RESEARCH ARTICLE

Examining the Extended Parallel Process Model for communicating about cardiovascular disease to an at-risk population utilising a think aloud methodology [version 1; peer review: 1 approved, 1 approved with reservations]

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Abstract

Background: Previous research has raised a number of questions about the core propositions of the Extended Parallel Process Model (EPPM). Very few previous examinations of the model have included qualitative assessments.

Methods: The current study utilised a mixed method approach to experimental test EPPM-based threat-to-efficacy ratios in health risk messages about CVD and the associated health behaviours among older adults (60+ years) who would be at an alleviated risk of CVD. The current focus is on the qualitative aspect of this assessment and utilised a think aloud methodology in order to gain greater insight into participants’ thinking and problem-solving processes when presented with EPPM-based communications about cardiovascular disease (CVD). 24 participants (4 per group; Female = 14; Age, $M = 74.38, SD = 7.16$) were randomly assigned to one of six EPPM threat-to-efficacy ratio CVD message groups.

Results: A thematic analysis was conducted, and the important themes were those of different threat perceptions for varying CVD manifestations (heart disease versus stroke), and the role of comparative (versus personal) threat and efficacy perceptions for all participants. The difference between threat appraisals for stroke versus other CVD manifestations was a novel finding.

Conclusions: For the EPPM and other theories of health risk and decision-making, the impact of comparative risk and social examples for individual threat and efficacy perceptions needs to be counted.

Keywords
Extended Parallel Process Model, Cardiovascular disease, Health communication, Think aloud, Older populations
This article is included in the Ageing Populations collection.

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Introduction

Extended Parallel Process Model

The Extended Parallel Process Model (EPPM; Witte, 1992; Witte, 1994) has been posited as a theory for assessing cognitive and emotional mechanisms that occur in reaction to fear communications about health. Interactions between the levels of perceived threat, perceived efficacy and fear experienced by the individual in response to the health message will determine if the individual partakes in danger control or fear control processes. Danger control processes are cognitive-based and encourage the individual to engage in changes to attitudes, intentions and behaviours, as the individual is consciously thinking about the threat and furthermore, the active ways that they can deal with that threat (Witte et al., 1996). Fear control processes are more emotion-based, possibly resulting in defensive avoidance, denial and reactance, and are most likely to happen when an individual perceives a high level of threat but low levels of efficacy (Witte, 1992; Witte, 1994).

A number of gaps have been identified within the literature on the EPPM: none of the core theoretical propositions of the EPPM have received complete support, there are inconsistencies between the level of examination given to each proposition, there is a lack of operational definitions for the ‘critical point’ and what constitutes a ‘true control’, and a lack of in-depth experimental assessments of the model processes (Maloney et al., 2011; Ooms et al., 2015; Popova, 2012). When assessing illnesses and their related health behaviours, further complications can arise as inconsistent results could be attributed to potential differences in the specific illnesses and health behaviours (Rimal, 2001).

Think aloud

Think aloud methodologies, in line with protocol analysis (Ericsson & Simon, 1993, Ericsson & Simon, 1998), have been used across a range of diseases and health behaviours, in order to better understand information and decision-making processes for individuals in relation to their health (Anderson-Lister & Treharne, 2014; French & Hevey, 2008). Furthermore, it has been used by researchers to aid in the development of the most effective in-person and online health communications (Backlund et al., 2004; Hopmans et al., 2014). Utilising a think aloud methodology, Bonner et al. (2014) examined the possible differences between presenting CVD risk information as “heart age” compared to 5-year percentage risk based on the Framingham risk equations within online CVD risk calculators. The study found that in spite of high levels of misinterpretation and confusion among the older (40 – 67 years) participants for the risk factor questions based on both formats the information included in the calculator did encourage individuals to begin thinking about lifestyle changes for living a more heart-healthily life.

Furthermore, a recent think aloud investigation found that adults with Type 2 diabetes reacted with a range of cognitive and emotional processes while working through an online CVD risk factors programme (Nolan et al., 2015). A contrast was noted between patients depending on pre-existing beliefs before completing the calculator. Those who reported more optimistic pre-existing beliefs compared to the information included in the calculator expressed more feelings of worry and anxiety while reading the information, and those who reported less optimistic pre-existing beliefs in comparison to the information included in the calculator, expressed more feelings of cheer and encouragement (Nolan et al., 2015). Similar think aloud methods have emphasised the role of positive emotional reactions, increases in awareness, and contemplation of behaviour change for communications about CVD and the associated health behaviours among older populations (Bonner et al., 2014; Nolan et al., 2015; Luger et al., 2014). Such investigations have provided greater insight into the influencing factors that can impact the effectiveness of EPPM-based communications for various diseases and populations, as think aloud methods allow researchers to see how participants react to the threat and efficacy messages in the moment that they encounter them.

Older populations

Among older populations, the EPPM has been used to examine communicating information about CVD, cancer and influenza vaccination (Leung et al., 2016; McKay et al., 2004). For CVD, McKay et al. (2004) provided limited support for the EPPM for communicating about CVD associated behaviours. Prati et al. (2012) utilised two messages about influenza vaccination, both based on the EPPM and including measures of social threats and trust, in order to assess if didactic or narrative formats of communications were more effective. In an Italian sample of older (65+ years) adults, no significant differences between the two message groups in their perceived risk, perceived efficacy and intentions to get the flu shot were found. It should be noted that the authors did not measure levels of fear, which may have shown differences between the message formats. However, the didactic group reported higher risk perception compared to the control group, and the narrative based group reported higher risk perception and higher efficacy compared to the control group (Prati et al., 2012). Additionally, the study found results to support the importance of social factors on perceptions, intentions and vaccine acceptance. Similar results were found by Smith and colleagues (2007) from HIV/AIDS messages among Namibian residents. It should be noted that both studies included measures of social threats and trust due to the possible confounding effects of such on the particular health threat under investigation (e.g., HIV/AIDS messages among Namibian residents and influenza vaccination messages among older individuals), rather than as a component of the EPPM.

Objective

Given the lack of clear theoretical definition around a number of the EPPM’s core propositions and the fewer number of qualitative assessments of the EPPM, the current study utilised a mixed method approach to experimental test EPPM-based threat-to-efficacy ratios in health risk messages about CVD and the associated health behaviours among older adults (60+ years) who would be at an alleviated risk of CVD. This article is focused on the qualitative aspect of this assessment and utilised a think aloud methodology in order to gain greater insight into participants’ thinking and problem-solving processes when presented...
with EPPM-based communications about cardiovascular disease (CVD). In line with EPPM propositions (Witte, 1992; Witte, 1994), it was expected that participants in the “standard” and “overload” message groups would process the equal components of threat and efficacy information included in the messages, and therefore, consider more danger-control processes. Furthermore, due to receiving more threat than efficacy information, it was expected that those in the “low efficacy” and “high threat” groups would consider more fear-control processes.

Methods

Design

A between-groups design was utilised and participants were randomly assigned to one of six EPPM threat-to-efficacy CVD message groups: 1) “standard” message with 1/1 threat-to-efficacy ratio, 2) “low efficacy” message with 1/0 threat-to-efficacy ratio, 3) “low threat” message with 0/1 threat-to-efficacy ratio, 4) “high efficacy” message with 1/2 threat-to-efficacy ratio; 5) “high threat” message with 2/1 threat-to-efficacy ratio; and 6) “overload” message with 2/2 threat-to-efficacy ratio. A think aloud procedure was utilised.

Ethical considerations and consent

Ethical approval for this study was obtained from the Trinity College School of Psychology Research Ethics Committee and participants provided written informed consent before participating.

Participants

A convenience sample was recruited in line with the demographic characteristics of the population of interest. The only inclusion/exclusion criteria were that participants had to be 60 years of age or older, and with English language proficiency. Recruitment and testing took place between February and August 2016. A large number of ageing and volunteer organisations, active retirement groups, Men’s Shed groups, GP office and church parishes were contacted, and asked to share information about the study with their members. The researcher’s contact details were included in the information, and potential participants were asked to contact the researcher. After being provided with further information about the study, if potential participants wanted to take part in the study, a testing session was arranged for a time convenient to them. Informed consent was obtained from potential participants before testing began.

After examining examples from previous research utilising similar think aloud procedures (Bonner et al., 2014; Nolan et al., 2015), a sample size of 12 to 18 was the initial aim. There is no specific formula for calculating sample size in think aloud qualitative approaches. The goal of qualitative research should be the attainment of saturation. However, as the research design included six groups, four participants per group were recruited ($N = 24$, Female = 14; Age, $M = 74.38$, $SD = 7.16$). This was done in order to allow adequate confidence in the results and trends noted within the data across the six message groups. See Table 1 for sample characteristics of participants split across the six EPPM threat-to-efficacy CVD message groups.

Materials

The EPPM-based threat-to-efficacy ratio messages were compiled using CVD risk information from Irish Heart Disease Awareness, the Irish Heart Foundation, the United Kingdom National Health Service (NHS), and the Changing Cardiovascular Health: National Cardiovascular Health Policy 2010–2019.

Table 1. Self-reported medical history and health behaviour information for think aloud sample.

| Medical History | Standard | Low Efficacy | Low Threat | High Efficacy | High Threat | Overload |
|-----------------|----------|--------------|------------|---------------|-------------|----------|
| CVD: Personal History |          |              |            |               |             |          |
| Yes             | 3 (75%)  | 3 (75%)      | 2 (50%)    | 1 (25%)       | 2 (50%)     | -        |
| No              | 1 (25%)  | 1 (25%)      | 2 (50%)    | 3 (75%)       | 2 (50%)     | 4 (100%) |
| CVD: Family History |          |              |            |               |             |          |
| Yes             | 1 (25%)  | 3 (75%)      | 2 (50%)    | 1 (25%)       | 2 (50%)     | 3 (75%)  |
| No              | 3 (75%)  | 1 (25%)      | 2 (50%)    | 3 (75%)       | 2 (50%)     | 1 (25%)  |
| On-going Health Issues |          |              |            |               |             |          |
| Yes             | 3 (75%)  | -            | 3 (75%)    | 3 (75%)       | 1 (25%)     | 3 (75%)  |
| No              | 1 (25%)  | 4 (100%)     | 1 (25%)    | 1 (25%)       | 3 (75%)     | 1 (25%)  |
| Depression/Anxiety |          |              |            |               |             |          |
| Yes             | 1 (25%)  | -            | 1 (25%)    | -             | 2 (50%)     | -        |
| No              | 3 (75%)  | 4 (100%)     | 3 (75%)    | 4 (100%)      | 2 (50%)     | 4 (100%) |
| Do not want to answer | -        | -            | -          | -             | -          | -        |

CVD – Cardiovascular disease
published by the Department of Health and Children (2010). While information relating to the associated health behaviours was taken from the SLAN 2007: Survey of Lifestyle, Attitudes & Nutrition in Ireland: Main Report (Morgan et al., 2008) and the Changing Cardiovascular Health: National Cardiovascular Health Policy, 2010–2019 (Department of Health and Children, 2010). The amount and format of the information was changed so that the six varying ratios of threat and efficacy information could be achieved, with messages containing either zero, one or two components of threat and efficacy information. The structure for the messages was based on the EPPM and the example of Carcioppolo et al. (2013). Six different versions of the EPPM-based CVD messages were created, depending on the amount of threat and/or efficacy information included: 1) “standard” message with 1/1 threat-to-efficacy ratio (i.e., one piece of threat information and one piece of efficacy information), 2) “low efficacy” message with 1/0 threat-to-efficacy ratio, 3) “low threat” message with 0/1 threat-to-efficacy ratio, 4) “high efficacy” message with 1/2 threat-to-efficacy ratio; 5) “high threat” message with 2/1 threat-to-efficacy ratio; and 6) “overload” message with 2/2 threat-to-efficacy ratio (see Table 2).

Measures
At the beginning of each testing session, participants completed a demographics, medical history and health behaviours questionnaire (see extended data (Hevey & Moylett, 2019)) designed by the authors for the specific purposes of the study. This scale had received psychometric validation prior to the study’s commencement. Details of the sample’s health behaviour profile are presented in Table 3.

Furthermore, after reading the EPPM-based CVD message, participants were asked to complete the Risk Behaviour Diagnosis (RBD) scale (see extended data (Hevey & Moylett, 2019)). The scale was adopted from the validated RBD scale (Witte et al., 2001), to assess perceived threat severity and susceptibility of CVD, perceived response and self-efficacy in terms of the associated health behaviours (e.g., smoking, eating healthily and physical activity), and reactions to the health messages.

Procedure
All sessions were conducted in testing rooms within the university and audio recordings were taken. The anonymised audio recordings and transcripts are stored in password-protected files on a password protected computer and in a locked filing cabinet in a locked office in the University. In line with the University policy, the data are stored in a secure location with access limited to the researchers and will be kept for the data will be stored securely for 10 years. Recording began when participants were given the demographics, medical history and health behaviour questionnaire to complete. After completing this questionnaire, participants were presented with one of the six EPPM-based CVD risk messages. Participants were given the following instruction before reading the EPPM-based CVD risk message: “Please read and consider the following health information about cardiovascular disease. Please read the message aloud and ‘think aloud’ any of your thoughts as you do so. Say aloud anything that comes to mind as you read the health information.” If participants needed further instructions, they were given the following: “What I mean by ‘think aloud’ is that you say aloud anything that comes to mind as you read the message and while answering the questions.” If participants became quiet, they were prompted to “keep talking”.

After reading the EPPM-based CVD message, participants were asked to complete the RBD scale. Participants were given the following instructions before beginning the questionnaire: “As you are completing the questionnaire, please say aloud each question and then ‘think aloud’ your thoughts as you give your answer – why are you answering the way that you are?” If participants became quiet, they were prompted to “Keep talking” or asked, “Why did you answer that way?” Once participants had completed the RBD scale, the recording was stopped, they were debriefed, and thanked for their participation. Testing sessions varied in length from 15 to 30 minutes.

Analysis
A thematic analysis was conducted in accordance with the steps outlined by Braun & Clarke (2006) and taking into consideration the guidelines of Yoder & Simmonds (2010) for developing coding frameworks. The recordings of each participant were transcribed verbatim. Transcriptions were segmented, in accordance with think aloud procedures (Ericsson & Simon, 1993), into six main sections based on the procedure of the study. As participants read the CVD message and each question out loud before responding, segmentation was unproblematic.

Based on an in-depth reading of the first think aloud session and the main concepts of the EPPM, a number of preliminary themes were selected as a starting point for the thematic analysis. However, coders were instructed to remain open to new and emerging themes (Braun & Clarke, 2006). Microsoft Excel 2016 was utilised for data management. After initially transcribing and coding two transcriptions each, a meeting was organised between the two coders to compare the data, both within and across themes. Following in-depth discussion of the preliminary themes and participants’ data, themes were subsequently refined, created, and deleted as needed. The final coding framework developed in a flexible manner (Braun & Clarke, 2006), based on the theoretical concept of the EPPM and what could be identified within the data itself through the trained coders’ experience and knowledge (Alasuutari, 1996), and therefore, themes emerged in an inductive and deductive manner. This coding framework was then applied to all 24 transcriptions.

The transcriptions of three participants were coded by both coders utilising the final coding framework and were analysed in order to determine inter-coder agreement (over 20% of the data in accordance with previous guidelines; Bakeman & Quere, 2011; Hallgren, 2012). Cohen’s κ was run using SPSS v.23 to determine agreement between the two coders on their administration of the final coding framework. Strong agreement was found between the two coders, κ = 0.825, p < 0.001.

Results
Findings were consistent across message groups, and it was not possible to differentiate between the groups in terms of their danger- and fear-control processes, and therefore, their threat and
### Table 2. Extended Parallel Process Model (EPPM) threat-to-efficacy ratio messages.

#### 1/1 Ratio (“Standard” message)

**Please read and consider the following health information about cardiovascular disease:**

*Men and women over the age of 60 years are susceptible to cardiovascular disease (CVD).*

- Cardiovascular disease (CVD), which includes stroke and heart diseases such as heart attacks, is the single largest cause of death in Ireland, with 1 in 4 people dying from heart disease or stroke.

**Cardiovascular disease, as well as causing death, has serious health consequences.**

- Risk factors for cardiovascular disease include lifestyle factors such as unhealthy eating, smoking, drinking alcohol, and physical inactivity, as well as high blood pressure, high blood cholesterol, and diabetes.

**Preventing CVD can be extremely easy.**

- Maintaining a healthy body weight, eating healthily, taking part in physical activity, reducing salt intake, refraining from or quitting smoking and consuming alcohol responsibly can all significantly reduce the chance of getting cardiovascular disease.

**There are many things you can do to protect yourself against cardiovascular disease.**

- You can control your risk of heart disease by following a heart-healthy lifestyle through maintaining the following five healthy lifestyle habits:
  1. Eating a healthy diet
  2. Being physically active
  3. Limiting your alcohol intake
  4. No smoking
  5. Managing and coping with stress

#### 1/0 Ratio (“Low efficacy” message)

**Please read and consider the following health information about cardiovascular disease:**

*Men and women over the age of 60 years are susceptible to cardiovascular disease (CVD).*

- Cardiovascular disease (CVD), which includes stroke and heart diseases such as heart attacks, is the single largest cause of death in Ireland, with 1 in 4 people dying from heart disease or stroke.

**Cardiovascular disease, as well as causing death, has serious health consequences.**

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  4. No smoking
  5. Managing and coping with stress

#### 0/1 Ratio (“Low threat” message)

**Please read and consider the following health information about cardiovascular disease:**

*Men and women over the age of 60 years are susceptible to cardiovascular disease (CVD).*

- Cardiovascular disease (CVD), which includes stroke and heart diseases such as heart attacks, is the single largest cause of death in Ireland, with 1 in 4 people dying from heart disease or stroke.

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- Cardiovascular disease, as well as causing death, has serious health consequences.
  - Risk factors for cardiovascular disease include lifestyle factors such as unhealthy eating, smoking, drinking alcohol, and physical inactivity, as well as high blood pressure, high blood cholesterol, and diabetes.

Preventing CVD can be extremely easy.

- Maintaining a healthy body weight, eating healthily, taking part in physical activity, reducing salt intake, refraining from or quitting smoking and consuming alcohol responsibly can all significantly reduce the chance of getting cardiovascular disease.
- Many of the deaths caused by cardiovascular disease were premature because those people were not aware they had heart disease, which could have identified early and learned to manage well over time. Past research has found that 90% of heart disease cases are completely preventable by modifying diet and lifestyle factors.

There are many things you can do to protect yourself against cardiovascular disease.

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  1. Eating a healthy diet
  2. Being physically active
  3. Limiting your alcohol intake
  4. No smoking
  5. Managing and coping with stress

No matter what your age, you can take matters into your own hands to help reduce your risk of cardiovascular disease. You're never too young – or too old – to take care of your heart. Even small, basic steps based on the five healthy lifestyle habits above can go a long way toward reducing your risk of heart disease.

Please read and consider the following health information about cardiovascular disease:

Men and women over the age of 60 years are susceptible to cardiovascular disease (CVD).

- Cardiovascular disease (CVD), which includes stroke and heart diseases such as heart attacks, is the single largest cause of death in Ireland, with 1 in 4 people dying from heart disease or stroke.
- In 2008, cardiovascular disease accounted for 9,883 (35%) of all deaths. Of these, 5,188 were due to heart disease, 2,116 due to stroke and 2,579 due to other cardiac-related diseases.
- Cardiovascular disease, as well as causing death, has serious health consequences.
  - Risk factors for cardiovascular disease include lifestyle factors such as unhealthy eating, smoking, drinking alcohol, and physical inactivity, as well as high blood pressure, high blood cholesterol, and diabetes.
  - The personal burden of heart failure is great, with patients experiencing high levels of physical, functional and emotional distress. Life expectancy for patients with chronic heart failure has been shown to be poorer than for most of the common cancers.

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Table 3. Reported health behaviours for the think aloud sample (n per group = 4).

| Health Behaviour                        | Standard Efficacy | Low Efficacy | Low Threat | High Efficacy | High Threat | Overload |
|-----------------------------------------|-------------------|--------------|------------|---------------|-------------|----------|
| **Eating Habits**                       |                   |              |            |               |             |          |
| I don’t pay any attention to what I eat |                   |              |            |               |             |          |
| Sometimes I take up a healthy diet because I feel guilty, but eventually I always go back to my previous eating habits | -                 | 1 (25%)     | 1 (25%)    | -             | -          | 2 (50%)  |
| I usually watch what I eat but sometimes I like to treat myself | 3 (75%)           | 2 (50%)     | 2 (50%)    | 3 (75%)       | 4 (100%)    | 2 (50%)  |
| I always watch what I eat and my diet is very healthy | 1 (25%)           | 1 (25%)     | 1 (25%)    | -             | -          | -        |
| **Exercise**                            |                   |              |            |               |             |          |
| Exercise for the suggested amount      | 1 (25%)           | 1 (25%)     | 2 (50%)    | 2 (50%)       | 2 (50%)     | 1 (25%)  |
| Exercise for more than the suggested amount | 2                 | 3 (75%)     | 1 (25%)    | 1 (25%)       | 2 (50%)     | 2 (50%)  |
| Exercise for less than the suggested amount | -                 | -           | 1 (25%)    | 1 (25%)       | -          | -        |
| Do not exercise                        | 1 (25%)           | -           | -          | -             | -          | -        |
| **Alcohol consumption**                |                   |              |            |               |             |          |
| Drink the suggested amount of alcohol  | -                 | -           | 1 (25%)    | 1 (25%)       | -          | -        |
| Drink more than the suggested amount of alcohol | 1 (25%)           | 1 (25%)     | 1 (25%)    | 1 (25%)       | -          | 2 (50%)  |
| Drink less than the suggested amount of alcohol | 2 (50%)           | 3 (75%)     | 1 (25%)    | -             | 3 (75%)    | 1 (25%)  |
| Do not drink alcohol                   | 1 (25%)           | -           | 1 (25%)    | 2 (50%)       | 1 (25%)    | 1 (25%)  |
| **Smoking Status**                     |                   |              |            |               |             |          |
| Current smoker                         | 1 (25%)           | -           | -          | 1 (25%)       | -          | -        |
| Ex-smoker                              | 3 (75%)           | 3 (75%)     | -          | 1 (25%)       | 2 (50%)    | 2 (50%)  |
| Never smoked                           | -                 | 1 (25%)     | 4 (100%)   | 2 (50%)       | 2 (50%)    | 2 (50%)  |

a Exercise recommendation: Adults take part in moderate activity or exercise for at least 30 minutes a day on 5 days a week (or 150 minutes a week).
b Alcohol recommendation: Men should drink less than 21 units of alcohol per week and that women should drink less than 14 units per week.

efficacy perceptions. The most salient findings from the themes of threat and efficacy are presented.

**Threat**

In general, interviewees reported high threat perceptions of CVD, as displayed quite succinctly by one interviewee when discussing the susceptibility of CVD:

*I suppose we all think we’re at risk. *(Interviewee 07, Overload)

However, what follows is a presentation and description of the main findings that arose from the think aloud interviews that can give further insight and greater understanding of the factors impacting these high threat perceptions.

**Personal versus comparative threat.** Interviewees were asked about their personal and family history of CVD within the demographics, medical history and health behaviours questionnaire, along with their personal and comparative threat perceptions of CVD within the RBD scale (see extended data (Hevey & Moylett, 2019)). It was noted that the majority of interviewees brought up comparative examples when discussing general information about CVD, as well as the personal and comparative aspects of such. There was a considerable lack of personal discussion of CVD and its impact. Although interviewees did discuss their own CVD problems when asked and in response to the measures of personal susceptibility and severity, a large number of interviewees drew on examples or comparisons from their family, friends and general references to ‘others’ throughout the testing session. Before being asked about comparative susceptibility and severity, while reading the information about CVD in the EPPM-based risk message, interviewees irrespective of which message group they had been randomly assigned to, consistently raised examples from family or friends to discuss threat perceptions of CVD.

*Seen friends and, around me who, who, who are aligning as well and other, other ways and some of them have eh cardio, cardiovascular eh problems. *(Interviewee 02, High Efficacy)

*There is a lot of people after getting stents in. *(Interviewee 10, High Efficacy)*
The majority of comparative perceptions were used to highlight the prevalence of CVD and the large number of friends and/or family that either had symptoms of CVD, were on medication or had received treatment for such, and/or died due to CVD. One interviewee in particular used a comparative example of CVD in order to anchor their own personal threat perception:

When you hear of somebody having things like that you kind of go oh, I don’t want that to happen to me. (Interviewee 03, High Threat)

Susceptibility due to aging. A common trend among interviewees was a general susceptibility to health problems due to aging. Interviewees discussed their awareness of aging and inevitable death; however, they did not discuss this in relation to CVD specifically. A number of references were made to thoughts and awareness of aging, and only one interviewee expressed a negative feeling (e.g., dread) towards such:

When you get to 77 you, you would be conscious of a lot of things. (Interviewee 06, Low Efficacy)

Because I mean talking to people again of my own age, like we’re, we all dread, we don’t know how we’re going to finish up and we’d see some of our, some of our friends, the way they’re: you know, the problems that they have had. (Interviewee 18, Standard)

Comparisons were made by two interviewees to when they were younger, and the differences now in their health awareness as they get older. One interviewee did express a feeling of regret in relation to not taking action sooner to prevent the level of treatment currently needed to control CVD symptoms:

I suppose that, that, the age I am now I’m, I’m more, I’m more health conscious…. I’m a little more em, more, em, a little, I’ve more time for me to think about me [sic] health. (Interviewee 02, High Efficacy)

I suppose if I had’ve been, in my younger years if I had have taken more heed of things, you know, that I should have been doing I mightn’t be on so many tablets. (Interviewee 05, Low Threat)

Following on from such, it was noted that two interviewees expressed how the awareness of aging was impacting on their motivation for self-care and in carrying out health behaviours. Increases in awareness due to aging were linked to greater motivation to take part in the associated health behaviours so as to avoid early death and have a longer life:

So you have to decide yourself do you want a long life? It’s up to you to do it…. Once you get to a certain age you, have to look after yourself more…. I don’t want to go yet, an awful lot of living to do still…. I understand that if I don’t exercise, if I don’t do, you know, have the healthy diet, I’m not going to live very long. (Interviewee 15, Low Efficacy)

The fear of being a burden or causing disruption to family members due to the inevitable health outcomes of aging was a common thread among the interviewees:

Well I live on my own… I’ve no-one. I don’t want us to be a burden to anybody. You’ve probably heard that phrase before. No I, I, it would pose a problem because I am very independent. (Interviewee 11, High Threat)

You would need somebody to look after you, em, and em, my husband now, he’s coming up to 70 and all my family, they’re all rearing their young children, so I would hate to put, em, responsibility on to them. They’re in the throes of leading their own life and rearing children and I do think about it, I do. (Interviewee 12, Overload)

Differences in threat perceptions

A key finding from the interviewees was the difference in threat perceptions of different CVD manifestations, in particular for stroke versus other CVD manifestations. Interviewees compared stroke to other CVD manifestations and expressed strong dislike and negative emotional reactions to the former:

I don’t like stroke. I don’t like it. I don’t like the immobility and the dignity that you lose. Heart attacks don’t frighten me as much. (Interviewee 04, Overload)

Thoughts of having a stroke would make anyone nervous. (Interviewee 14, Standard)

I don’t mind, well, I won’t say don’t mind, but if you have a heart attack in my view, you either live or die. A stroke can be like my aunt, a living death. So I’m much more scared about a stroke; than I am about a heart attack. (Interviewee 17, High Threat)

Along with the lack of fear of heart attacks versus strokes, two interviewees discussed the benefits of death from an immediate cardiac event versus a stroke:

It’s, it’s, [pause] to tell you the truth now I’m going to be eighty-one in September, am I bothered now what takes me? It would be a nice quick way to go. (Interviewee 22, Low Threat)

In fairness a few advantages of it, you know, sudden death isn’t too bad either. (Interviewee 23, Overload)

The difference in threat perceptions for stroke and the strong negative emotional reactions were linked to interviewees’ perceptions of the consequences of a stroke. Similar to their discussion of general CVD threat perceptions, interviewees drew on comparative examples of family and friends to explain such:

I would say for anyone really who’s after having their health and to be struck down with either heart or em, a stroke, a stroke is, can be very debilitating. (Interviewee 12, Overload)

Well like course you could be left an invalid, you could be left a stroke, you could, you know…. A stroke comes on like a twitch in the night…. The thoughts, now frightening, the very thoughts are very frightening at the thoughts of it. (Interviewee 14, Standard)

Coupled with the fear of being a burden due to aging, interviewees emphasised the considerable impact of a stroke on their
own personal functionality, with one interviewee using the word “immobilised” (Interviewee 04, Overload) to describe the consequences of a stroke, and what that would entail for family members:

You would hate, you would hate to take a stroke and you would be left as eh, somebody, trouble to somebody. (Interviewee 10, High Efficacy)

Well, yeah, but they won’t think in terms of a heart attack. They will think in terms of having a stroke because it makes, people have problems afterwards, you see, you would think more of a heart attack as goodbye. (Interviewee 24, High Efficacy)

Two interviewees discussed examples from interactions with medical professionals where this stark difference in threat perceptions for stroke versus other CVD manifestations was utilised as a motivating factor for medical adherence:

Doctor [name] is my cardiologist at the [hospital]... but I remember asking him one time could I come off Warfarin. He said, “You could, but I regard it as a principle defence against a stroke.” (Interviewee 17, High Threat)

I don’t like taking tablets and I sort of half sort of said [to the doctor], “Are you sure I have to take these?” And he said, “No, no, you needn’t bother, you can go home and have a stroke.” So that, that was just the jokingly way he put it to me. (Interviewee 24, High Efficacy)

Efficacy
As with threat perceptions, interviewees in general reported high levels of efficacy for the associated health behaviours. A similar trend was reflected for the majority of interviewees, as encompassed by the following quote from one individual:

I’m pleased to say that I think I do look after myself with exercise and the fact that I don’t smoke. I don’t drink very much, you know, occasionally. Managing and coping with stress, which I think I have a good handle on. (Interviewee 03, High Threat)

Similar to the findings above for threat perceptions, interviewees consistently utilised comparative examples when discussing their efficacy appraisals for the associated health behaviours. Additionally, inconsistencies in maintaining health behaviours and the need for motivation was a salient theme among interviewees.

Comparative efficacy. Similar to their discussions of CVD threat perceptions, interviewees used a large number of comparative examples from family and friends to highlight the efficacy of each health behaviour:

I am saying that because some of my own family, brothers, sisters and some of my children, they smoke and you can see the difference between... the ones that smoke and the ones that don’t. (Interviewee 15, Low Efficacy)

Interviewees drew on individual and general comparative examples to present arguments for and against the efficacy of each health behaviour, and a number of interviewees presented ‘man-who’ arguments against such:

Although my own grandmother lived to 84 and she smoked 20 to 30 a day in a holder... health and her mind was as clear as a bell. So, she goes, contra, she goes against all this. (Interviewee 13, Low Efficacy)

I know people who eat unhealthily, and em, seem to have no cardiovascular disease, no cholesterol problems, nothing. They mightn’t be quite as old as myself, but they’d be old enough and they don’t. (Interviewee 13, Low Efficacy)

Inconsistencies in maintaining health behaviours and need for motivation. A common theme for interviewees when discussing the efficacy of the health behaviours was to discuss inconsistencies in maintaining the health behaviours over a particular time period. In general, interviewees used personal references and examples to discuss their lapses in maintaining a healthy diet, carrying out physical activity and limiting alcohol intake:

I know what, you know, I, I understand about it and I understand... how easy it is to kind of float off and go away from diets. (Interviewee 21, High Threat)

I’m very conscientious about starting a healthy diet... Then I drop off very quickly. (Interviewee 06, Low Efficacy)

Although it was a common theme to discuss lapses in health behaviour maintenance, only a few interviewees provided explanations for their lapses. General lifestyle activities and habits were the main explanation given. In reference to eating healthily, two interviewees did discuss the attractiveness of food and giving into cravings as their reasons:

Just running around and being busy and you sometimes don’t eat. I try my best, but like everything. (Interviewee 07, Overload)

I get a longing and once I start, I can’t stop. That’s my problem... and I’m not disciplined enough to just eat two. (Interviewee 11, High Threat)

Coupled with the discussions of inconsistencies in maintaining health behaviours, it was noted that interviewees made a large number of references to the need for motivation and discipline in order to carry out such:

If I make up my mind I don’t find it difficult but making up, you know, there’s... getting the determination. (Interviewee 05, Low Threat)

One interviewee in particular emphasised that there was a “responsibility” to each individual in order to carry out the relevant health behaviours if they wanted to take care of their health:

I think people have, a bit of responsibility for certain parts of their own health, the exercise and smoking and, the diet and, it’s up to ourselves.... I feel quite strongly that people
are responsible, a lot, for their own health.” (Interviewee 16, High Efficacy)

It was noted that when discussing the need for motivation, commitment or discipline interviewees were more likely to speak in general terms and refer to others rather than the self:

*It is easy, if you’re motivated.* (Interviewee 04, Overload)

You have to have the motivation. Not everyone has the motivation for exercise. (Interviewee 12, Overload)

**Discussion**

Findings were consistent across message groups and no considerable differences were noted between the message groups in terms of their thought processes for threat, efficacy, and danger- and fear-control processes depending on which message group they had been randomly assigned to. The findings highlight concerns for the use of the EPPM for communicating about CVD risks and the associated health behaviours among individuals over 60+ years of age. Despite this, separate communications for different CVD manifestations and the role of comparative threat and efficacy perceptions were identified as important theoretical and practical implications from the investigation.

**Threat appraisals**

In general, interviewees reported high threat appraisals for CVD. However, the most noteworthy finding from the current investigation were the differences between interviewees’ threat appraisals for stroke in comparison to other CVD manifestations, in particular heart disease and myocardial infarctions (MIs). When considering such, acknowledgement should be given to the advances in medical treatment for MI in particular. Currently fewer individuals die from an MI than in the past, and their levels of functionality following an MI have improved (Petrie et al., 2002). However, the same cannot be said for outcomes following a stroke. One previous study did examine the use of the EPPM for increasing stroke awareness and knowledge in both a young and old population (Davis et al., 2009); however, the main outcome of the study was stroke knowledge and no measures of threat appraisal based on the EPPM or any form of stroke risk perception were measured.

The current study did not measure stroke knowledge and awareness; however, from the qualitative data participants consistently expressed high threat perceptions for stroke predominantly based on comparative examples from family and friends, which could suggest high levels of awareness for the disease. Lambert et al. (2013) noted how individuals at higher levels of risk for CVD reported higher levels of stroke knowledge. Participants were assigned to a low, moderate and high risk of CVD utilising a risk assessment tool, and their knowledge for MI and stroke were measured. Although stroke knowledge did increase as participant’s risk of CVD increased, it was also found that participants’ knowledge of stroke was consistently lower than their knowledge of MI (Lambert et al., 2013).

There are relatively few studies examining the differences in threat perceptions between different CVD manifestations, and none that have utilised the EPPM. Furthermore, a large amount of previous research, this study included, have asked individuals to report their perceptions, knowledge and/or awareness of CVD as a whole or with the phrase ‘heart attack/disease or stroke’ (Mosca et al., 2000; Scarborough et al., 2011). The findings from the current study would suggest that such a combination is not appropriate, as older Irish adults seem to display considerably different threat perceptions for stroke versus other CVD manifestations. Such differences underlying the threat appraisals could have reduced the effectiveness of the CVD risk communication (Kreuter & Strecher, 1995) and in turn impacted the effect on behavioural intentions for the associated health behaviours. Any future investigations into such should take note of the strong, negative emotional reactions displayed by participants in the current study to stroke and the possible health and functionality outcomes from such. High levels of fear in reaction to stroke communications could result in defensive reactions, message derogation and fear-control processes (Carcioppolo et al., 2013; Witte, 1992; Witte, 1998; Witte & Allen, 2000).

**Comparative examples**

Consistently across all message groups, participants utilised social examples and comparative perceptions for both threat and efficacy appraisals in relation to CVD and the associated health behaviours. Also utilising a think aloud methodology, Nolan et al. (2015) noted how diabetic patients when reacting to online information about CVD discounted the personal relevance of the information by drawing on a number of health beliefs, two of which were family history and personal experiences. The findings in the current study show the large number of vicarious experiences that participants drew on when making their own personal threat and efficacy appraisals for CVD and the associated health behaviours. Greater consideration of such needs to be given by the EPPM and other health behaviour change theories when communicating to various populations about their specific health risks. In a review article discussing the large use of social-cognitive models for examining health behaviours, Mielewczyk & Willig (2007) did call for a larger focus on social influences that can affect various health behaviours.

When assessing risk perceptions, there are common and consistent trends for the influence of comparative risk that highlight the impact of social influence on various health risks (Clemens et al., 2008; Weinstein & Klein, 1995). Additionally, as previously mentioned, a couple of examples can be found within the EPPM literature where the impact of specific social factors such as social trust and collective efficacy where included due to their relevance for the particular health risk under investigation (Prati et al., 2011; Smith et al., 2007). In spite of these examples from previous research and the results of risk perception meta-analyses, still not all health dual-processing or behaviour change theories consider the possible role and impact of social influences; both the EPPM and the Health Belief Model lack such considerations. There is a lack of consistency across the theories that include social influences in terms of their theoretical assumptions, which social influence they pay attention to, in the terminology used to describe such, and in their
measurement techniques (Tyson et al., 2014). The TPB (Ajzen, 1991) considers the impact of subjective norms on health behaviours, whereas Bandura’s (1986) Social Cognitive Theory posits the role of vicarious experiences. In general, across the body of literature examining various risks, little attention has been paid to the impact of social factors for health risks, particularly when compared to other risks such as flooding, gambling and radiation (Kellens et al., 2013; Kim, 2016; Spurrier & Blaszczyński, 2014).

Limitations
The overall sample was predominantly between the ages of 65 to 72 years and were highly educated with the majority of participants having completed some form of third level education. Such factors could raise questions about the generalisability of results particularly for individuals over the age of 75 years and those without higher education. It should be noted that think aloud methodologies are dependent on participants verbalising their conscious thoughts. If participants choose not to do so or if the thought process is an unconscious one, then the information will not be collected.

Conclusions and future research
The findings from the current investigation highlighted a number of important considerations for future research. Future communications may benefit from focusing on one particular CVD manifestation, rather than the disease group as a whole (e.g., stroke versus myocardial infarction). In developing focused EPPM-communications on stroke great care should be taken to alleviate the strong negative emotional reactions displayed by participants when discussing social examples of such (e.g., greater levels of information around efficacy, affirmation task to reduce defensive reactions; Ferrer et al., 2012; van Koningsbruggen et al., 2014). For the EPPM and other theories of health risk and decision-making, the impact of comparative risk and social examples for individual threat and efficacy perceptions needs to be counted. Future research may consider following the examples of Prati et al. (2011) and Smith et al. (2007) who included aspects of social influence as part of the original study design due to the high confounding effects of such for the particular diseases in question (e.g., HIV/AIDS). The findings from the current study would suggest that similar consideration needs to be paid to these social confounding variables for diseases such as cardiovascular disease and the associated health behaviours.

Data availability
Underlying data
Open Science Framework: EPPM for communicating about CVD to an at-risk population utilising a think aloud methodology. https://doi.org/10.17605/OSF.IO/WJS4Z (Hevey, 2019)

This project contains the following underlying data:
- EPPM messages for CVD with think aloud analysis_
- Transcriptions.docx (transcripts of the think aloud data generated by participants)

Extended data
Open Science Framework: EPPM for communicating about CVD to an at-risk population utilising a think aloud methodology. https://doi.org/10.17605/OSF.IO/JG9HS (Hevey & Moylett, 2019)

This contains the following underlying data:
- Questionnaire.docx (Study questionnaire)

Data are available under the terms of the Creative Commons Zero “No rights reserved” data waiver (CC0 1.0 Public domain dedication).

Grant information
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The paper reports the findings of a qualitative investigation of participants’ responses to different health messages, based on the Extended Parallel Process Model. The methods and analysis are appropriate and the findings and discussion are useful and thought provoking. The original objective was to explore the different types of processing that would be expected based on the differing content of the messages. However, no difference was found in the information provided by participants when exposed to different content. I think this is an interesting finding in itself and it would be useful if the authors expanded on the potential reasons for this and any implications this might have for the model. For example, on the basis of the findings it appears that considerations of efficacy are present to the same extent whether efficacy information is communicated or not. Can we say this based on this sample and, if so, what are the implications of this for interventions that include messages about efficacy?

Is the work clearly and accurately presented and does it cite the current literature?
Yes

Is the study design appropriate and is the work technically sound?
Yes

Are sufficient details of methods and analysis provided to allow replication by others?
Yes

If applicable, is the statistical analysis and its interpretation appropriate?
Yes

Are all the source data underlying the results available to ensure full reproducibility?
Yes

Are the conclusions drawn adequately supported by the results?
Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Health psychology.

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

Abstract

- Background – what gap did you expect to address by examining EPPM constructs in a qualitative way? Need to add more for the rationale. Also unclear why EPPM was chosen if it was known to be questioned.

- The “social examples” part of the conclusion does not follow from the results in an obvious way, need to explain this a bit more.

Introduction

- The EPPM model needs a bit more explanation, e.g. how are the constructs you mention related (danger control, fear control, true control and critical point).

- Can you explain how the study conditions relate to EPPM a bit more, i.e. which would you expect to be most effective according to this model (e.g. for overload it’s not clear whether it would be most effective or too much information).

- Why is the study based on EPPM when deficiencies are identified in the background?

- What other models are there that could be applied to understand the effect of different threat/efficacy ratios?

- Need a clearer rational for what a qualitative study was aiming to add to the literature on EPPM.

Methods
Can you mention where the quantitative results are available?

4 participants per group is unlikely to be sufficient to find different themes across the 6 conditions; especially since the characteristics are different in each group. Did you consider showing participants more than one condition for comparison within subjects rather than between subjects?

Since there were no differences in themes by group, I would consolidate the participant characteristics in Table 1 and Table 3 by adding an extra “total” column at the end.

The description of the 6 conditions is repeated, only need one with reference to table.

Can you provide the coding framework as a supplementary file?

**Results**

- The themes are clear and illustrated with quotes.

- Need to refer to all tables in text.

- The two quotes on page 11 showing how stroke risk was used to motivate patients to adhere to medication also illustrates very clearly that the doctor is using this to disregard the patient's concerns and avoid discussing it further – this could be worth further discussion with reference to the shared decision making literature for CVD medication amongst older people, as the benefit to harm ratio is less certain and dependent on individual values.

**Discussion**

- The main findings are highlighted well here.

- Use a consistent term for heart attack vs myocardial infarction.

- In the description of the Lambert 2013 paper on page 12, it's not clear how participants were assigned to low/mod/high risk - was this randomised using hypothetical vignettes, or was the “participant's risk” actually determined using a CVD risk calculator?

- Interesting point about heart attack and stroke risk being combined – this is because of the clinical guideline risk algorithms being based on combined CVD events. If they were separated, the perceived threat may be reduced because the two separate numbers for absolute risk (e.g. 4/100 + 6/100) will be smaller than the combined number (e.g. 10/100); or it may be increased because the salience of stroke by itself could be greater.

- I believe other researchers have found a difference between stroke and heart attack perceptions, in line with your findings - have you looked beyond the EPPM literature for this?

- Can you move your points about theory into a separate section on “implications for theoretical models” so that all the models mentioned are in one place and any important differences explained.

- Can you also suggest a better theory than EPPM that best fits your findings about the
importance of comparative information and stroke vs heart attack differences?

Is the work clearly and accurately presented and does it cite the current literature?
Yes

Is the study design appropriate and is the work technically sound?
Yes

Are sufficient details of methods and analysis provided to allow replication by others?
Yes

If applicable, is the statistical analysis and its interpretation appropriate?
Not applicable

Are all the source data underlying the results available to ensure full reproducibility?
Yes

Are the conclusions drawn adequately supported by the results?
Yes

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Risk communication, shared decision making, behavioural science, CVD prevention, primary care.

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.