). New York: Random House, pp. 233–346.

McGuire WJ (2001) Input and output variables currently promising for constructing persuasive communications. In: Rice RE and Atkin CK (eds) *Public Communication Campaigns* (3rd edn). Thousand Oaks, CA: SAGE, pp. 22–48.

McGuire WJ (2013) McGuire's classic input-output framework for constructing persuasive messages. In: Rice RE and Atkin CK (eds) *Public Communication Campaigns* (4th edn). Thousand Oaks, CA: SAGE, pp. 133–146.

Mcinnes N and Haglund BJ (2011) Readability of online health information: Implications for health literacy. *Informatics for Health and Social Care* 36(4): 173–189.

Marques A, Santos T, Martins J, et al. (2018) The association between physical activity and chronic diseases in European adults. *European Journal of Sport Science* 18(1): 140–149.

Ministry of Health, Labor and Welfare (2008) *Anerobics/Anoxic Exercise*. Available at: https://www.e-healthnet.mhlw.go.jp/information/dictionary/exercise/ys-055.html (accessed 1 October 2019).

Ministry of Health, Labor and Welfare (2017) National health and nutrition survey. Available at: https://www.mhlw.go.jp/stf/seisakunitsuite/bunya/kenkou_iryou/kenkou/eiyou/h29-houkoku.html (accessed 13 December 2019).

Nielsen-Bohlman L, Panzer A and Kindig D (2004) *Health Literacy: A Prescription to End Confusion*. Washington, DC: National Academies Press.

Novemsky N, Dhar R, Schwarz N, et al. (2007) Preference fluency in choice. *Journal of Marketing Research* 44: 347–356.

Okuhara T, Ishikawa H, Goto E, et al. (2018) Processing fluency effect of a leaflet for breast and cervical cancer screening: A randomized controlled study in Japan. *Psychology, Health and Medicine* 23: 1250–1260.

Okuhara T, Ishikawa H, Okada M, et al. (2016) Readability comparison of pro-and anti-cancer screening online messages in Japan. *Asian Pacific Journal of Cancer Prevention: Asian Pacific Journal of Cancer Prevention* 17(12): 5237–5242.

Okuhara T, Ishikawa H, Okada M, et al. (2017a) Designing persuasive health materials using processing fluency: A literature review. *BMC Research Notes* 10: 198.

Okuhara T, Ishikawa H, Okada M, et al. (2017b) A readability comparison of anti-versus pro-influenza vaccination online messages in Japan. *Preventive Medicine Reports* 6: 47–52.

Okuhara T, Ishikawa H, Okada M, et al. (2017c) Readability comparison of pro-and anti-HPV-vaccination online messages in Japan. *Patient Education and Counseling* 100(10): 1859–1866.

Oppenheimer DM (2006) Consequences of erudite vernacular utilized irrespective of necessity: Problems with using long words needlessly. *Applied Cognitive Psychology* 20: 139–156.

Piredda M, Migliozzi A, Biagioli V, et al. (2016) Written information improves patient knowledge about implanted ports. *Clinical Journal of Oncology Nursing* 20(2): E28–E33.

Reber R and Greifeneder R (2017) Processing fluency in education: How metacognitive feelings shape learning, belief formation, and affect. *Educational Psychology* 52: 84–103.

Reber R and Schwarz N (1999) Effects of perceptual fluency on judgments of truth. *Consciousness and Cognition* 8: 338–342.

Resnick B and Jenkins LS (2000) Testing the reliability and validity of the Self-Efficacy for Exercise Scale. *Nursing Research* 49: 154–159.

Rudd RE, Moeykens BA and Colton TC (2000) Health and literacy: A review of medical and public health literature. In: Comings JP, Garner B and Smith C (eds) *The Annual Review of Adult Learning and Literacy*. San Francisco, CA: Jossey-Bass, pp. 158–199.

Schraw G and Lehman S (2001) Situational interest: A review of the literature and directions for future research. *Educational Psychology Review* 13: 23–52.

Schwarz N (2004) Metacognitive experiences in consumer judgment and decision making. *Journal of Consumer Psychology* 14: 332–348.

Sheeran P (2002) Intention–behavior relations: A conceptual and empirical review. *European Review of Social Psychology* 12: 1–36.

Shoemaker SJ, Wolf MS and Brach C (2013) *The Patient Education Materials Assessment Tool (PEMAT) and user's guide*. AHRQ Publication No. 14-0002-EF, August. Rockville, MD: Agency for Healthcare Research and Quality. Available at: https://www.ahrq.gov/sites/default/files/publications/files/pemat_guide.pdf

Sohal T, Sohal P, King-Shier KM, et al. (2015) Barriers and facilitators for type-2 diabetes management in South Asians: A systematic review. *PLoS ONE* 10(9): e0136202.

Song H and Schwarz N (2008) If it's hard to read, it's hard to do: Processing fluency affects effort prediction and motivation. *Psychological Science* 19: 986–988.

Song H and Schwarz N (2009) If it's difficult to pronounce, it must be risky. *Psychological Science* 20: 135–138.

Torgerson DJ and Torgerson CJ (2008) *Designing Randomised Trials in Health, Education and the Social Sciences: An Introduction*. New York: Palgrave Macmillan, pp. 76–86.

Tversky A and Kahneman D (1973) Availability: A heuristic for judging frequency and probability. *Cognitive Psychology* 5: 207–232.

Tversky A and Kahneman D (1981) The framing of decisions and the psychology of choice. *Science* 211: 453–458.

Wilcox S, Sharpe PA, Hutto B, et al. (2005) Psychometric properties of the Self-Efficacy for Exercise Questionnaire in a diverse sample of men and women. *Journal of Physical Activity and Health* 2(3): 285–297.