Auditory information and its parameters in health persuasion
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Chapter 9
General Discussion
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Different key aspects of the communication of a persuasive health message via the auditory mode of communication are studied in the current research. More specifically, we tested the parameters of auditory health persuasion: the conditions under which auditory persuasive information can lead to health behavior change. Two types of parameters are distinguished: Method parameters (i.e., the use of intonation, background music, source introductions, and self-referencing) and individual difference parameters (i.e., involvement and self-efficacy expectations). In the context of the current thesis, the parameters can be used to translate the intervention method into practical strategies (Bartholomew, Parcel, & Kok, 1998; Bartholomew, Parcel, Kok, Gottlieb, & Fernández, 2011; Buunk & van Vugt, 2008; Kok, Schaalma, Ruiter, van Empelen, & Brug, 2004; Kok, Harterink, Vriens, de Zwart, & Hospers, 2006). In addition, two studies compared the auditory mode with the visual mode of communication. In this final chapter, I will summarize and integrate the findings and focus on recommendations for future research and practice in auditory health persuasion.

Summary and integration of the main findings

Recipients seemed to be able to form an impression of the reliability of the source based on the voice only (Chapter 2). More specifically, this impression was probably based on perceptions of the voice (especially the extent to which it is perceived as pleasant) and the person (such as perceived similarity). In addition, the contextual factors (message framing, self-affirmation and gender matching) contributed to perceived source reliability as well. Furthermore, only message framing influenced persuasion, and this relation was mediated by perceived source reliability: Perceived source reliability may be relevant in auditory health communication, but it is not always related to persuasion.

In Chapter 3, it was aimed to gain more knowledge on the effects of voice intonation as a method parameter in auditory health persuasion. Involvement (operationalized as the perceived own health status) was identified as an individual difference parameter. Two studies consistently showed that intonation influenced the intention to increase fruit and vegetable intake: A lower intention was found after listening to the message spoken with a high level of intonation, but only in people with a good perceived health status. In addition, by showing that the intention was higher after applying a self-affirmation procedure, it can be concluded that for these recipients the low intention is related to a defensive response after a self-threat (Harris & Napper, 2005; Sherman & Cohen, 2006). Possibly, this is because the information is less relevant for them; recipients with good perceived health have less to gain from the information. The
motivation to change is likely to be lower, which is associated with a lower priority to invest in changing (Bandura, 1986, 1998). The findings indicate that the use of a high level of intonation is not always beneficial. In fact, it might be associated with unwanted side-effects, at least under certain conditions (e.g., Gélinas-Chebat, Chebat, & Vaninsky, 1996). In the process of the development of the current intervention, it will be most useful to apply health messages that are spoken with a moderate level of intonation.

The use of background music was tested as another method parameter in Chapter 4. Again, involvement (operationalized as health value) was identified as an individual difference parameter. In recipients who moderately valued their health, lower scores on intention were found after listening to the music recipients positively or negatively identified with, whereas the highest intention was reported after listening to the health message without background music. It may be that recipients who moderately value their health are not ready to invest in health behavior change and show defensive responses instead (Dijkstra & van Asten, 2014). A process of “motivated distraction” seems to better explain the results than identification processes. With regard to the development of our smartphone application intervention, it seems better to use a health message without background music.

In Chapter 5, the auditory mode of communication was compared to the visual mode of communication. Recipients either were exposed to an auditory or textual health message, or to a text stream, which means that the content information was offered in meaningful units of a few words that subsequently appeared at a fixed point on a screen for two seconds. The immediate intention and later behavior were only related to each other in the text stream condition, which has probably less opportunities to engage in defensive self-regulation (Chambliss & Garner, 1996; Pfau, Holbert, Zubric, Pasha, & Lin, 2000; van ‘t Riet & Ruiter, 2013): Only in the text stream condition, the low post-test intention was translated into low fruit and vegetable consumption. The findings show that the relationship between intention and behavior can partly depend on the “external” availability of sources for self-regulation. Although central pieces of information were better remembered (recognized) after listening to the auditory message, no differences between the auditory and textual message were reported on behavior. To further explore the effects of these communication modes, the auditory and textual message were compared to each other again in the smartphone application.

Chapter 6 provided insight into the use of source introductions in the auditory health intervention. Involvement (operationalized as health value) was again a relevant individual difference parameter. Especially when the source introduced herself as a physician - probably making the persuasive message the most threatening - differences between those scoring moderate versus high were observed. Only recipients who valued their health as top-priority seemed to benefit from listening to this tough source: The message is in line with their most important value. Again, recipients who valued health
moderately seemed not willing to invest in change, as evidenced by their lower scores on persuasion when the message was communicated by the physician. However, they were able to face the message of their in-group member, the student. Still, none of the source introductions led to significantly higher scores on intention or behavior compared to the control condition without a source introduction. Thus, in the absence of such a main effect, it will be most useful to apply health messages without source introduction in the intervention.

In Chapter 7, the effect of self-referencing is investigated as a method parameter by assessing the influence of tailoring ingredients in auditory persuasion. With regard to intention, providing feedback on the personal fruit and vegetable intake resulted in the highest intention. In addition, involvement (operationalized as the own perceived health status) was identified as a relevant individual difference parameter: Recipients who perceived the own health as good showed no differences between the conditions, whereas recipients who perceived the own health as poor lowered the intention especially after the personalized auditory information. With regard to behavior, however, perceived self-efficacy was identified as an individual difference parameter, showing that the overall fruit and vegetable intake was lower for recipients with low perceived self-efficacy. Yet, after listening to the personalization message, a high fruit and vegetable intake was found in these recipients. It may be that auditory personalization was so strong that it motivated recipients with low self-efficacy expectations to make more investments. Thus, auditory tailoring seems to be effective in some circumstances. The differential effects on intention and behavior further illustrate that the relationship between intention and behavior is complex (Sheeran, 2002; Webb & Sheeran, 2006; Sutton, 1998), also in auditory communication as demonstrated in Chapter 5.

In sum, the findings on the parameters learned us to avoid the use of a high level of intonation, background music and source introductions, as no main effects could be reported for these specific method parameters in the current studies. Yet, with regard to self-referencing as a parameter, feedback and adaptation could be used in the smartphone intervention. That is, feedback is one of the most relevant behavior change techniques in general (Abraham & Michie, 2008; Brug, Glanz, van Assema, Kok, & van Breukelen, 1998; Dijkstra, 2005, 2008) and the main effect on intention seems promising: It led to higher persuasion after a single moment of exposure, whereas recipients will be more often exposed to the feedback in the intervention. In addition, the results were inconclusive with regard to the effects of adaptation but the rationale of adaptation (Dijkstra, 2008) and the empirical evidence in textual persuasion (for example, Skinner, Strecher, & Hospers, 1994; Snyder & DeBono, 1985) is strong enough to include it in the smartphone intervention. Personalization will not be applied in the current smartphone intervention for two reasons; it will be difficult in terms of logistics to deliver these auditory personalized messages, and when taking into account the significant main effect, the
lowest score on intention was found after respondents listened to the personalized message, suggesting that personalization can be counter-effective.

Finally, the smartphone intervention was developed to compare the efficacy of textual and auditory tailored health information on fruit and vegetable intake while taking into account the findings of the earlier studies. The intervention was tested in a randomized controlled trial with a follow-up period of six months (Chapter 8). Higher fruit intake was reported after exposure to the auditory intervention, showing that auditory information as integrated in a smartphone application can change health behavior in the advocated direction. Two individual difference parameters were identified: involvement (operationalized as perceived own health status) and health literacy. The effect on fruit intake was especially found in recipients who perceived the own health as poor; for them, the auditory mode of communication did have beneficial effects up to six months later on fruit intake, possibly because they were willing to invest in their health. In addition, recipients with high health literacy reported a higher vegetable intake after being exposed to either one of the interventions, whereas recipients with relatively low health literacy reported a higher vegetable intake when not exposed to one of the interventions at all. They may not have understood the health information or have lacked the motivation to change the health behavior. All in all, we learned that the smartphone application intervention has the potential to change behavior six months later. Different conditions were identified under which the intervention was effective.

The individual difference parameters

The current research showed that the method parameters influenced persuasion in interaction with individual difference parameters. Involvement and self-efficacy expectations were identified as relevant individual difference parameters, whereas health literacy seemed to have an additional influence in the smartphone application. These moderators can be regarded as indicators of how recipients may react to threatening health information. The findings will be integrated and discussed below.

Indicators of involvement. Health information is more personally relevant to two groups of recipients with a high level of involvement: those who perceive the own health as relatively poor and those who value health as a top-priority in their lives. Both groups will be more eager to process the information and more willing to make investments to perform the behavior. Recipients with a poor perceived own health have more to gain from the information, as they can use the information to improve their own health, while recipients with a high health value prioritize health and the information is in line with their most important value. Therefore, it was initially expected that highly involved recipients are likely to change their health behavior in the advocated direction, regardless of the applied method parameters.

This is confirmed by several findings in the current thesis, for instance when in
highly involved recipients no differences between the conditions were found: Recipients for whom the information was highly relevant reported an increased intention compared to recipients for whom the information was less relevant, for instance regardless of the level of intonation and self-affirmation (Chapter 3). In addition, the highly involved reported an increased intention or fruit and vegetable intake after being exposed to the health information that may have induced the strongest threat; they did not seem to get defensive easily. This was the case when the information was accompanied with negative identification music (Chapter 4), when the source was introduced as a physician (Chapter 6) and when they were exposed to the rich and immediate auditory information in the smartphone application (Chapter 8). These findings indicate that highly involved recipients are willing to invest more effort to change the behavior. An exception refers to the low intention that was found after listening to the personalization message (Chapter 7). The perceived level of threat may have been too high in this specific condition, which may have contributed to a defensive response, and therefore, a low intention. Such a reaction to personalization has also been found in highly involved smokers towards a textual message on the negative consequences of smoking (Dijkstra, 2014), and it is in line with personalization being a strong tailoring element that needs to be applied in a careful way (Dijkstra & Ballast, 2012).

In contrast, the information is less relevant (or not relevant enough) for recipients with a low level of involvement. For those who perceive the own health already as relatively good the information indicates less benefits of fruit and vegetable intake, while for those who value health moderately the information is not in line with the most important value; they have others values to work on. Both groups have less to gain from the information and lack a certain motivation or readiness to change (e.g., Braverman, 2008). They have a lower priority to make investments to change their health behavior. Therefore, defensive processing of the information can be expected in recipients who are not highly involved (Dijkstra & van Asten, 2014; Pietersma & Dijkstra, 2011). This was confirmed by the defensive response after listening to a message with a high level of intonation (Chapter 3), and the pattern of findings of Chapters 4 and 6. However, this was not found when testing the effects of self-referencing (Chapter 7) and the smartphone application (Chapter 8): The low involved recipients did not show differential responses between conditions that translated into persuasion. It may be that levels of threat were insufficient to motivate behavior change.

Based on dual-pathway models of persuasion (e.g., elaboration likelihood model; Petty & Briñol, 2012; Petty & Cacioppo, 1986, heuristic systematic model; Chaiken, Liberman, & Eagly, 1989), the characteristics of the voice and speech can be conceptualized as peripheral cues that activate heuristics. In the most extreme case, based on these models it could be expected that high involved recipients would be persuaded especially by the content information, and therefore would show no
differences between the conditions. They use the central route of information processing and show no defenses towards persuasive health information using strong arguments. Furthermore, low involved recipients would be persuaded by the contextual information and show differences between conditions (the method parameters): They might use the peripheral route of information processing. It also could be reasoned that low involved recipients would show more behavior change after listening to auditory information, compared to reading textual information. That is, auditory information consists of more rich information in terms of peripheral cues (e.g., voice characteristics; Braverman, 2008; Chebat, El Hedhli, Gélinas-Chebat, & Boivin, 2007), whereas high involved recipients may want to elaborate on the content information by re-examining the information, which is less possible while listening to auditory information (Chambliss & Garner, 1996). However, this pattern for low and high involved recipients was not found when we compared the efficacy of the communication modalities in Chapters 5 and 8 of the current thesis.

In most studies, our measurement of involvement did not lead to the expected differences between low and high involved recipients in the perspective of dual-pathway models of persuasion. It may be that there were no clear and consistent effects for low and high involved recipients because of the nature of auditory information processing. Within dual-pathway models of persuasion, the voice and speech characteristics are characterized as the peripheral cues of the information, to be processed via the peripheral route of information processing, whereas the content information is processed via the central or systematic route. However, in auditory communication, the content information and the voice and speech characteristics are processed simultaneously, from the beginning to the end. The source is now represented by the voice of the messenger, which cannot be distinguished from the content information. Thus, the content information and the peripheral cues are integrated in mental images (D'Esposito et al., 1997): The words as well as the voice and speech contribute to the quality of the mental image. For instance, the findings reported in Chapter 3 suggest that a threatening message spoken with a high level of intonation (peripheral information) may make the consequences of a certain health behavior (central information) seem more severe. Indeed, research shows that peripheral information can bias central processing, leading to more or less persuasion (see Levin, Nichols, & Johnson, 2000).

Besides the dual-pathway models of persuasion, another perspective is offered by the unimodal of persuasion (Kruglanski & Thompson, 1999), which does not make an explicit distinction between two routes of information processing. Rather, it is reasoned that recipients are persuaded by cues of the message that match with personal premises of the recipient, without the distinction between central and peripheral cues. Instead of the voice or source as a peripheral cue, it is now treated as information that may match with a personal premise that can lead to persuasion, for example, “when a doctor talks
about fruit and vegetables, low intake must be related to serious conditions”. This is an interesting issue to take into account in the current research (see for instance Chapter 6). All in all, dual-pathway models seem not a very strong explanation of the effects of involvement that were found in our studies.

In the present context, it is also important to distinguish between subjective and objective involvement. In studies testing the dual-pathway models of persuasion, involvement is most often operationalized as objective involvement: Low involvement means that the topic of persuasion is objectively irrelevant or does not apply to the personal situation of the recipient. For instance, a student recipient is thought to be highly involved in the case of an increase in tuition fees at the own university, or low involved in the case of an increase in tuition fees at a university at the other side of the country. However, in the domain of health this is different. That is, health is objectively relevant for everybody, and, therefore, health information is objectively relevant for everybody. Furthermore, although a recipient may consume sufficient fruit and vegetables according to guidelines, this does not mean that the recipient finds the topic irrelevant. Similarly, a recipient may consume insufficient fruit and vegetables according to guidelines, but this does not mean that the recipient finds the topic not personally relevant. Therefore, the involvement measures that were used here are measures of value-involvement, defined as the association between the topic of the persuasive information (health) and the recipient’s value (Eagly, 2007; Johnson & Eagly, 1989; Pietersma & Dijkstra, 2011): Perceived own health and health value. With regard to the latter measurement, another aspect of involvement in the domain of health stood out: Almost all people do value health as they know that it is objectively relevant for them. Therefore, we distinguished between moderate (but not low) and high health value (Dijkstra, 2014; Dijkstra & van Asten, 2014; Pietersma & Dijkstra, 2011). The robustness of the effects of involvement in the present studies is further indicated by the fact that statistical analyses were controlled for objective and subjective measurements of fruit and vegetable intake (when possible).

**Self-efficacy expectations.** Perceived self-efficacy is identified as a moderator in testing the effect of self-referencing as a method parameter by means of tailoring ingredients (Chapter 7). It refers to perceived behavioral control, or the perceived capabilities to engage in the advocated health behavior (Bandura, 1986; Conner, Norman, & Bell, 2002; Kreausukon, Gellert, Lippke, & Schwarzer, 2012) and it was here operationalized as the extent to which the behavior is perceived as difficult to perform (de Vries, Dijkstra, & Kuhlman, 1988; Webb & Sheeran, 2006).

Recipients with low self-efficacy expectations can experience difficulties in performing and maintaining the behavior and may not see the possibility to change the health behavior in the advocated direction. Therefore, people with low perceived self-efficacy will not easily change their behavior and they may even be more inclined to react
defensively when confronted with threatening information. In Chapter 7, indeed, lower scores on fruit and vegetable intake were found for this group. Yet, recipients with low perceived self-efficacy reported an especially high fruit and vegetable intake after listening to the personalized message; a message that can be expected to result in a high threat. Their reaction was not in line with our initial expectations, but it may be that the auditory personalization was so strong for this group that central processing was instigated that penetrated the defenses recipients originally had (Block & Williams, 2002; Dijkstra, 2014). The resulting threat must have led to the willingness to make more investments to change.

Recipients with high self-efficacy expectations do experience less difficulties in performing the behavior and perceive they can act according to the persuasive health information. The results showed that recipients with high perceived self-efficacy did not show defensive responses after being exposed to the threatening information. They were persuaded evenly high regardless of the application of tailoring ingredients. In addition, this finding confirms the theoretical assumption that a threat can lead to behavior change, but only when people have a sufficient level of self-efficacy expectations (Maloney, Lapinski, & Witte, 2011; Witte, 1992, 1994).

Health literacy. When testing the effects of the smartphone application in a community sample, health literacy was found to moderate the effects on vegetable intake (Chapter 8). It was assessed by the perceived ease or difficulty to understand health information in general (for instance, from a physician). Recipients with lower health literacy reported a lower vegetable intake after being exposed to the health information, either the auditory or the textual, whereas recipients with high health literacy reported a higher vegetable intake after being exposed to the auditory or textual health information. It is not immediately clear why people with relatively low health literacy (given the highly educated sample) consumed significantly less vegetables after being exposed to the app. This finding suggests that the app was not inert for these people, meaning that other factors than the (in)ability to understand the information could have played a role. Although health literacy was not significantly related to our measurements of involvement (or self-efficacy), recipients with low health literacy may have a lower motivation to change the health behavior in the advocated direction. Thus, health literacy may not only refer to a cognitive ability but also to a general reluctance to process health information. Besides a motivational construct (Nutbeam, 2000, 2008), health literacy may also be related to suboptimal health beliefs, more negative attitudes towards health behaviors and less perceived possibilities to self-regulate the persuasive health information (Federman, Wisnivesky, Wolf, Leventhal, & Halm, 2010). Based on the results we cannot draw any firm conclusions with regard to the underlying processes in people with low health literacy. It is however important to unravel the construct of health literacy (also in oral forms of health communication; Rubin, 2012) and increase knowledge on how
people with low health literacy can be stimulated to increase fruit and vegetable intake, especially as low health literacy is associated with poor health outcomes (Möttus et al., 2014; Norman & Skinner, 2006).

**The complex role of threat**

Based on the findings in the current thesis, it seems that specific individual differences may influence persuasion under specific conditions. However, we do not know on forehand what individual difference will influence persuasion in a specific situation. That is, the influence of individual differences depends on the level of physical and self-threat as perceived by the recipient. This threat is an essential and complex mechanism in the current research; it is the motive to engage in health behavior change in the first place (Tesser, Crepaz, Collins, Correl, & Beach, 2000; van ‘t Riet & Ruiter, 2013). The threat appraisal is influenced by the method parameters (how is the information presented in terms of intonation, background music, source presentations and tailoring mechanisms) and the individual difference parameters (level of involvement and perceived self-efficacy). Yet, the relative differences in threat between the different conditions remain unknown in the current research. That is, there is no standard against which differences in threat potential of manipulations can be judged. For example, it is unknown whether an auditory health message communicated by the physician as a source is 10% more threatening or 50% more threatening than the no-source message. In a psychological model in which it is expected that these manipulation will lead to different levels of threat, the assessed level of threat may even depend on the sample composition (e.g., the amount of recipients with a high health value). Thus, the extent to which messages are threatening is largely an empirical issue; on forehand, it is unknown how the threat is perceived in a specific population and when the threat becomes too high and may lead to defensive responses (van ‘t Riet & Ruiter, 2013). The basic lack of insight into absolute levels of threat and the influence of the sample on the level of threat shows the complexity of the research and practice of (auditory) persuasion.

In the following paragraphs, I will reflect on some remaining relevant issues that are typical for the present research. These issues concern the nature of the auditory communication, the context of persuasion and our measures of fruit and vegetable intake and intention.

**Auditory communication**

In auditory communication, the voice is the most important means to communicate the content information, which consists of voice and speech characteristics that may consequently influence source evaluations and persuasion (e.g., Chattopadhyay, Dahl, Ritchie, & Shahin, 1999; Chebat et al., 2007). It is reasoned that auditory health information is perceived as more threatening as it includes richer information and it is
more immediate. Because of the latter, the auditory information may seem to be more personally addressing the recipient (Chaiken & Eagly, 1983; Jensen, Farnham, Drucker, & Kollock, 2000), which means that auditory presented information is self-referencing to a certain extent. In addition, when auditory information is presented through headphones it may even create a more intense listening experience compared to listening through speakers (Kallinen & Ravaja, 2007). These aspects make it plausible that auditory persuasion has unique effects, and that theories and findings regarding textual persuasion may not apply to auditory persuasion. However, most studies of the current thesis were not developed to contrast the auditory mode with other communication modes, but to learn on the effects of auditory health persuasion under different conditions to develop an auditory app to be used in the practice of large scale health promotion.

Throughout the current studies, we only used a small selection of unique voices, which limits the generalizability of the findings. In all chapters, a female voice was used; only in Chapter 2 a male and female voice were used, but no clear gender effects could be reported. Although people mostly can accurately assess whether the speaker is male or female (Wolfinger & Rabow, 1997), in these studies gender was not a relevant aspect of perceived similarity between the speaker and the recipient, and the gender matching variable presented in Chapter 2 did not influence persuasion either (although a gender match did lead to higher perceived reliability). Yet, one might expect differences between listening to a male and female voice. For instance, characteristics of (wo)men might activate certain stereotypes that can transfer to the content of the message and therefore can influence persuasion (i.e., a female voice might be associated with caring, security and warmth; Ko, Judd, & Blair, 2006). In addition, it has been found that the communication of health information by a female voice (but not a male voice) was associated with the identification of more risks for both male and female listeners, particularly when the content was female-stereotyped (Dearborn et al., 2006).

Besides the gender of the messenger in auditory persuasion, the gender of the recipient might also make a difference: Male and female recipients might respond differently towards persuasive health information. For instance, men may have different goals and expectations, and they may perceive the information in another context compared to women: Men tend to react more defensively towards persuasive health information, possibly because they are more likely to take risks and deny potential vulnerability (Courtenay, 2000; Emslie & Hunt, 2008). Possibly, the influence of our method parameters may work out differently for men and women. However, in the current studies, we did not take this matter into account. To deal with the specificity of the voice, “prototypical” voices were selected that did not contain any possible distracting elements. The benefit is that the differences between our studies cannot be attributed to large differences in voices. Further research is needed to study the influence of common idiosyncratic elements of human speech on persuasion.
Perspectives on persuasion

Throughout the empirical chapters of the current thesis, recipients were exposed to persuasive health information on the topic of fruit and vegetable intake. Besides increasing our knowledge on the processes involved, we primarily aimed to change health behavior in the advocated direction. Thus, in the development of the persuasive health messages, arguments were selected to convince recipients on the positive effects of fruit and vegetable intake. This is common practice in, for example, health persuasion with regard to alcohol consumption or smoking in which only the benefits of reducing alcohol consumption and quitting smoking are addressed. In the context of fruit and vegetable intake, these positive arguments can refer to the prevention of chronic diseases (Boeing et al., 2012; WHO, 2003) and being part of a nutritional pattern aimed to reduce weight or stay healthy (van Kreijl, Knaap, & van Raaij, 2006).

Although the potential health benefits of fruit and vegetable intake are well-known and generally outweigh the potential negative outcomes by far, negative outcomes of fruit and vegetable intake do exist as well. For example, more balanced persuasive information might include information about the magnitude of the positive effects and about potential risk factors of disproportionate consumption of fruit (juices) and vegetables. That is, robust, but only small protective effects of fruit and vegetable consumption have been found on specific types of cancer (WCRF/AICR, 2007) and a disproportionate consumption of fruit (juices) can be a potential risk factor for dental health problems (Jarvinen, Rytomaa, & Heinonen, 1991; Moynihan & Petersen, 2004), and diabetes type II (Bazzano, Li, Joshipura, & Hu, 2008). Furthermore, it is important to recognize that recipients may have worries with regard to the exact health benefits of fruit and vegetables, for example because they may contain less nutrients than in the past or they may have been treated with pesticides (Petrie et al., 2001).

When the persuasive information aims to support people to make a balanced decision themselves, for instance in a health education context, it may be appropriate to acknowledge that both objectively positive and negative arguments exist. In addition, a one-sided approach of persuasion (as is used in the current studies, and which is similar to the health communication by national health institutions) is aimed to persuade recipients to increase their fruit and vegetable intake. Therefore, scientists need to provide information about the effectiveness of interventions and about the (positive and negative) effects of fruit and vegetable intake, while it is up to policy-makers to select the types of interventions for public health purposes.

Fruit and vegetable intake

The research presented in the current thesis focused solely on fruit and vegetable intake, referring to a common health behavior that comprises an important aspect in general dietary patterns. Nowadays, it is also a behavior that is or should be performed
'to prevent the onset of a health problem' (Rothman & Salovey, 1997, p. 9), and it needs a certain investment to create the actual health benefits. This means that our findings cannot be automatically generalized to other health behaviors that are illness-detecting (i.e., screening behaviors), or unhealthy behaviors that have strong (hedonic) functions (e.g., smoking or high-caloric food intake).

Furthermore, we used a continuum to measure fruit and vegetable intake, which means we did not assess it in the perspective of a guideline. Guidelines for fruit and vegetable consumption differ across the world and are subject to change; for instance, most current recommendations take into account that fruit and vegetable juice and apple sauce (a common Dutch product) are sweetened. We included these products in our measurement of behavior for the sake of consistency. Only in Chapter 8 the category of fruit and vegetable juice was excluded, as this category did not allow us to distinguish between fruit and vegetable intake.

We regarded (the intention to increase) fruit and vegetable intake as an aggregated measure as is often done in current dietary guidelines and research. However, no particularly high correlations between the perceived intake of fruit and the perceived intake of vegetables were found (for instance, ranging between .23 to .45 across the studies in Chapter 4-7), and in Chapter 8, different effects on fruit intake and vegetable intake were reported. It can be reasoned that fruit and vegetable intake are markedly different behaviors, for example with regard to taste, preparation and culinary uses (Trudeau, Kristal, Li, & Patterson, 1998). That is, fruit is mostly consumed at breakfast or as a snack throughout the day and it does not need a lot of preparation. In general, it takes more time and different tasks and capabilities to prepare vegetables, that are mostly consumed as a part of dinner. In addition, the perceived ease of changing the intake of fruit or vegetables may differ (Pietersma & Dijkstra, 2011). This is in line with the finding of the influence of health literacy on vegetable intake (and not on fruit intake, Chapter 8): It may be that people with low health literacy find it especially difficult to increase their vegetable intake as it demands multiple behaviors. Thus, the different qualities of fruit versus vegetable consumption may be associated with different underlying psychological processes to be targeted in health interventions, which can translate into differential effects on fruit intake and vegetable intake (Chapman & Armitage, 2012).

On forehand, we did not hypothesize differential effects of the smartphone intervention on fruit intake and vegetable intake. It is argued that the differences between the effects on these behaviors may be caused by the follow-up period: In our earlier experiments with found effects on fruit and vegetable intake as an aggregated measure, the follow-up period was mostly two weeks, compared to the six-month follow-up period in the smartphone intervention. As proposed in the Health Action Process Approach (Schwarzer, 2008), different structures of motivation can play a role in health behavior
change. It may be that on the short term the obstacles that people face to consume more vegetables (e.g., preparation, cooking techniques) are overcome by a strong motivation; the promise to prevent illness. However, on the longer term the actual experience with vegetable meal preparation may become more important. In addition, in fruit consumption, with its fewer obstacles, this longer term process may be different compared to the processes in vegetable consumption.

**The measurement of intention.** Intention is often expressed as ‘the most immediate and important predictor of a person’s behavior’ (Sheeran, 2002, p. 1), also in the context of fruit and vegetable intake (Conner, Norman, & Bell, 2002; Pietersma & Dijkstra, 2011). In the current research, the intention regarding fruit and vegetable consumption is operationalized (with at least two and maximally six items) as the extent to which one is planning and/or the likelihood to start performing the behavior: Respondents were asked to report their intention to start eating more fruit and vegetables, at pre-test as well as at post-test. This formulation may seem especially relevant for recipients who consume insufficient fruit and vegetables. That is, people who do already consume enough fruit and vegetables may score low on this intention because they do not intend to eat more than enough. Thus, low scores on our measurement of intention can reflect different interpretations by recipients.

The different interpretations are caused by the participants’ perceptions of the own fruit and vegetable intake. These were assessed at pre-test (“Is your fruit intake sufficient?”), and “Is your vegetable intake sufficient?”). This perception of one’s own intake was positively correlated ($r = .64$, $p < .001$) with the objective (self-reported) fruit and vegetable intake as indicated at pre-test, also within specific conditions (this could only be tested in Chapter 7). In most studies, we controlled for this variable when analyzing the results on intention or behavior, thereby neutralizing possible effects of differences between the conditions in the distribution of this variables. More importantly, we checked the influence of the perception of the own fruit and vegetable intake on the outcomes of conditions by conducting the main analyses in two chapters (4 and 5) only in recipients who subjectively reported eating either insufficient fruit or vegetables. The results in this subsample were very similar to the effects in the sample including the recipients who thought they consumed sufficient fruit and vegetables. This suggests that the formulation of our intention measures (“eating more fruit and vegetables”) did not have a strong influence on the results, probably because recipients who think they eat sufficient fruit and vegetables often might still be motivated to increase their intake and may report a high intention regardless of the formulation of the question. However, the intention measures as used in the current research are not optimal and need to be revised to increase its relevance to all recipients.

Furthermore, intention is assessed within different timeframes (one month, six months, and five years), as is suggested by Ajzen (1988) and as has been done in
previous research in which this format was the strongest predictor of subsequent behavior during a period of eight months (Dijkstra & den Dijker, 2005). Within the current research, the effects across the different studies were not always found on all timeframes. That is, the composition of the specific sample will influence which timeframes effects will be found. For instance, in a low motivated sample a low intention to change within one month may be reported, leading to a left-skewed distribution when only this timeframe would be taken into account. On the other hand, in a more motivated population a right-skewed distribution might be found with regard to the one-month time-frame. Therefore, multiple timeframes were included in the intention measure.

**The relationship between intention and behavior.** In Chapter 5, 6, and 7, both intention and behavior were taken into account as outcome measures. In all three studies, differences on behavior were found, independent of the results on intention. To increase our knowledge on the relationship between intention and behavior, post-hoc correlational analyses were performed while taking into account three relevant covariates: pre-test intention, the own perceived health and the subjective fruit and vegetable intake. No significant correlations between intention and behavior were found within these three samples (r ranging from -.16 to .16).

In two studies, the correlations could be analyzed within the specific conditions (in Chapter 6, the number of recipients per condition was too small, \(n \leq 18\)): As reported in Chapter 5, the correlation between intention and behavior was only significant when recipients were exposed to the text stream (\(n \geq 42\) per condition: \(r = .37, p < .05\)). This was explained by the absence of “external” self-regulatory opportunities when exposed to the text stream: This may have modified or lowered the use of self-regulatory defenses. Furthermore, a marginally significant correlation of similar magnitude between intention and behavior was found in the personalization condition (Chapter 7, \(n \geq 24\) per condition: \(r = .39, p < .10\)). The combination of the auditory mode, which is relatively direct and self-referring, and personalization, which explicitly addresses the recipient, may have penetrated emotion-regulation processes (Dijkstra, 2014), thereby also influencing the use of self-regulatory defenses.

These findings can be seen in the perspective of other research showing that the intention-behavior relationship may depend on moderating factors (conditions) that can facilitate or hinder health behavior change (Cooke & Sheeran, 2004; Sheeran, 2002; Schwarzer, 2008). Further research is needed to unravel the processes of self-regulatory defenses and the intention-behavior relationship. For instance, the findings in Chapter 5 cannot be automatically generalized to other situations, as a negatively framed message with a high level of intonation was applied here. Finally, the correlations within the remaining conditions of the two studies as reported above were non-significant (ranging from -.03 to .23). Given the non-significant correlation between intention and behavior
when an auditory message was presented (in Chapter 5), this finding is not unexpected. In general, the inconsistency between intention and behavior has been widely recognized as the intention-behavior gap (Sheeran, 2002; Webb & Sheeran, 2006).

Our measure of intention reflects a reaction to a threat as immediately assessed after being exposed to persuasive health information. This immediate intention informs us on the process of self-regulating threatening health information in auditory persuasion. Possibly, when recipients can perform the behavior immediately after the formulation of a high intention, this may automatically translate into behavior (Bargh & Chartrand, 2000). However, the exact processes of change after the formulation of an initial intention are hard to assess: After the experimental setting in which the intention was formed, the intention may change once the recipient is at the supermarket or at home, and it may be affected by experiences of personal barriers, by memories, by implementation intentions, social norms or self-efficacy expectations. In the smartphone application intervention we aimed to take these factors into account by designing repeated exposure and repeated activation of knowledge and intentions, and tailoring the content information to personal barriers and beliefs (Chapter 8). All in all, our research showed that a formulation of an immediate intention mainly reflects a reaction to threatening health information, and intention and behavior become related under circumstances in which external sources for self-regulation are less available to the recipient. By taking into account the intention to increase fruit and vegetable intake, we learned about the processes involved in auditory health persuasion.

**Theoretical and practical implications**

The current research increased insight into the processing of auditory information, a widespread phenomenon in our daily lives, for instance while listening to the radio and having telephone conversations. We asked ourselves the practical question how we could develop an effective intervention to increase fruit and vegetable intake, with the use of behavior change techniques (Abraham & Michie, 2008), the Intervention Mapping protocol (Bartholomew et al., 1998, 2011; Kok et al., 2004) and the PATH-model (Buunk & van Vugt, 2008). Auditory persuasion is investigated from different points of view by taking into account the influence of method parameters and individual difference parameters, as specified in our model of auditory persuasion. Eventually, this helped us to gain understanding on the conditions under which auditory health information can lead to persuasion and for whom. For instance, providing feedback on the own fruit and vegetable intake increased the intention. Furthermore, negative findings with regard to the parameters of auditory information processing were found as well; for instance, a high level of intonation lead to a lowered intention in low involved recipients, and background music and source introductions did not seem to have beneficial effects in auditory health persuasion. These specific research findings as well as our broader
experience with auditory communication in these studies have been essential in the development of the smartphone application intervention.

Although we focused on the main behavior change techniques available and we took into account some of the most relevant parameters of auditory health information, the current research does not claim to provide a systematic test of the method parameters or the individual difference parameters. The model of auditory persuasion presented in the introduction of this thesis was used to design research on important aspects of auditory persuasion to be tested. The research was not designed to test the model. For example, it is assumed that the appraisal of threat plays an important role in auditory persuasion processes, but at the same time we did not measure any of these influences directly. This means we explored the relationship between aspects of auditory health information (such as voice characteristics) and persuasion (instead of threat). We hope to inspire further research to study the interplay between the perceived threat and the (method and individual difference) parameters under which auditory health information may lead to health behavior change.

The test of our smartphone application can be regarded as the most important practical implication of the (experimental) studies. Effective behavior change techniques were applied, such as persuasion and argumentation, based on psychological determinants of fruit and vegetable intake (Guillaumie, Godin, & Vézina-Im, 2010). In the current thesis, method parameters and individual difference parameters were tested to develop practical strategies to include in the smartphone intervention. Other practical strategies were applied that were not explicitly tested but that were added to create a coherent intervention package. For instance, to increase perceived self-efficacy, recipients received information about skills and relevant practical tips. Finally, the efficacy of the smartphone application intervention was tested, as reported in Chapter 8. The actual implementation of the smartphone intervention to promote fruit consumption within a larger societal health promotion context may be a next step. In the following section, I will briefly address new directions for future research and practical recommendations.

**Future studies and recommendations.** Listening to information via smartphone applications is widely accepted, which enhances the possibilities to implement it as an intervention in diverse settings, such as the workplace, neighborhood and health care services. Yet, it remains a challenge to develop smartphone applications that people keep using within the personal routine of using apps, as people tend to spend most of the time of online activities in top-ten smartphone applications (TNS NIPO, 2012). Even in our scientific study in which incentives were applied to stimulate people to use the smartphone application, only 44.5% of the research participants finished the post-test questionnaire, and on average participants logged in 7.6 times during the 6 months period. Outside the research context these numbers on the actual use of smartphone health applications can be expected to be substantially lower (Comstock, 2014; Evers,
Cummins, Prochaska, & Prochaska, 2005). Thus, getting people to install the application, visit it, return to it, and follow its recommendations, is presently a main issue with regard to Internet-delivered interventions (Brouwer et al., 2011; Crutzen et al., 2008).

To build effective interventions that are actually used, the collaboration in a multidisciplinary team with technologists, scientists and health professionals is essential. In general, scientists aim to include the elements that are effective for health behavior change, but they lack the knowledge on how technological aspects can be applied. This is where the technologist can complement the capabilities and knowledge of the scientific psychologist (e.g., what is technologically possible with regard to communicating reminders to recipients). Both perspectives need to be integrated to be able to use the ground rules that are necessary to develop an effective smartphone application intervention.

Another step to be made in the development of future smartphone applications to stimulate health behavior change is to ensure an increased level of interactivity. This is in line with the elementary basis of interactive information systems, such as persuasive robots, that may serve as online coaches and that can interact more directly with the recipient, while making use of the same relevant ground rules as our smartphone application. Furthermore, these robots may use auditory input, they may observe natural cues such as gazing (Ham, Cuijpers, & Cabibihan, 2015) and they might adjust their level of intonation while speaking to ensure more fluent conversations with recipients. These are prospective challenges for future research in this area of (health) persuasion and behavior change.

Furthermore, based on the findings in Chapter 8 it seems relevant to explore how the smartphone application can be effective for people with low health literacy, as both the auditory and textual intervention led to a lower vegetable intake. It is important to gain more knowledge on which intervention characteristics possibly could have contributed to this negative effect, in order to discover how these people may benefit from a smartphone intervention as well. Until now, no magic bullet has been found to communicate health information to “hard to reach” groups (Santo, Laizner, & Shohet, 2005). As our experiments were mainly conducted among student recipients with a high educational level, it is recommended to keep doing further research on effective behavior change techniques for vulnerable groups, such as people with low health literacy or a low socio-economic status.

To conclude, the current research helped us to improve our understanding on the processes of auditory forms of health communication. In addition, the smartphone application intervention contributed to an important element of health behavior change, and showed that auditory information can have beneficial effects in specific segments of users. To stimulate people to eat more healthily, it seems promising to include auditory forms of health persuasion in integrated policies, not only because it can be effective,
but also because people are used to be exposed to auditory information in our society today. In the future, novel technological applications for health behavior change can be expected, with an increased use of interactive and more fluent auditory communication. Furthermore, scientists in the field of health communication and persuasion are stimulated to focus on effective behavior change techniques in vulnerable groups of people as well. All these efforts, including the efforts invested in the present dissertation, aim to gather knowledge on our world to find possible ways to support behavior change.