

Emotional Alignment Between Older Adults and Online Personalities: Implications for Assistive Technologies

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ABSTRACT

We elicited the emotional ratings of 22 older adults (> 50yrs) to a visual presentation of a set of six manually curated online seller personalities, taken from the world wide web and homogenized (filtered and cleaned). We found significant correlations between the ratings the participants provided about the seller's emotional self (and their own), and their tendency to buy a generic memory product from the same seller. We further found a correlation between the *variance* in the ratings of sellers and the tendency to buy. Overall the paper shows that the sentiments portrayed by online memory supplement sellers is a significant element in the marketability of the product. This has implications for the design and deployment of effective eHealth resources, as well as for development of emotionally aligned online presences and virtual assistants for older adults seeking to live more independently in the face of memory impairments such as Alzheimer's.

Author Keywords

Affect Control Theory; trust; assistive technology; emotion

CCS Concepts

•Human-centered computing → Human computer interaction (HCI); HCI theory, concepts and models; Empirical studies in HCI; *User studies*;

INTRODUCTION

Many older adults concerned about cognitive decline refer to online resources to find answers to their questions or to seek an approach that could help them maintain their cognitive abilities. However, the quality of online resources are highly variable [6, 26] and it may be hard for many users, especially those with low health literacy, to properly evaluate online health information [5]. Further, assistive technologies, such as virtual agents or robots can help older adults with cognitive impairments in multiple domains and improve their quality of lives. However, eHealth advisers and assistive technologies cannot become successful unless the users are willing to adopt them and follow their advice and instructions.

The identity (defined as sentiments about a person's social role) of a virtual assistant/eHealth advisor, and the way it delivers instructions/guidelines to older adults can be crucially important and affect their acceptance. We know that personalities of virtual agents or assistants can highly affect users [28, 21, 9], and it is suggested that such preference can be dependant on users' personalities [27, 23]. Yet a clear link between a user's identity (defined as sentiments about a person's social role) and their preference for the identity of a computer agent is not determined. Gaining a more in-depth understanding of this relationship would enable the development of virtual assistants that can be personalized for the end-users to ensure the uptake of beneficial messaging and counter the impact of potentially harmful, low-quality online resources.

We hypothesize that successful assistants should be able to generate instructions that are tightly related to the emotional state of their users at the moment of interaction, and should have identities that are related to the identity of each older adult. Therefore, here we ask how older adults perceive online personas in general, as a first step toward understanding how they perceive virtual assistants. To this end, we present par-

ticipants with images and information about different online health information providers (sellers), who promote a certain eHealth product: a memory supplement. We ask why a specific online persona becomes successful in selling a product to an individual, while the other personas may not succeed. Specifically, we ask how the portrayal of the seller affects different individuals on an emotional level.

To model these emotional relationships, we turn to Affect Control Theory (ACT), a powerful predictor of humans' social behaviour developed in social psychology and sociology [12]. The basic principle of ACT is that people interpret situations and behave in ways to increase the perceived emotional coherence between themselves, the person they are interacting with, and the behaviours of both parties. The emotional meanings of the *actor* (e.g. the older adult), the *object* (e.g. the seller) and the *behaviour* (e.g. to purchase) are used in ACT to predict the emotional coherence and thus the likelihood for a particular type of person to purchase from a particular type of seller. By measuring these emotional meanings through carefully designed questionnaires, we can make these predictions and see if they are borne out by the actions of the experiment participants.

In the following sections, we will first provide a review of the related work and discuss the problem statement. Research questions and hypotheses of the study are presented afterwards. We will then discuss our methodology in Section 4 and present the results in section 5. We conclude by a discussion of the results and pointing out the study's limitations.

BACKGROUND

Building tools and technologies that assist in a way that can be successfully adopted and trusted by older adults can be challenging. To improve users' cooperation and trust, systems should be both personalized and persuasive. Personalized systems try to enhance users' experience by considering their preferences and interests when assisting them to achieve their goals [1], while persuasive technologies are those that shape or change behaviours, feelings, or thoughts depending on an issue [1]. Fusion of persuasion and personalization is proposed by Berkovsky et al. [1] to have an important impact on both research and practical design.

Persuasive technologies persuade users by providing social cues, for example by modeling a specific target behavior or attitude [8]. These cues can be in many different forms such as psychological (having a specific personality or showing feelings) [8]. The indirect cues are argued to be important by Oinas-Kukkonen and Harjuma [24], as some relevant cues may trigger heuristics (especially for those individuals that seek simple cues) that would help users to evaluate the information provided.

The social cues are shown to have important effects on users' behaviour. For example, tailoring prompts for those with Alzheimer's Disease based on their affective identity is argued to lead to a smoother and more effective interaction [17, 18]. Users are also shown to trust and like a relational agent (an agent that has social behaviour, e.g., keeps social dialogues and has humor) more [2], and proper expression of emotions

in virtual agents is shown to positively affect users' enjoyment and cooperation with the technology [4, 10]. Further, users of the e-commerce websites are likely to be impacted by surface attributes of virtual agents (such as appearance) in many cases to judge their trustworthiness [13].

Further, several technologies have been developed to decrease dependence of people with dementia and Alzheimer's disease on caregivers [14]. COACH, a prompting system that assists people with dementia through hand-washing is an example of such technologies [15, 22]. ACT@HOME is another example of an intelligent cognitive assistant based on the COACH that will be programmed to learn affective identities of people during an interaction, to personalize the prompts based on their needs [20, 18]. In most of these technologies, the affective connection is discussed to be a key for the success of the technology. Findings of this study can also help with improving the affective connection between these assistive technologies and the older adults.

Affect Control Theory: To understand affective connections, we use Affect Control Theory (ACT) [12], a powerful predictor of humans' behaviour. ACT is a social psychological theory of social interaction, which proposes that peoples' actions, perceptions, and emotions are governed by a psychological need to maintain consistency between fundamental sentiments (which are culturally shared) and transient impressions resulting from the interactions. Sentiments are represented along three dimensions of emotion (valence/evaluation, arousal/activity and dominance/power) that are known to be fundamental to human's interpretation of the meanings of events on an emotional level [25]. In this paper, we use this theory to understand the identities that people would prefer to interact with.

Based on ACT, the three dimensions of affective space are Evaluation, Potency, and Activity (EPA, sometimes referred to as Valence, Arousal Dominance or VAD). EPA profiles can be created through surveys, where respondents rate affective meanings of concepts on numerical scales (originally from -4.3 to 4.3) with opposing adjectives at each end. The data from these surveys are collected into EPA "dictionaries" that give means and variances of fundamental sentiments for the ratings of identities (e.g. doctor, mother) and behaviours (e.g. advise, buy something from). Concepts include identities such as "mother", which is generally perceived to be very good, quite powerful, and quite active, and is rated as (Evaluation=2.48, Potency=1.96, Activity=1.15) on the EPA dimensions.¹ For example, an infant is perceived to be very good, but quite powerless and only slightly active (2.23, -1.46, 0.57). EPA ratings can also be applied to behaviours: the action of helping others is considered to be very good, very powerful, and quite active (2.9, 2.65, 1.58), while lying to people is perceived to be very bad, slightly powerless, and somehow inactive (-2.3, -0.18, -0.64).

In ACT, social situations can cause *transient impressions* of behaviours and identities that are derived from individuals' fundamental sentiments using a set of non-linear equations.

¹All EPA values are taken from the Indiana, 2003 dataset. See <https://research.franklin.uga.edu/act/> for all datasets and dictionaries.

To measure how much transient impressions deviate from fundamental sentiments, *deflection* is defined and calculated as the Euclidean distance between the transient impressions and the fundamental sentiments. Deflection shows how much the outcome of the event deviates from what is culturally expected. A high deflection is not expected and people try to minimize deflection in social interactions. We more precisely show how deflection can be calculated in the following.

ACT assumes a combination of actor-behaviour-object (ABO) for each event, which can be represented as a nine dimensional vector:

$$f = \{A_e, A_p, A_a, B_e, B_p, B_a, O_e, O_p, O_a\}$$

In this formula, *A* is the actor, *B* is the behaviour, and *O* is the object. *e*, *p*, and *a* stand for Evaluation, Potency, and Activity dimensions, respectively. Therefore, A_e represents the out of context Evaluation value for the Actor. Assuming the sentence "The doctor helps the patient", doctor is the Actor, and A_e shows the Evaluation value for "doctor", A_p represents the Power value for "doctor" and A_a represent the Activity value for "doctor". Further, "helps" is the behaviour and its fundamental sentiments are represented by $B_e, B_p,$ and B_a . Finally, "patient" is the object, whose fundamental sentiments are $O_e, O_p,$ and O_a .

If we consider the EPA ratings in the context of a specific ABO, for example ratings of "doctor", "helps", and "patient" in the context of "the doctor helps the patient", the ratings would represent *the transient impressions* within this specific situation. So as an example, a doctor will have a much higher E value in this context, as compared to the context of "The doctor offends the patient". These *transient impressions* are shown with another nine-dimensional vector, τ :

$$\tau = \{A'_e, A'_p, A'_a, B'_e, B'_p, B'_a, O'_e, O'_p, O'_a\}$$

Transient impressions (in-context ratings) can be calculated for events (ABO) on the EPA dimensions. These ratings can be predicted from the existing out of context ratings (fundamental sentiments). For example, the transient impression of the Evaluation of an Actor in an ABO can be calculated as:

$$A'_e = 0.42B_e + 0.12B_E O_E - 0.05B_p O_e \dots$$

This would suggest that a good behaviour ($0.42B_e$) would positively affect E of the actor, a good behaviour toward a good object ($+0.12B_E O_E$) would also positively affect E of the actor. However, a powerful behaviour toward a good object ($-0.05B_p O_e$) or a weak behaviour toward a bad object can negatively affect E of the actor (see [11] for complete equations).

Therefore, deflection, which is a squared difference between the transient impressions, as a result of events, and the fundamental sentiments, is calculated with the formula below:

$$deflection = \sum_i (f_i - \tau_i)^2 = (A_e - A'_e)^2 + (A_p - B'_p)^2 + \dots + (O_a - O'_a)^2 \quad (1)$$

We also use a Euclidean distance between the identities of actor and object as a separate measure of emotional alignment

in this paper. We call this measure the "EPA Distance" and it is defined as:

$$EPA \text{ Distance} = (A_e - O_e)^2 + (A_p - O_p)^2 + (A_a - O_a)^2 \quad (2)$$

RESEARCH QUESTIONS AND HYPOTHESES

We ask how identities of different sellers of a specific health product affect an older adult's tendency to purchase the product from them. This would help us understand which identities are more persuasive, and how such persuasive effects change depending on the identity of the buyer. The hypotheses of this study were as below:

- **H1:** Participants' purchase tendency will increase if the perceived identity of the seller is similar to the participant's identity. In other words, participants will prefer to buy the products from people who are similar to them.
- **H2:** Participants will have a higher purchase tendency, if this action reduces "deflection", defined according to the affect control theory principles.

METHOD

In this experiment, we studied participants preference of purchasing a specific health product from multiple sellers with different personalities. This section provides details about the methodology.

Preparation of Study Materials

The creation of study materials began with a systematic search of brain supplements using 3 key words related to (1) supplements, (2) brain health, and (3) aging, conducted across 3 search engines: Google, Bing, and Yahoo. Websites that included images and descriptions of the brain supplements were recorded. The inclusion criteria yielded 60 websites that sell and/or promote supplements claimed to improve brain health. Examples of these websites were ProHealth.com, American-SupplementsLab.com, and Onnit.com, which feature "Optimized Curcumin Longvida", "ChemiLift", and "Alpha Brain" supplements respectively. Based on common characteristics of these supplements, an image of a fictional supplement called "Memory & Mind" for use in this study was created.

To generate true-to-life seller profiles, the 60 websites were narrowed to 19 that contained both an image and biographic information of a single seller connected to the brand. Each of the sellers' biographic information was manually codified. The content analysis involved labelling the presence of specific relevant information like professional designation, advocacy work, personal philosophy, experience level, anecdotes, and awards; these labels were later grouped into broader thematic codes such as 'education', 'credibility', 'purpose-driven', 'reliability', and 'prestige'. In order to develop a comparable set of seller profiles with congruent information, combinations with the greatest number of sellers having the greatest number of similar thematic codes were identified. Of these potential optimal combinations, the most diverse combination (minorities, sex) of 6 sellers was selected (2 visible minorities, 1 female) which shared 4 similar thematic codes.

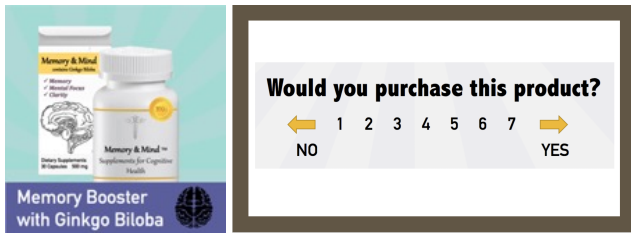


Figure 1: Image of the product shown to the participants on the left, and the questionnaire used to measure baseline tendency on the right.

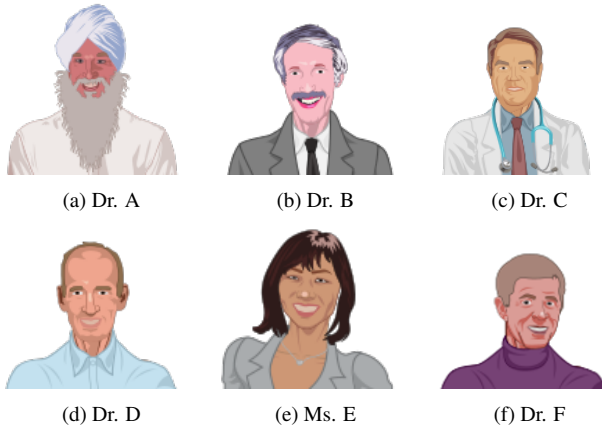


Figure 2: Avatars of Sellers representing the pictures used in the study.

From each of the 6 selected seller website-biographies, the information corresponding to the 4 similar thematic codes was used to construct the seller profiles (one paragraph per thematic code) presented to participants and was adapted to be of similar length.

The identity survey interview questions were developed from the *ACT@Home: Identities and Technology Interview* template and were revised to better focus on participants' personality and values [17].

Procedure

Prior to and upon arrival, participants were provided with study information and consent forms and were given a brief overview of the study. The one-time, 45-minute in-person session consisted of 4 parts, which were audio recorded upon obtaining consent.

In part 1, participants verbally answered a set of interview questions. This included asking participants about their past roles/identities (e.g., mother, teacher, housewife). The interview guide was based on a set of biographical questions developed as part of previous work investigating the integration of affect control theory in prompting from assistive technologies [19]. Interview questions were designed to elicit precise information related to the participants cultural backgrounds, family situations, employment and occupations, achievements, and values. Participants answered questions verbally and the

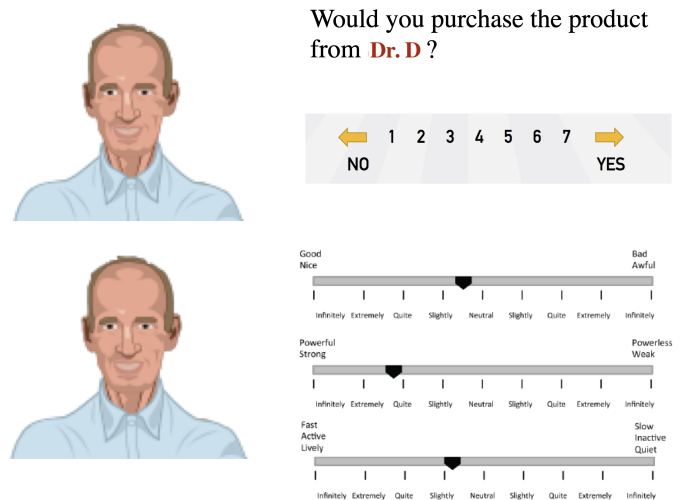


Figure 3: Example of questions shown to participants after reading the description of each seller.

interviewer took written notes during the interview to supplement the analysis of the recordings.

In part 2, participants rated their own identity (as a single "self") according to the 3 affect control theory dimensions (evaluation, potency, activity) on a set of continuous scales.

In part 3, participants were asked to rate their likelihood of purchasing a fictional brain health supplement. The brain supplement was the same for all the participants. It is shown in Figure 1.

Finally, in part 4, participants were placed in a hypothetical scenario, whereby they were invited to read the biographic profiles of six sellers, and rate their likelihood of purchasing the same fictional brain supplement from these individuals online. Participants were also asked to rate the seller's identity according to the 3 affect control theory dimensions on three semantic differential scales (as used in ACT dictionary surveys).

Sellers are shown in Figure 2.² For each seller, the participants first saw a picture of the seller and read a description about them. They were then asked to (1) indicate how likely they were to purchase the product from that seller (purchase tendency), and (2) rate the seller on the EPA scale. Figure 3 shows these questions and Figure 4 shows an example of the seller description.

The experiment was concluded by a short debrief session and a few follow-up questions. Participants were informed that the study was not affiliated with the products or the people shown to them. They were also informed about the purpose of the study. After the completion of all parts, follow-up questions were used to ask participants about their comments and opinion about the study.

²To comply with copyright, in this publication images of the sellers are replaced with avatars and names have been removed.



Dr. D

Dr. D is a Doctor of Osteopathic Medicine (D.O.), specifically board-certified in family medicine.

Dr. D's passion is to advocate for practical health solutions and to transform traditional medicine by focusing on preventive health care.

When **Dr. D** realized that traditional medicine wasn't working, he began exploring the world of natural medicine and changed the way he practiced medicine.

DOs are licensed physicians who, similar to MDs, can prescribe medication and perform surgery. Osteopathic physicians practice a "whole person" approach, treating the entire person rather than just symptoms. He began seeing patients at his private wellness clinic in 1985.

Figure 4: Example of the seller description.

Participants

The study was approved by the Research Ethics Board of the University of British Columbia and participants provided informed consent to participate. Recruitment was advertised through flyers, snowball sampling, and promotion following related presentations to the public. A total of 22 participants (13 female and 9 male) were recruited³ over a six-month period and received a \$25 gift card as a token of gratitude for their participation. All participants were ages 50 and above, able to speak English fluently, and had no known cognitive impairments.

Measurements

We defined two factors that can affect participants' purchase tendency: (1) how similar the participant was (perceive to be) to the seller. This was measured by calculating the distance between the participant's and seller's EPAs, both of which were rated by the participant. (2) the deflection caused by the participant's action, or in other words, the deflection of $Participant_i$ "requests something from" $seller_j$, where the behaviour has an EPA of (0.43, -0.21, 0.03). We will call the former "EPA distance", defined by Equation 2, and the latter "deflection", defined by Equation 1.

RESULTS

Here, we will discuss how deflection and the EPA distance between sellers and participants affected participants' purchase tendency. We will also show other factors, such as ambiguity in sellers' identity, that could have affected participants' perception of the sellers.

Deflection and EPA Difference

All the sellers received a wide range of ratings from different participants. The average purchase tendency for each seller is shown in Figure 5. The difference among ratings of different

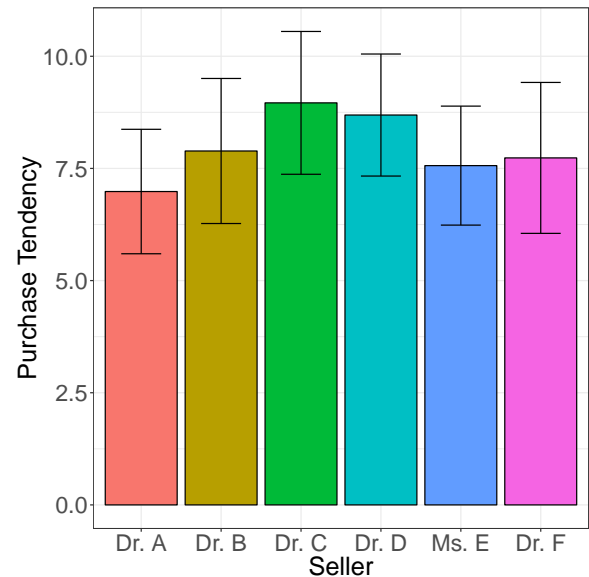


Figure 5: Average purchase tendency for each seller. 95% confidence intervals are visualized.

sellers was not significant, except for Dr. A, who was the first person that was rated and received a relatively lower rating.

Figures 6 (a) and (b) show how purchase tendency changed based on deflection and EPA distance, respectively.⁴

These results suggest that purchase tendency increased as EPA distance decreased (confirming H1). However, surprisingly, purchase tendency increases as deflection increases (opposite

⁴The lines in the figures show a simple linear model fitted to the data, without taking other factors into account. The results of the models are more accurate, as they take other confounding factors into account.

³The study was powered using 95% confidence level at $N > 20$

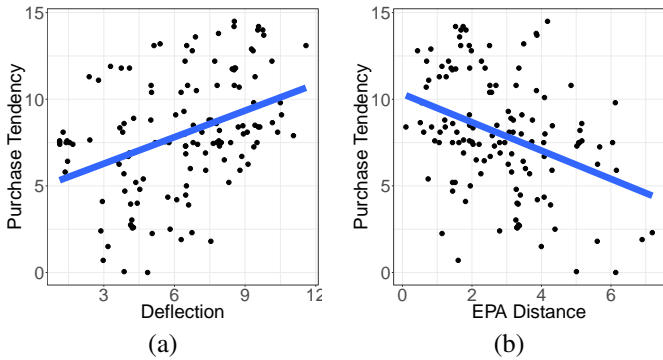


Figure 6: (a) Purchase tendency based on the calculated deflection of 'Participant requests something from seller'. Purchase tendency significantly increased with deflection. (b) Purchase tendency based on the EPA distance between the participants and the sellers. Purchase tendency significantly decreased as the EPA distance increased. Modeling results are shown in Table 1.

effect as hypothesized in H2). In other words, the participants preferred to purchase the product from those sellers that they perceived to be similar to themselves on the EPA scale. However, they preferred to purchase the product when this action increased deflection.

To study whether there is a significant effect of EPA distance and deflection on purchase tendency, we have fit a linear mixed-effects model to the data. The model predicted purchase tendency based on the EPA distance and deflection. Baseline tendency (participants' initial rating of how likely they were to buy the product regardless of the seller) was controlled for, as it can affect participants' ratings. Because it is a within subject study with repeated measures, we have also fit a random intercept based on participant. Gender was included as a factor, but was not a significant predictor of purchase tendency and did not improve the models (AIC criteria was used), therefore, it was removed.

Results are shown in Table 1. Both EPA distance and deflection significantly affected purchase tendency, but their effects are in the opposite directions. As the EPA distance increases, purchase tendency significantly decreases. However, purchase tendency significantly increases as deflection increases.

The correlation between deflection and EPA distance was very low (0.075), which showed that EPA distance and deflection affected purchase tendency independently.

Note that although the cultural backgrounds of the sellers and participants might not be balanced, affect control theory considers cultural background when defining "identity". Therefore, the cultural background of the participants are reflected in their self EPA ratings and their EPA ratings for each seller reflect these cultural elements for the sellers.

Next we asked whether the perceived EPA of the sellers, in general, affected purchase tendency. In other words, we asked whether how *good*, *powerful*, and *active* the seller was perceived to be affected the tendency of purchasing the product

Table 1: Mixed-effects linear model predicting Purchase Tendency. A random intercept based on participant is fit. 'Baseline' shows the baseline tendency.

Covariate	Estimate	SE	t	Pr ($> t $)
Intercept	5.629	1.031	5.460	< 0.0001
Baseline	0.267	0.114	2.342	< 0.05
EPA Dist.	-0.880	0.141	-6.231	< 0.0001
Deflection	0.767	0.143	5.372	< 0.0001

Table 2: Mixed-effects linear model predicting Purchase Tendency. A random intercept based on participant is fit. 'Baseline' shows the baseline tendency.

Covariate	Estimate	SE	t	Pr ($> t $)
Intercept	5.547	0.534	10.382	< 0.0001
Baseline	0.261	0.120	2.185	0.051
Seller E	0.461	0.192	2.401	< 0.05
Seller P	0.869	0.285	3.046	< 0.01
Seller A	0.019	0.258	0.073	0.942

from him/her. Therefore, we fit a mixed-effects model to predict purchase tendency based on EPA ratings. Similar to the previous model, the effect of baseline tendency is taken into account and a random effect is fit based on participant. Table 2 shows the results. Perceived Evaluation and Power of the sellers significantly affected purchase tendency. Tendency to buy the product was increased when the seller was perceived more "powerful" and "good". However, there was no effect of how "active" the seller was perceived on purchase tendency ($p = 0.942$).

Ambiguity and Purchase Tendency

Lastly, we asked if the ambiguity in identity of the sellers can affect purchase tendency negatively. Therefore, different identities of the sellers were extracted from their description, and we calculated a variance in their different identities. To extract the different identities, two of the authors independently searched for nouns used to describe the seller in the biography, and the subset of nouns that both agreed upon as identities were selected and looked up in the ACT dictionary (Indiana 2003). In cases we were not able to find an exact match, we looked for synonyms in thesarus.com and found one that matched. For example, the word "Leader" was used instead of "Pioneer" for Dr. C (see Figure 7 for an example of how facts were extracted).

We then calculated the variance in different identities. For example, Dr. D is a "doctor", a "chiropractor", "supporter", and "scholar". The variance in the EPAs of these identities were calculated to measure ambiguity in Dr. D's identity. Variance in the Evaluation dimension ranged from 0.273 to 0.801, with the lowest being for Ms. E and the highest for Dr. D. In the Power dimension, the variances ranged from 0.273 to 1.347 (Dr. A and Ms. E, respectively). Finally, the variance for the Activity dimension ranged from 0.5 to 1.396 (Dr. D and Dr. A, respectively). We then calculated an average of the variance in



Dr. C Doctor Author Teacher
Dr. C is a Doctor of Medicine (M.D.). He is an author, lecturer, and founder of the **C** Wellness Institute.

Dr. C believes that the true meaning of "health care" is achieving wellness, not managing disease.
 Leader Researcher

He is a true pioneer and trusted authority of alternative medicine. Through research and first-hand experiences, he quickly became convinced that natural therapies held far more potential for maintaining and restoring health than prescription drugs and invasive procedures.

benefactor Entrepreneur
 He spent more than 40 years helping people improve their quality of life. In 1979, **Dr. C** founded the **C** Wellness Institute medical clinic and wellness center. More than 45,000 patients from around the world participated in the clinic's Back to Health Program

Figure 7: Example of different identities of one of the sellers extracted based on the facts in their descriptions.

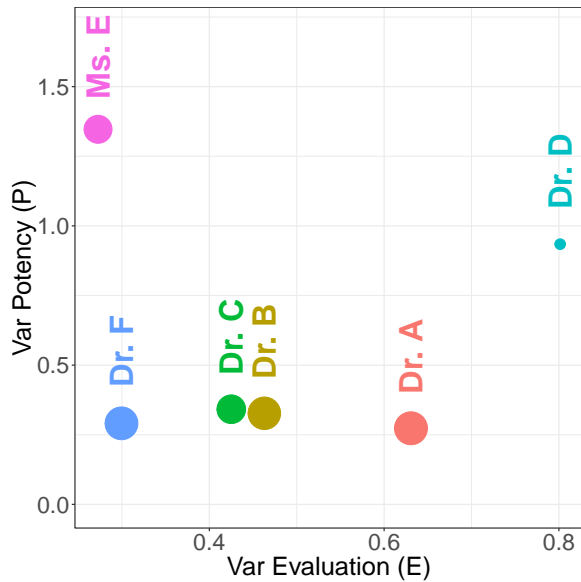


Figure 8: Variance in different dimensions of identity. Size of the circles show variance of the Activity (A) dimension.

these three dimensions. Dr. F had the lowest average variance (0.617), while Ms. E had the highest average variance (0.886).

Results are shown in Figures 8 and 9 and suggest that sellers had different variances. Also, as variance increased (causing more ambiguity in a seller's identity and thus possibly causing more confusion for the participants), purchase tendency decreased.

Perceived Identity

Further, we used these facts to calculate an average EPA value for each seller to ensure that the sellers represented different values on the EPA scale. Results are shown in Figure 10. The

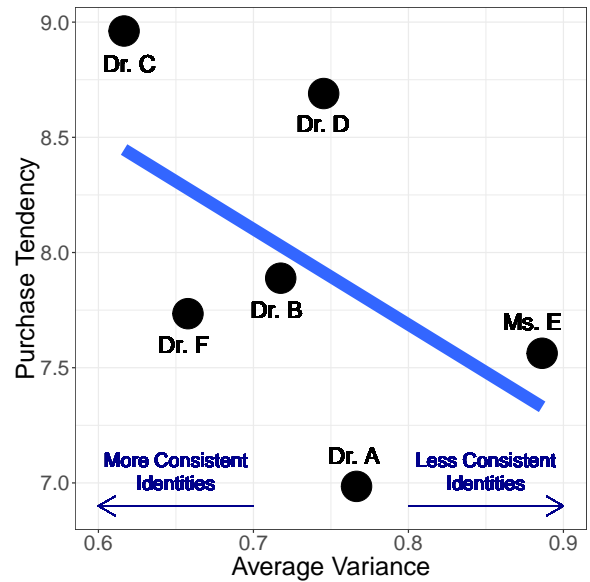


Figure 9: Participants' ratings of purchase tendency based on the average identity variance. Points show average ratings.

sellers indeed represented a diverse range of EPAs. According to the extracted facts, Ms. E was evaluated to be the most active seller, Dr. D was ranked the highest on Evaluation, and Dr. C was calculated to be the most powerful seller.

DISCUSSION

In this paper, we studied how perceived identities affect older adults' acceptance of a health product, with the goal of developing assessment tools or assistive technologies that could successfully help older adults with dementia and their caregivers (e.g., by advising them against buying supplements that do not have any scientifically proven benefit, but are presented

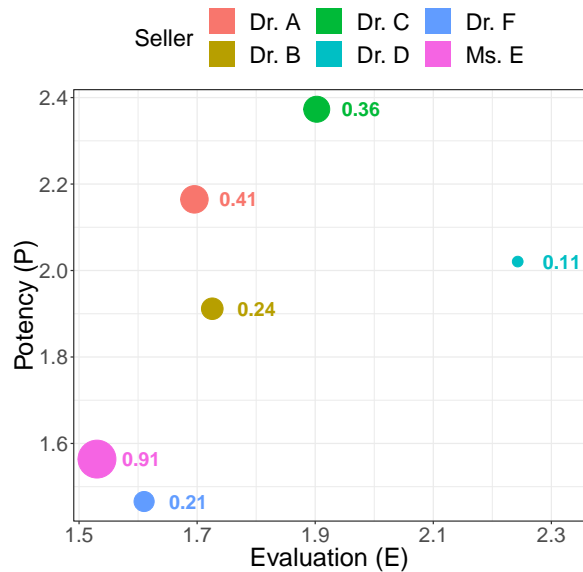


Figure 10: EPA of the sellers calculated based on the facts in their descriptions. The size of the circle shows the Activity (A) dimension. Numbers indicate the average variances for the sellers.

well by a specific seller that can gain individuals' trust). Acceptance of different identities was measured through older adults' tendency to buy a fictional health supplement from different sellers. We used concepts from Affect Control Theory to define two measures: (1) EPA distance, showing how similar the seller is perceived to be to the participant, and (2) deflection, showing how much the action of buying the product from the seller deviates from cultural expectations emotionally.

EPA distance significantly affected the purchase tendency: participants had a higher tendency to buy the health product from a seller, if she/he was perceived to have an identity that was closer to them. This confirmed our first hypothesis, suggesting that it would be better to personalize assistive tools and technologies with identities that are similar to their users'. This is in line with findings of [3], who showed that people find those that have a similar personality to them more attractive.

However, although we hypothesized that deflection reduces purchase tendency, participants preferred to purchase the product when the action of *requesting the product from the seller* increased deflection. This effect was in the opposite direction to what was hypothesized. One possible explanation is that deflection increases cognitive processing (probably leading to slower, more explicit thinking that requires careful reasoning - e.g. "system 2" thinking [16]), and more cognitive processing and counterarguments are shown to increase acceptance of the products through distraction effects [7, 29]. So in this specific context, deflection positively affected purchase tendency. Future research is required to understand whether this effect would persist beyond this context.

We found that variance in identity profiles of sellers also negatively correlated with purchase tendency. That is, sellers with more widely varying emotional meanings of identity sets tended to elicit less purchase tendency from buyers (participants). There are two possible reasons for this. First, as variance in identity is reduced, the seller presents a more consistent identity, leading to a belief about the buyer that is more sharply "peaked" (less dispersed) and thus creates a stronger motivation to buy. Second, less dispersed beliefs create stronger affective meanings, and these will tend to dominate any more rational thinking about the product. That is, while a rational thinker will evaluate the facts shown and combine these to make a decision, these evaluations will be lost if there is a stronger emotional motivation to buy, and will be less salient in the buyer's mind.

This study provided a valuable blueprint for the modeling of appearances and personalities of virtual agents to enhance their alignment with end-users and, in turn, their impact. The results can be informative not only for older adult users, but also for a larger range of users and in different domains, where personalizing virtual agents is feasible and can affect users' perception of the agent.

Our work has limitations. First, although the seller profiles were derived from real, existing eHealth resources, the action of buying the products was hypothetical and the participants did not actually purchase the brain health supplements. This could affect the nature of the action. Regardless of this limitation, we saw significant effects of sellers' identities on people's choices. Further, as our goal was to use real sellers as opposed to creating fake profiles, we could not balance the gender or other demographic features of the sellers. Also, the order at which the sellers were presented could have affected people's judgments (e.g., one of the participants changed all their answers after seeing all the sellers). Lastly, our study measured trust in the context of buying a medical product, which may not be generalizable to other contexts where an assessment tool or an assistive technology helps an older adult. Further investigation is required to understand if these effects persist in other contexts.

CONCLUSION

This paper studied how older adults' acceptance of a health product changes depending on their perception about the identity of the seller. The results showed that different identities of the sellers can significantly affect participants' decisions about purchasing a medical product. These results emphasized that understanding users' and personalizing tools that provide assessments for medical information/products or assistive technologies based on their identities could be critical for developing systems that can successfully help older adults. The results provided insights about what identity to select and how to do such personalization.

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REFERENCES

- [1] Shlomo Berkovsky, Jill Freyne, and Harri Oinas-Kukkonen. 2012. Influencing individually: fusing personalization and persuasion. *ACM Transactions on Interactive Intelligent Systems (TiiS)* 2, 2 (2012), 9.
- [2] Timothy W Bickmore and Rosalind W Picard. 2005. Establishing and maintaining long-term human-computer relationships. *ACM Transactions on Computer-Human Interaction (TOCHI)* 12, 2 (2005), 293–327.
- [3] Donn Byrne and Don Nelson. 1965. Attraction as a linear function of proportion of positive reinforcements. *Journal of Personality and Social Psychology* 1, 6 (1965), 659–663. DOI : <http://dx.doi.org/10.1037/h0022073>
- [4] Andry Chowanda, Martin Flintham, Peter Blanchfield, and Michel Valstar. 2016. Playing with social and emotional game companions. In *International Conference on Intelligent Virtual Agents*. Springer, 85–95.
- [5] Nicola Diviani, Bas van den Putte, Stefano Giani, and Julia CM van Weert. 2015. Low health literacy and evaluation of online health information: a systematic review of the literature. *Journal of medical Internet research* 17, 5 (2015), e112.
- [6] Eamonn Fahy, Rohan Hardikar, Adrian Fox, and Sean Mackay. 2014. Quality of patient health information on the Internet: reviewing a complex and evolving landscape. *The Australasian medical journal* 7, 1 (2014), 24.
- [7] Leon Festinger and Nathan Maccoby. 1964. On resistance to persuasive communications. *The Journal of Abnormal and Social Psychology* 68, 4 (1964), 359.
- [8] B. J. Fogg. 2002. Persuasive Technology: Using Computers to Change What We Think and Do. *Ubiquity* 2002, December, Article 5 (Dec. 2002). DOI : <http://dx.doi.org/10.1145/764008.763957>
- [9] Adrian Furnham. 1990. Language and personality. (1990).
- [10] Moojan Ghafurian, Neil Budnarain, and Jesse Hoey. 2019. Role of Emotions in Perception of Humanness of Virtual Agents. In *Proc. International Conference on Autonomous Agents and Multiagent Systems (AAMAS)*. Montreal, Canada.
- [11] David R Heise. 1987. Affect control theory: Concepts and model. *Journal of Mathematical Sociology* 13, 1-2 (1987), 1–33.
- [12] David R Heise. 2007. *Expressive order: Confirming sentiments in social actions*. Springer Science & Business Media.
- [13] Morten Hertzum, Hans H.K Andersen, Verner Andersen, and Camilla B Hansen. 2002. Trust in information sources: seeking information from people, documents, and virtual agents. *Interacting with Computers* 14, 5 (10 2002), 575–599. DOI : [http://dx.doi.org/10.1016/S0953-5438\(02\)00023-1](http://dx.doi.org/10.1016/S0953-5438(02)00023-1)
- [14] Jesse Hoey, Craig Boutilier, Pascal Poupart, Patrick Olivier, Andrew Monk, and Alex Mihailidis. 2013. People, Sensors, Decisions: Customizable and Adaptive Technologies for Assistance in Healthcare. *ACM Trans. Interact. Intell. Syst.* 2, 4, Article 20 (Jan. 2013), 36 pages.
- [15] Jesse Hoey, Pascal Poupart, Axel von Bertoldi, Tammy Craig, Craig Boutilier, and Alex Mihailidis. 2010. Automated handwashing assistance for persons with dementia using video and a partially observable Markov decision process. *Computer Vision and Image Understanding* 114, 5 (2010), 503–519.
- [16] Daniel Kahneman. 2011. *Thinking, fast and slow*. Macmillan.
- [17] Alexandra König, Linda E Francis, and Jesse Hoey. 2018. Emotionally adaptive technologies for people with dementia. *Alzheimer's & Dementia: The Journal of the Alzheimer's Association* 14, 7 (2018), P208.
- [18] Alexandra König, Linda E. Francis, Aarti Malhotra, and Jesse Hoey. 2016. Defining Affective Identities in Elderly Nursing Home Residents for the Design of an Emotionally Intelligent Cognitive Assistant. In *Proceedings of the 10th EAI International Conference on Pervasive Computing Technologies for Healthcare (PervasiveHealth '16)*. ICST (Institute for Computer Sciences, Social-Informatics and Telecommunications Engineering), ICST, Brussels, Belgium, Belgium, 206–210.
- [19] Alexandra König, Aarti Malhotra, Jesse Hoey, and Linda E Francis. 2016. Designing personalized prompts for a virtual assistant to support elderly care home residents. In *Proceedings of the 10th EAI International Conference on Pervasive Computing Technologies for Healthcare*. 278–282.
- [20] Luyuan Lin, Stephen Czarnuch, Aarti Malhotra, Lifei Yu, Tobias Schröder, and Jesse Hoey. 2014. Affectively Aligned Cognitive Assistance using Bayesian Affect Control Theory. In *Proc. of International Workconference on Ambient Assisted Living (IWAAL)*. Springer, Belfast, UK, 279–287.
- [21] François Mairesse and Marilyn A. Walker. 2010. Towards personality-based user adaptation: psychologically informed stylistic language generation. *User Modeling and User-Adapted Interaction* 20, 3 (01 Aug 2010), 227–278. DOI : <http://dx.doi.org/10.1007/s11257-010-9076-2>
- [22] Alex Mihailidis, Jennifer N Boger, Tammy Craig, and Jesse Hoey. 2008. The COACH prompting system to assist older adults with dementia through handwashing: An efficacy study. *BMC geriatrics* 8, 1 (2008), 28.

- [23] Youngme Moon and Clifford I Nass. 1996. Adaptive agents and personality change: complementarity versus similarity as forms of adaptation. In *Conference companion on Human factors in computing systems*. ACM, 287–288. DOI : <http://dx.doi.org/10.1145/257089.257325>
- [24] Harri Oinas-Kukkonen and Marja Harjumaa. 2009. Persuasive systems design: Key issues, process model, and system features. *Communications of the Association for Information Systems* 24, 1 (2009), 28.
- [25] Charles E. Osgood, William H. May, and Murray S. Miron. 1975. *Cross-Cultural Universals of Affective Meaning*. University of Illinois Press.
- [26] Julie M Robillard and Tanya L Feng. 2017. Health advice in a digital world: quality and content of online information about the prevention of Alzheimer’s disease. *Journal of Alzheimer’s Disease* 55, 1 (2017), 219–229.
- [27] Adriana Tapus and Maja J. Matarić. 2008. Socially Assistive Robots: The Link between Personality, Empathy, Physiological Signals, and Task Performance. *AAAI Spring Symposium* (2008), 133–141. <http://www.aaai.org/Papers/Symposia/Spring/2008/SS-08-04/SS08-04-021.pdf>
- [28] Ning Wang, W. Lewis Johnson, Richard E. Mayer, Paola Rizzo, Erin Shaw, and Heather Collins. 2008. The politeness effect: Pedagogical agents and learning outcomes. *International Journal of Human-Computer Studies* 66, 2 (2008), 98 – 112. DOI : <http://dx.doi.org/https://doi.org/10.1016/j.ijhcs.2007.09.003>
- [29] Peter L Wright. 1973. The cognitive processes mediating acceptance of advertising. *Journal of marketing research* (1973), 53–62.