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Does the medium matter? Comparing the effectiveness of videos, podcasts and online articles in nutrition communication

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Abstract

Videos and podcasts have become popular in nutrition communication. However, it is unclear whether they are more effective than online texts in conveying knowledge and promoting behavioural intentions. Based on the Cognitive Theory of Multimedia Learning, it was hypothesised that videos are more effective than podcasts or texts in communicating nutrition-related information. In addition, differences in behaviour change intentions were explored. The pre-registered online experiment used a 3 (medium: video, podcast and text) × 3 (topic: diet and climate change, sugar content, and nudging) between-subjects design with 320 participants who were randomly assigned to the conditions. After receiving the respective content, the participants' intention to change their behaviour accordingly and their knowledge about all topics were assessed. A mixed Analysis of Variance revealed a significant interaction of topic and knowledge, indicating that knowledge was higher for the topic that participants were assigned to, compared to the two topics they received no information about. There were no differences in knowledge or intention for the three media. Videos, podcasts and texts are equally suitable for

conveying nutrition knowledge and may also be equally beneficial for promoting intention. Communicators may thus base their choice of medium on considerations like available resources and preferences of the target group.

KEYWORDS

digital media, healthy diet, multimedia, science communication, sustainability

INTRODUCTION

Online communication of scientific topics is becoming increasingly important. In Germany, 79% of adults use the internet to learn about science and research (Wissenschaft im Dialog & Kantar, 2021). Communication about food and nutrition related topics is increasingly taking place online as well. For instance, nutrition is frequently discussed and even showcased in social media, for example, when the self-prepared breakfast bowl is posted (Godemann & Bartelmeß, 2018). Also, nutrition experts increasingly leverage social media to convey knowledge about food and eating to facilitate behaviour change in the population. For this endeavour to succeed, it is crucial to identify effective formats of communication.

Indeed, media-based learning is one of the most common forms of knowledge transfer. Most learning media consist of texts (printed or spoken) and images (static or dynamic; Horz, 2011). The combination of these two elements is referred to as multimedia. 'Multimedia learning' thus refers to learning through the reception of images and words (Mayer, 2014a). In various studies, a multimedia effect was observed: Learning is more effective when information is conveyed via both images and words instead of via text only (Mayer, 2021). This effect is in line with two prominent learning theories, the Cognitive Theory of Multimedia Learning (CTML; 2021) and the Integrated Model of Text and Picture Comprehension (ITPC model; Schnotz, 2014). Both assume that two distinct channels are used to receive and process visual and auditory information. The capacity of each channel is limited, meaning that only a certain amount of information can be processed at once (Mayer, 2021; Schnotz, 2014). Accordingly, if information is presented by multiple channels, the likelihood of processing is increased.

In addition, numerous other principles for the design of multimedia learning materials were derived from the CTML (Mayer, 2014a) that may support knowledge acquisition. For example, the modality principle states that illustrations support learning more effectively when combined with spoken rather than written text (Low & Sweller, 2014). Written words and pictures are received through the visual channel, thus not using the cognitive capacities of the auditory channel (Mayer, 2021). Based on these principles, it can be assumed that online media may differ in their effectiveness to convey information; videos and texts with images should be more effective in supporting knowledge transfer than podcasts. Furthermore, videos with an audio track should also be more effective than illustrated texts.

Based on empirical evidence, no consistent conclusion can be drawn as to whether there are indeed differences between the media in conveying knowledge. So far, only one study has empirically investigated these assumptions by directly comparing digital texts, videos and audio recordings in the effectiveness of knowledge transfer. This study reported no statistically

significant difference in transfer of knowledge on cancer between the different media (Bader & Strickman-Stein, 2003). Other studies focussed on one or two of these media. For instance, a study comparing only videos and texts on health-related topics also concluded that the success of knowledge transfer did not differ between these two media (Wright Clayton et al., 1995); similarly, another study did not yield differences between podcasts and texts (Abt & Barry, 2007). Yet another study compared blog posts with audio podcasts on two different medical topics and found differences in effectiveness only for one of the two topics: blog posts were more effective than podcasts when toxicology was discussed, but not when asthma was addressed (Lien et al., 2018). On the other hand, differences in the effectiveness of podcasts and texts were also found by Daniel and Woody (2010), who state that texts are more beneficial than podcasts. Moreover, a number of studies indicates that video podcasts—presentations with an audio track—might be more effective in conveying knowledge than texts (Back et al., 2017; Kennedy et al., 2013, 2016).

These diverging results may be partly attributed to methodological shortcomings (Mayer, 2021). For example, in some studies, the materials created for the different media were inconsistent in content (Back et al., 2017; Kennedy et al., 2013, 2016; Lien et al., 2018). Consequently, it cannot be determined whether differences in the effectiveness can be attributed to the media per se or to different content (Mayer, 2021). If studies were conducted without control groups or pre–post assessments of knowledge (Daniel & Woody, 2010; Wright Clayton et al., 1995), it also remains unclear how beneficial the media were for knowledge acquisition.

Furthermore, it should be noted that older studies have limited validity for contemporary media. For example, since YouTube and similar platforms were established, many new video formats have emerged (Bétrancourt & Benetos, 2018). As a result, some formats, such as the video used by Bader and Strickman-Stein (Bader & Strickman-Stein, 2003), are now considered obsolete. The now higher quality of audio recordings also reduces the validity of older studies. Research suggests that good audio quality is more important in the reception of a video than its image quality (Beautemps & Bresges, 2021). Additionally, audio quality is considered the most important criterion when using a podcast (Brand, 2020). Lastly, it should be noted that only three studies provided digital texts to the participants (Back et al., 2017; Bader & Strickman-Stein, 2003; Lien et al., 2018), whereas the other studies presented participants with printed text (Abt & Barry, 2007; Daniel & Woody, 2010; Kennedy et al., 2013, 2016; Wright Clayton et al., 1995). This is critical for the present research question in that printed texts are generally read more attentively (Institut für Demoskopie Allensbach, 2020), especially because longer texts are more difficult to understand digitally than printed (Singer & Alexander, 2017). No study was identified in which materials with identical content, control groups and digital texts were used.

The present study therefore examines the extent to which there are differences in the effectiveness of knowledge transfer among online texts, videos and podcasts in nutrition communication. Based on the CTML, it is assumed that differences between the media can be identified with suitable study designs. Accordingly, multimedia learning materials such as videos or texts with illustrations should be more effective in conveying information than mono-media materials such as audio files. None of the previous studies found the audio format to be more effective compared to videos and texts, but in two studies, it was found to be significantly less effective than texts (Daniel & Woody, 2010; Lien et al., 2018). These results confirm the assumptions of the CTML. Thus, it is hypothesised that audio recordings are less effective in conveying knowledge compared to both videos and online texts. Comparisons of

video podcasts and texts suggest that the combination of images and spoken text is more effective in conveying information (Back et al., 2017; Kennedy et al., 2013, 2016), which is consistent with the CTML. Furthermore, it should be noted that the present study compares online, non-printed texts, which are generally read more superficially (Institut für Demoskopie Allensbach, 2020). For this reason, it is assumed that videos are also more effective than digital texts.

Especially in health-relevant disciplines such as nutrition, communication efforts may not only aim to inform but also to change behaviour (Ziegler & Fischer, 2020). Providing knowledge is a behaviour change technique frequently used in health behaviour interventions (see, e.g. Villinger et al., 2019, for a summary). Knowledge about beneficial and harmful behaviours can be seen as an important prerequisite of behaviour change because it contributes to intention formation via both attitudes and perceived behavioural control (Ajzen, 1991; see, e.g. Chien et al., 2018, for an empirical test). Because social media can reach large numbers of people, online communication may thus be a lever to promote behaviour change in the population via knowledge provision. The present study therefore also aimed to explore whether media differ in their effectiveness to stimulate intention formation.

Finally, to test the generalisability of the findings across different topics (Lien et al., 2018), three timely nutrition-related topics were addressed, that is, the impact of nutrition on climate via greenhouse gas emissions, sugar in food products and harnessing the influence of the environment to promote healthier food choices (nudging).

METHODS

The study was preregistered on AsPredicted.org (https://aspredicted.org/y5y56.pdf). Data and translated materials are provided on the Open Science Framework (OSF; https://osf.io/nmh8u/). The study adhered to the Declaration of Helsinki and was approved by the University of Bayreuth ethics committee.

Sample

Recruitment took place via social media. Furthermore, links were distributed via mailing lists of the University of Bayreuth and the Competence Centre for Nutrition. The link was forwarded via private contacts of the authors to students in various nutrition-related degree programmes in Germany. In addition, the study was promoted via SurveyCircle. The participants did not receive any incentives for taking part in the study.

Based on Bader and Strickman-Stein (2003), a medium effect was expected (eta-squared of 0.056); G*Power yielded a sample of $N = 207$ for 80% power and $\alpha = 0.025$ (because of two comparisons of interest) for a mixed Analysis of Variance (ANOVA), within-between interaction, using the group allocation (nine levels) as the between-subjects factor and the knowledge score (three levels) as within-subjects factor (Faul et al., 2007). Accordingly, data were collected until at least 23 participants provided complete data per group.

In total, $N = 321$ participants completed the study, but one participant was excluded because of more than 25% missing values in all variables. The final sample thus comprised $N = 320$ participants (74% female). The participants were aged 18 to 77 years ($M = 31.17$, $SD = 11.12$). Seventy-nine percent had completed the A-levels; 54% were working and 40%

in training or studying for a university degree. Eighteen percent of the participants had or were currently completing a degree related to food and nutrition, for example, nutrition science and food chemistry; 4% were working in a job related to food and nutrition, for example, farmer and saleswoman in food retail. The participants were randomly assigned to one of the nine experimental groups. The number of participants per group is depicted in Figure 1. There were no differences in the distribution regarding age, $F(8, 311) = 0.82$, $p = .582$, or gender and studies or occupation related to nutrition, χ^2s$(8) \geq 2.72$, ps $\geq .538$, as well as to school-leaving qualification, $\chi^2(40) = 44.92$, $p = .273$, and employment status $\chi^2(32) = 24.70$, $p = .818$. The participants were not evenly distributed among the groups regarding their educational qualifications, $\chi^2(56) = 81.95$, $p = .013$, Cramér's $V = .19$. Descriptive statistics per group are presented in Table S1 in the online supporting information.

Design and procedure

The experiment used a between-subjects 3 medium (video vs. podcast vs. text) × 3 topic (nutrition and climate, sugar in food and dietary behaviour) design with nine experimental groups. The dependent variable knowledge was assessed as a within-subjects factor in a quiz at the end of the survey, so that the participants served as control groups for the media and topics they were not assigned to.

The study was conducted using the online survey tool Unipark (Tivian XI GmbH, 2021). The procedure of the study is depicted in Figure 1. In short, the participants first read the study description and provided informed consent by ticking a box. They then provided demographic information and answered questions related to their attitude towards science and media consumption. After having been randomly assigned to one of the nine conditions, the participants were presented with the respective content, which they afterwards rated on several dimensions. Finally, they indicated their intention to change their behaviour accordingly and answered a brief quiz to assess their knowledge before they were debriefed.

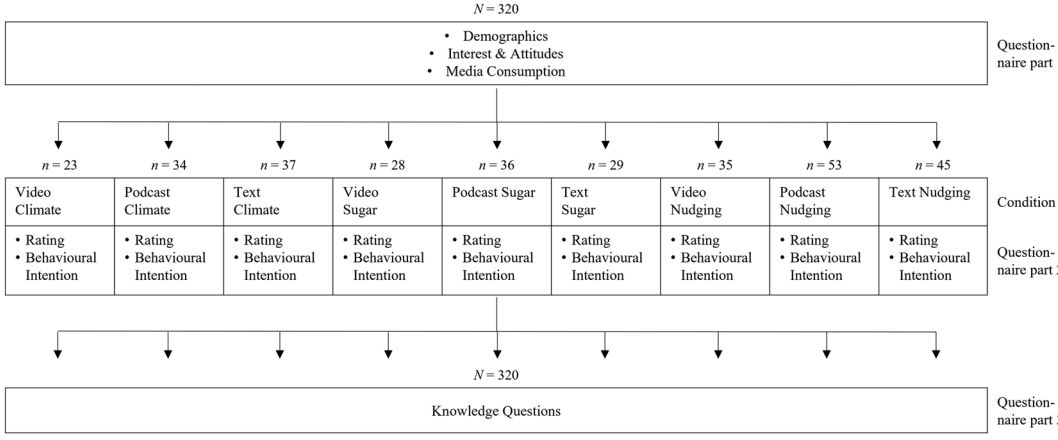

FIGURE 1 Participants per experimental group and procedure of the study

Material

Experimental manipulation

The material consisted of one video, one podcast and one article on each of the topics identified in a pilot study, where 24 participants indicated their interest in 7 different food- and nutrition-related topics and were tested in their knowledge. For the main study, three topics were chosen which were rated most interesting and showed comparable knowledge levels: the impact of nutrition on climate, sugar in foods, and the influence of nudges on eating behaviour. In the following, the topics will be abbreviated as 'climate', 'sugar' and 'nudging'. To ensure that the contributions about the various topics were comparable in terms of length, detail and presentation, all study materials were prepared by the authors. Principles for the design of multimedia learning material derived from the CTML were considered for the production. For each topic, all three media had the same content: The texts served as the video scripts, and the audio tracks of the videos were used as podcasts. To make them more engaging, the podcasts were accompanied by approximately 20-s background music during the introduction and at the end. Based on typical YouTube videos and podcast series, a logo with the slogan '9 minutes of nutrition sciences' was also designed.

Questionnaire

Interest and trust

The participants were asked to indicate their interest in the topics nutrition, health and sustainability on a 5-point-scale ('not at all', 'rather not', 'neutral', 'rather' and 'very'). The extent to which the participants have trust in science and research and interest in these topics was assessed with four items (Wissenschaft im Dialog & Kantar Emnid, 2019). For example, the participants were asked to indicate their trust in scientists and researchers at universities and public research institutions as well as in industry and business on a 5-item-scale, ranging from 'not at all' to 'fully'. Internal consistency was acceptable (Cronbach's $\alpha = .70$).

Media consumption

The participants were asked to indicate how frequently they consumed the digital media video (on portals like YouTube), podcast and online text both in general and when searching for nutrition-related information. Frequencies were listed on a 5-item scale ranging from (1) 'never' to (5) '(almost) daily'.

Evaluation of the media

After having been presented with the respective content, the participants were asked to evaluate the medium on 11 different 6-point semantic differentials ranging from 1 to 6. Four items of the User Experience Questionnaire (Laugwitz et al., 2012) were considered suitable: bad–good, unpleasant–pleasant, soporific–activating, and confusing–clear. Further items were added to assess whether the medium was interesting, high quality and attractively designed. In addition, the content was evaluated in terms of perceived reliability, respectability and trustworthiness (Pan & Chiou, 2011). Cronbach's α was calculated for all 11 items per medium. The results ranged from .93 to .95 for all groups, indicating very high internal consistency (Field, 2018).

Subsequently, the mean was calculated across ratings, which was used in the statistical analysis (see Table S2 in the supporting information).

Intention

In addition, the participants were asked to indicate their intention to change their behaviour according to the presented information (cause less greenhouse gases, eat less free sugars, and implement nudging in everyday life). For example, the participants who received information on the topic sugar had to state on a 5-point Likert scale to what degree ([1] 'fully disagree' to [5] 'fully agree') they agree to the following statement: 'I want to pay more attention to choosing low-sugar foods in the future.' Means and standard deviations per group are presented in Table S2 in the supporting information.

Knowledge questions

In the third part of the questionnaire, all subjects answered five quiz questions on each of the three topics. For example, the participants were asked where the climate-damaging methane gas is produced in agriculture. Possible answers were 'in the rearing of ruminants and rice cultivation' (correct answer), 'in the rearing of ruminants', 'in rice cultivation', 'none of the above' and 'do not know'. To process the questions, the proportion of correct answers on each topic were calculated (see Table S2 in the supporting information).

Statistical analysis

Missing data

Interest in health and sustainability, trust in science and research, and the frequency of general use of videos and general and food related use of online texts was not stated by 0.3% of the participants. Two participants (0.6%) did not indicate how often they listen to podcasts in general. On most of the items for evaluating the contribution between 0.3% and 0.9% of the answers were missing. For the knowledge questions, a maximum of 0.3% of answers were missing.

Statistical evaluation

JASP software version 0.16, IBM Statistical Package for Social Sciences Statistics version 26, and R version 4.0.3 using package car 3.0–12 were used to analyse the collected data. To rule out the possibility that any differences that might occur in the effectiveness of the media in conveying knowledge are because of divergent assessments of the quality, the evaluations of the media were compared with separate one-factor ANOVAs per topic, using the medium as the independent variable. The normality assumption was tested with Q–Q plots and the assumption of variance homogeneity with the Levene's test, $F(8, 311) = 1.02$, $p = .423$. Both prerequisites were fulfilled.

To test whether the media differed in the effectiveness to convey nutrition-related knowledge, a mixed ANOVA with the between-subjects factors medium and topic and the within-subjects factor knowledge was conducted. Because Mauchly's sphericity test was significant (Mauchly-W $= 0.89$, $\chi^2[\text{df} = 2] = 37.02$, $p < .001$), Greenhouse–Geisser-corrected values are reported ($\varepsilon = 0.90$). Significant interactions involving the within-subjects factor knowledge

were followed up by separate within-subjects ANOVAs that were again Greenhouse–Geisser-corrected ($\varepsilon_{climate} = 0.84$, $\varepsilon_{sugar} = 0.91$, $\varepsilon_{nudging} = 0.91$) because of significant Mauchly's sphericity tests (Mauchly-Ws ≤ 0.90, χ^2s[df = 2] ≥ 9.33, ps $\leq .009$). If significant, they were again followed up by paired-samples t tests.

To test whether the media differed in the influence on intention formation, a 3 topic × 3 medium ANOVA was to be conducted. However, because the Levene test indicated that the homogeneity of variance assumption was violated ($F[8, 311] = 3.06$, $p < .001$), the ANOVA was repeated in R with heteroscedasticity-consistent standard error estimators (cf. Hayes & Cai, 2007) via the 'hc3' adjustment. Significant main effects were followed up with Bonferroni-corrected paired comparisons.

Because two research questions were tested in this study, α was set to .025 for the latter two analyses.

RESULTS

Attitudes towards science and media consumption

Interest and trust

The participants showed great interest in nutrition ($M = 4.30$, $SD = 0.81$), health ($M = 4.30$, $SD = 0.76$), and sustainability ($M = 4.16$, $SD = 0.89$). They were somewhat less interested in science and research ($M = 3.80$, $SD = 0.88$). The participants tended to trust in science and research ($M = 4.20$, $SD = 0.72$) and in scientists at universities and public research institutions ($M = 4.17$, $SD = 0.76$). Trust in scientists in industry and business was lower ($M = 3.23$, $SD = 0.85$).

Media consumption

Almost all participants generally used online texts (99.4%) and videos (98.7%). Podcasts were listened to by 82.7%. More pronounced differences between media were found when the participants were specifically asked about media use in a nutrition-related context (see Figure 2). Although 95.6% of the participants stated that they generally read nutrition-related online texts, videos on nutrition-related topics were watched by 77.2% and 47.2% of the participants listened to nutrition-related podcasts. A similar distribution was found for regular media use: 72.7% stated that they regularly (i.e. at least once a month or more often) read digital texts with nutrition-related content. Videos were watched regularly by 44.7%, and podcasts were listened to regularly by 18.4%.

Evaluation of the media

A multifactorial ANOVA showed significant differences in evaluations between media, $F(2, 311) = 3.98$, $p = .020$, *partial* $\eta^2 = .03$, as well as between topics, $F(2, 311) = 8.73$, $p < .001$, *partial* $\eta^2 = .05$. No significant interaction between medium and topic was found, $F(4, 311)$

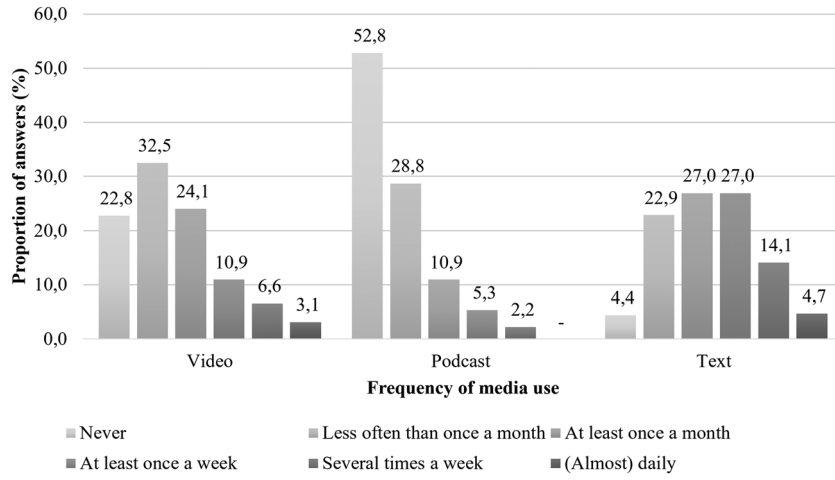

FIGURE 2 Use of digital media with nutrition-related content

$= 0.19$, $p = .945$. Bonferroni-corrected post-hoc tests revealed that the ratings of the podcasts were significantly lower than those of the videos ($p = .048$; $M_{\text{video}} = 4.78$, $SD_{\text{video}} = 0.92$, $M_{\text{podcast}} = 4.45$, $SD_{\text{podcast}} = 1.04$). No differences were found between the ratings of podcasts and texts ($p = .054$; $M_{\text{text}} = 4.71$, $SD_{\text{text}} = 0.87$) and videos and texts ($p = 1.0$). For the topics, Bonferroni-corrected post-hoc tests revealed that the topic climate was rated significantly lower than the topics sugar ($t = -3.61$, $p = .001$; $M_{\text{climate}} = 4.29$, $SD_{\text{climate}} = 1.08$, $M_{\text{sugar}} = 4.79$, $SD_{\text{sugar}} = 0.79$) and nudging ($t = -3.73$, $p < .001$; $M_{\text{nudging}} = 4.75$, $SD_{\text{nudging}} = 0.93$). No differences between sugar and nudging were found ($t = 0.17$, $p = 1.0$).

Effectiveness in conveying nutrition-related information

A mixed ANOVA revealed significant main effect of knowledge ($F[1.80, 559.07] = 49.12$, $p < .001$, *partial* $\eta^2 = 0.14$) and topic ($F[2, 311] = 47.28$, $p < .001$, *partial* $\eta^2 = 0.12$). The main effect of medium was not statistically significant ($F[2, 311] = 0.37$, $p = .690$). Furthermore, a significant two-way interaction between topic and knowledge emerged ($F[3.60, 559.07] = 45.79$, $p < .001$, *partial* $\eta^2 = 0.14$). The two-way interactions between knowledge and medium ($F[3.60, 559.07] = 4.06$, $p = .071$) and between medium and topic ($F[4, 311] = 0.56$, $p = .695$) as well as the three-way interaction between knowledge, medium and topic ($F[7.91, 559.07] = 1.75$, $p = 0.093$) did not reach statistical significance.

The significant interaction between topic and knowledge was followed up by within-subjects ANOVAs per topic. For the topic climate, the omnibus test was significant ($F[1.69, 156.90] = 30.84$, $p < .001$, *partial* $\eta^2 = 0.25$). Paired-samples t tests revealed significant differences between knowledge about climate and knowledge about sugar ($t[93] = 8.21$, $p < .001$, Cohen's $d = 0.85$; $M_{\text{climate}} = 2.90$, $SD_{\text{climate}} = 1.52$, $M_{\text{sugar}} = 1.46$, $SD_{\text{sugar}} = 0.83$) and between knowledge about sugar and knowledge about nudging ($t[93] = -5.68$, $p < .001$, Cohen's $d = 0.59$; $M_{\text{nudging}} = 2.33$, $SD_{\text{nudging}} = 1.55$). Accordingly, the participants who were assigned to a medium addressing the topic climate knew more about climate and nudging than about

sugar. For the topic sugar, no significant differences in knowledge were found, indicating that knowledge about the three topics was comparable independent of which topic the medium was about ($F[1.82, 167.66] = 0.12$, $p = .869$). For the topic nudging, the omnibus test was significant ($F[1.82, 239.64] = 91.17$, $p < .001$, *partial* $\eta^2 = 0.41$). Paired-samples t tests revealed significant differences between knowledge scores for all three topics ($t[132] \geq |5.76|$, $p < .001$, Cohen's $d \geq 0.50$, $M_{climate} = 2.92$, $SD_{climate} = 1.69$, $M_{sugar} = 1.84$, $SD_{sugar} = 0.86$, $M_{nudging} = 3.90$, $SD_{nudging} = 1.20$). Thus, knowledge of the participants who were assigned to a medium addressing the topic nudging was highest for nudging, followed by climate and sugar.

Differences in intention

A 3 *topic* × 3 *medium* between-subjects ANOVA was conducted to test differences in intention that yielded a significant main effect of topic, $F(2, 311) = 16.31$, $p < .001$, *partial* $\eta^2 = 0.10$. Bonferroni-corrected post-hoc tests revealed that the intentions to adhere to the recommendations presented in the media about nudging ($M = 3.56$, $SD = 0.97$) were significantly lower than to adhere to the recommendations about climate ($M = 3.98$, $SD = 0.96$; $p = .003$) or sugar ($M = 4.27$, $SD = 0.71$; $p < .001$). Neither the main effect of medium ($F(2, 311) = 1.28$, $p = .217$) nor the interaction was statistically significant ($F(4, 311) = 1.77$, $p = .078$).

DISCUSSION

Nutrition communication via online media is becoming increasingly popular; yet most research comparing different formats of information provision such as video, podcasts and (online) texts is relatively old (e.g. Bader & Strickman-Stein, 2003; Wright Clayton et al., 1995) and thus not in line with current practice of online science communication (Beautemps & Bresges, 2021; MacKenzie, 2019). This study therefore sought to extend previous research to provide guidance on the development of effective online communication of scientific evidence in the nutritional sciences.

Effectiveness in conveying nutrition-related information

The study's first aim was to test whether videos, podcasts and online texts differed in effectiveness to convey nutrition-related information. The assumption that videos are most effective followed by texts and podcasts was not supported. Rather, results suggest that all three media may be equally effective in conveying nutrition-related information, as indicated by a relative increase in knowledge about the topic that participants were assigned to, compared to the two topics that they received no information about. This result is in line with several studies that also reported no differences between all three media or between texts and videos or podcasts (Abt & Barry, 2007; Bader & Strickman-Stein, 2003; Wright Clayton et al., 1995).

The assumption that the media might differ in their effectiveness was based on the multimedia principle postulated in the CTML. Although numerous studies have been conducted that confirm this effect (Mayer, 2021), it is unclear to what extent these findings can be transferred

to the present study. The media used in previous studies mostly aimed to convey procedural knowledge, such as how to perform a medical treatment (Fiorella & Mayer, 2018; Mayer, 2021). The media used in the present study, however, concerned factual knowledge, such as the greenhouse gas emissions caused in food production. Furthermore, literature on the multimedia principle also mentions boundary conditions. An important prerequisite is that there is a content-related connection between text elements and images. Merely decorative images do not lead to improved learning (Schnotz, 2014), because learners spend their limited working memory capacity on irrelevant content (Mayer, 2021). This may also extend to talking-head videos that were used in the present study: If only the person speaking is visible, additional cognitive load may be created, and the focus is drawn away from the content of what is being said to the person speaking, which may hinder learning (Fiorella & Mayer, 2018; Mayer, 2014b). This assumption is supported by Boy et al. (2020), who reported that animated videos are more effective in conveying knowledge than talking-head videos. Thus, although talking-head videos are the most popular format in science communication (Beautemps & Bresges, 2021), other formats such as animated videos might be preferred; however, whether they are superior in conveying information to podcasts or online texts because of improved coupling between auditory and visual channels remains to be tested.

The findings of the present study contrast with earlier findings reporting differences in the effectiveness of videos, podcasts and texts to convey information (Back et al., 2017; Daniel & Woody, 2010; Kennedy et al., 2013, 2016; Lien et al., 2018). These studies, however, used materials that differed in content, which complicates drawing conclusions regarding media versus content effects. The present study thus aimed to create media that were identical in content, while preserving media-specific differences as much as possible (e.g. a brief jingle at the beginning of a podcast and images in an online text). We also tested for differences in the evaluation of the media to ensure that they were still positively received. Although podcasts were evaluated somewhat less favourably than videos, it is important to note that podcasts were still rated rather positively with 4.45 on a 6-point scale. This divergence in ratings may be attributed to the fact that podcasts with a single speaker are less popular (Podtail, 2022). However, it may also point towards the relative unfamiliarity of the sample with podcasts compared to online videos; more positive ratings for videos compared to podcasts could also be explained by mere exposure (Zajonc, 1968). Further, the difference between ratings for videos and podcasts can be classified as small (Cohen, 1992); it can thus be concluded that experimental manipulations were indeed comparable.

Differences in intention

Secondly, this study aimed to investigate whether media differed in their potential to elicit intention formation. Results show that the participants intended to change their behaviour according to the suggestions given, regardless of the medium they were assigned to. This is a first indication that all three media may be equally well suited to promote behaviour change via intention formation. However, it is important to note that intention was assessed between subjects and only after the media had been consumed. Further research is needed to confirm this finding, for example, using pre–post tests. It is also important to note that knowledge is not the only precursor of intention, and that the relationship between knowledge and intention may in fact be relatively weak (see e.g. Chien et al., 2018). One of the strongest predictors of intention is self-efficacy (Zhang et al., 2019); although knowledge about what to do and how to do it is of

course important, it does not determine whether a person actually feels capable of performing the required action. Furthermore, research has repeatedly demonstrated that forming an intention does not necessarily lead to enactment. In addition to knowledge provision, further behaviour change techniques thus may need to be implemented in online media to bridge this gap, for example, by promoting self-efficacy or planning (Sniehotta et al., 2005).

In addition to facilitating intention formation via increasing knowledge, it could also be assumed that different media may also induce varying levels of motivation to change behaviour. Typically, social media differ in the degree of social interaction (Kaplan & Haenlein, 2010); social support and interaction may be powerful facilitators of intention to change behaviour, as well as actual change, and are listed as primary reasons for why social media are used in the context of health communication (Moorhead et al., 2013). It is important to note, however, that the participants in this study had no opportunity to interact with the media, so the additional benefits of interaction, which may produce differential effects, are yet to be explored.

Interestingly, the participants showed a significantly lower intention to change their behaviour after receiving information about nudging compared to climate and sugar. Possibly, the content on nudging was less successful in convincing the participants that the implementation of measures can also be helpful in their daily life because the focus of the measures presented was on changes implemented in canteens and cafeterias, such to encourage patrons to make healthier food choices. In addition, criticism of the nudging concept was presented, as nudging is also discussed critically in the literature (e.g. Ewert, 2020). This may have led to a more elaborate processing of the criticism because of a recency effect (Jahnke, 1965) and thus may have reduced participants' willingness to implement the suggestions made. For the other two topics, no criticism was mentioned; support thus might have been higher.

The present study indicates the importance of taking communication theories into account when designing health behaviour interventions. To date, most research in this domain focusses on which behaviour change techniques (BCTs) to use to effectively change behaviour or its determinants; however, it also needs to be considered how these are delivered (Marques et al., 2020). Knowledge provision is one of the most frequently used BCTs in health behaviour interventions (see, e.g. Villinger et al., 2019), yet it is often ignored how the information is delivered. Integrating communication theories such as CMTL or ITPC may provide important insights into how to communicate most effectively. On the other hand, behavioural interventions need to go beyond knowledge provision because relationships between knowledge and behaviour are moderate at best (see, e.g. DONE framework, Stok et al., 2017). Health intervention research thus needs to go beyond mere communication to maximise effectiveness.

Limitations

Some limitations of the present study need to be acknowledged. First, the group of participants consisted of more women and was younger than the German national average (Statistisches Bundesamt, 2021, 2022). In addition, the individuals in the sample had a higher level of education than the general population (Maaz et al., 2020). The participants also showed somewhat higher trust and interest in science than a representative German sample (Wissenschaft im Dialog & Kantar Emnid, 2019). Furthermore, it needs to be considered that the participants

showed strong interest in nutrition, health and sustainability. Thus, the results of the present study are particularly meaningful for a young, female, well-educated target group that shows a high interest in nutrition-related topics; generalisability to other populations remains to be tested.

Second, knowledge was measured by five closed questions on each topic. This question format was chosen because the items can be evaluated objectively. However, the participants only had to recall instead of reproducing the information, which is less demanding. Furthermore, it has to be assumed that some correct answers were because of random selection. To reduce the probability of such random hits, at least three different answer alternatives were offered, as well as the option 'Do not know'. Finally, the participants filled in the quiz immediately after the exposure. It is thus unclear whether knowledge gains persist and whether some media may lead to information being retained for longer. Future research should thus test participants' knowledge again after a few weeks to overcome this limitation (e.g. Kennedy et al., 2013).

Third, creating media that were as similar as possible in terms of content and presentation might have reduced external validity of the study design. For example, the perceived ideal length of a podcast is significantly longer than 10 min (G + J Media Research, 2019), although it is recommended for educational videos not to be longer than 6 min (Findeisen et al., 2019). For the study, the length of the media was set at a maximum of 10 min, which meets neither requirement. In addition, animated videos might have been better suited to impart knowledge than talking-head videos (Boy et al., 2020). However, the latter is considered to be more popular with the audience because they usually feature recurring presenters (Beautemps & Bresges, 2021; Welbourne & Grant, 2016). To achieve the best possible knowledge transfer despite the less suitable format, the findings of CTML and Boy et al. (2020) were taken into account during production of the video material used in this study. For example, the speaker and illustrations were not shown at the same time, and the elements of a figure that were being spoken about were highlighted in colour in the video to guide attention and help the viewer to focus on relevant content (Boy et al., 2020; Mayer, 2014a).

Lastly, the nonsignificant findings need to be interpreted with caution. The study was powered to detect medium effects (cf., Cohen, 1992) based on previous findings (Bader & Strickman-Stein, 2003); small effects may thus have been missed. Accordingly, we encourage researchers to replicate the findings, either conceptually or directly using the materials that we provide on OSF.

CONCLUSION

Online texts, videos, and podcasts are popular sources of information—albeit with varying frequency. To the best of our knowledge, the study was the first comparative investigation of digital texts, videos and podcasts presenting identical content to ensure high internal validity. Results suggest that all three media are suitable for conveying nutrition knowledge and may even be equally beneficial for promoting the intention to change behaviour accordingly. Communicators may thus base their choice of medium on other considerations, such as available resources, and personal preference, as well as preferences of their target group (Schiro et al., 2020). In this vein, they may be able to counteract the spread of dubious information by providing trustworthy sources (Hirschfelder, 2018).

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CONFLICT OF INTEREST

None.

ETHICS STATEMENT

This study was conducted according to the Declaration of Helsinki; all procedures involving research study participants were approved by the ethics committee of the University of Bayreuth. Informed consent was obtained from all participants by ticking a box in the online questionnaire.

DATA AVAILABILITY STATEMENT

Data and translated materials are provided on the Open Science Framework (https://osf.io/nmh8u/).

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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