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# *A priori* acceptability of a multimodal system for the early detection of frailty in older adults

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**Abstract** – *Frailty would affect 4 out of 5 people aged of 85 and over in France. As part of a global project aimed to develop a multimodal system for the early detection of frailty among older adults living at home or in a senior residence, we reported prospective quantitative study assessing a priori acceptability of this system. This platform is composed of 5 devices: a weight scale, a tensiometer, a wrist-worn step counter, an activity tracker and a tablet to exchange data with the aforementioned sensors over internet. The inclusion criteria are: age  $\geq 80$  years old, living at home or in senior residence, assessed as 'robust' or 'pre-frail'. The a priori acceptability is assessed through self-evaluation questionnaires. The results of the first 22 volunteers included in this study would be in favor of an a priori intention to use rather favorable to the use of the system, despite an a priori acceptability judged rather moderate.*

**Keywords:** *Acceptability, frailty, prevention, information and communication technologies, gerontechnology*

## I. INTRODUCTION

As of 1 January 2020, the French population was estimated at 67,060,703, of which 9.5% were aged 75 and over and 3.4% were aged 85 and over [1]. The proportion of people aged 75 and over living at home is 90% [2]. Among them, 83.1% are considered independent [3]. The French National Institute for Statistics and Economic Studies estimates that in France, in 2060, the proportion of people aged 75 and over would be 16.2%, *i.e.* about 12 million individuals [4]. Most of French people express their desire to 'age' at home [5]. However, the risk of falls threatens this lifestyle choice. Indeed, falls are known to be the third most common cause of hospital admissions in acute medicine departments and the leading cause of fatal accidents among older adults [6, 7].

One of the main risk factors for falls is the 'frail status' [8-13]. Among approaches used to diagnose frailty syndrome, the phenotypic-type approach of Fried *et al.* [8] is one of the most frequently cited in international studies devoted to this concept [9-11, 13, 14]. According to Fried's frailty phenotype, people can be classified as 'robust', 'pre-frail' or 'frail', depending on

whether they meet respectively none, one or two, or three of the following criteria: unintentional weight loss, self-reported exhaustion, slow walking speed, weakness (grip strength) and low physical activity [8-11, 13, 14]. There is a continuum between the state of 'robustness' and the state of 'frailty', passing through a state known as 'pre-frailty' [8-10, 15, 16]. According to the European Survey of Health, Ageing and Retirement in Europe (SHARE), 9% of people aged 50 and over in France could be considered as 'frail' and 41% as 'pre-frail' [17]. The proportion of people aged 75 and over who are 'frail' and 'pre-frail' could be around 15% and 50% respectively. At the age of 85, less than one person out of five could be considered as 'robust'. The state of 'frailty' would increase the risk of falling (Hazard ratio (HR) = 1.23; Confidence interval (CI) 95% [1.50-2.21]), of loss of functional independency (HR = 1.79; 95% CI [1.47-2.17]), hospitalization (HR = 1.27; 95% CI [1.11-1.46]), and death (HR = 1.63; 95% CI [1.27-2.08]) at 2 years compared to people considered as 'robust' [8-11, 18].

The World Health Organization recommends a "proactive identification of older people in the community at risk of frailty" to provide "opportunities to intervene and so prevent or delay functional decline". Thus, we recently proposed the use of a multimodal health monitoring system for the early detection of elements linked to Fried's frailty, within a project presented in the next section. One of the key assumptions of this approach is that older citizens will use this information and communication technology (ICT)-enabled device. However, the development of ICTs is not always successful [19-24]. From this 'proof of concept' phase, we have developed an ancillary study to assess the acceptability of ICTs among older individuals.

In the present study, we present the results of the *a priori* acceptability of the system through the prism of Bel's integrative model, evaluated on the day of the inclusion of volunteers in the research protocol.

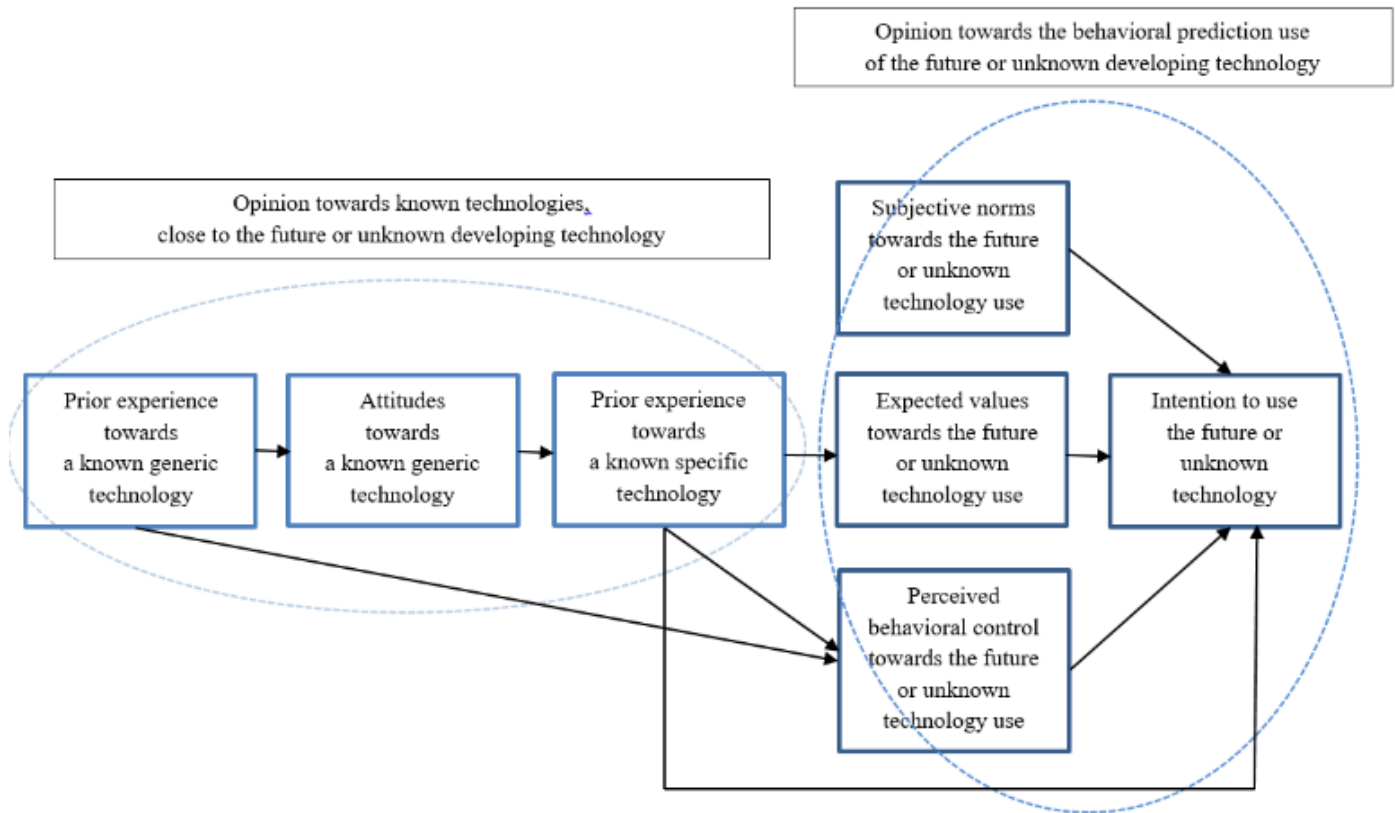


Figure 1. Bel's integrative model of the behavioral prediction use of an unknown technology, adapted from 'Bel M. Predicting the use of a new technology: the case of Cooperative Intelligent Transport Systems. 2016.'

## II. METHODS

### A. Bel's Integrative Model

To do so, we used a theoretical framework that proposes to explore acceptability in several sub-dimensions [19, 20]:

- *A priori* acceptability: this is the set of representations that individuals have of a future or unknown technology. Those representations will influence and participate in the individual's decisions to whether or not use this technology in the future.
- Acceptance: resulting from experience with the technology, the time of acceptance refers to the moment when the individual is first confronted with the technology. Thus, this phase does not refer to the representations of people but to the actual activities carried out with the new system.
- Appropriation: this refers to the integration of the new technology into the person's daily activity.

The 2016 Bel's integrative model of the behavioral prediction use of an unknown technology [20] is based on traditional models of technology acceptability: the 1980 Ajzen and Fishbein's theory of reasoned action, the 1985 Ajzen's theory of planned behavior, the 1989 Davis' technology acceptance model, the 2003 Rogers' diffusion of innovation theory, and the 2003 Venkatesh *et al.*'s unified theory of acceptance and use of

technology [19-22]. Although it does not take into account all the dimensions related to acceptability, Bel's integrative model emphasizes "the existence of a predictive chain [of influencing factors] ranging from a known generic technology that is conceptually close to the unknown technology, to increasingly specific technologies, leading to the prediction of the intention to use [...] the technology that does not yet exist" [20]. This model is shown in Fig. 1.

### B. The ACCORDS multimodal system

The Signal and Image Processing Laboratory (LTSI), French National Institute of Health and Medical Research - Unit 1099 of University of Rennes 1, the Geriatrics Department of Rennes University Hospital Centre, and the Clinical Investigation Centre - Technological Innovation 1414 of Rennes University Hospital Centre, have joined forces with the industrial companies RF-Track and AZNetwork to develop a multimodal platform for collecting data related to frailty. This project is named ACCORDS, a combinatory approach of connected functionalities for the collection of health data with multimodal aims. Its main objective is to develop one or more algorithms for the early detection of frailty of older people, thanks to the collection of clinical data, associated with paraclinical data obtained through the multimodal platform.

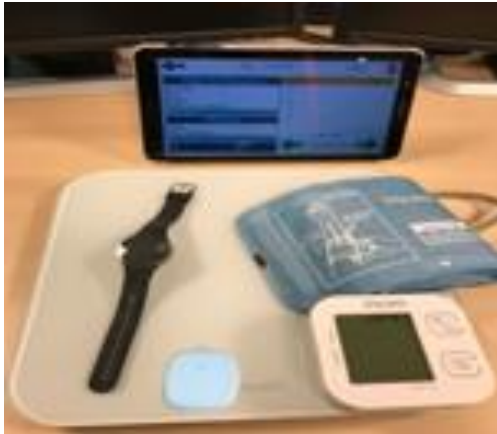


Figure 2. The ACCORDS platform including a weight scale, a tensiometer, a wrist-worn step and calories counter, an activity tacker and a tablet using the Calliopé® application

The present study assesses the *a priori* acceptability of this system by older adults. It was carried out on the base of collaborative and interdisciplinary work, from its design to its implementation, both in terms of choice of the collected parameters, the development of algorithms and interfaces and in the development of the research protocol for the present study on the ICTs' acceptability. The whole project received funding from the French National Research Agency in 2018 for a period of 4 years.

The device is entrusted to the volunteer for a maximum of 2 years, to be used in his/her daily living. It is composed of:

- a connected weight scale (iHealth HS2 and HS6), to monitor the subject's weight, to be used at least twice a month,
- a connected blood pressure monitor (iHealth Track KN-550BT), to monitor blood pressure and heart rate, to be used at least once a month,
- a wrist-worn step and calories counter (iHealth AM4), integrated into a wristwatch, to monitor the subject's activity via the number of daily steps, the estimated energy expenditure and the daily travelled distance, to be used at least 15 days, consecutive or not, per month,
- a sensor for quantifying physical activity called 'activity tracker' (manufactured by the company RF-Track) comprising an accelerometer, a barometer and a radio transceiver, which can be worn around the neck or the waist, to be used at least 15 days, consecutive or not, per month,
- a touch tablet (Samsung Galaxy Tab A 2016, Android 6.0 operating system) allowing access to a health monitoring application for the above-mentioned parameters, which is accessed by the subject at least once per two weeks.

The health monitoring application called Calliopé® was specially developed for this study, based on collaborative work within the team. It allows data to be retrieved from the 3 iHealth sensors, secure data connection and storage, as well as the

visualization of the daily data history for the volunteer. This platform is shown in Fig. 2.

### III. CLINICAL TRIAL

The project received a favorable opinion for its implementation from the Protection of Persons Committee Ouest VI - 1228 HPS2, under the code IDRCB 2019-A02316-51 on 2 January 2020. The French National Commission for Information Technology and Civil Liberties and the French National Agency for the Safety of Medicines and Health Products have been informed of this study. The duration of the inclusion period is 12 months from 1st September 2020. The estimated data processing time is 6 months. The total duration of the study is 54 months, including a 6-month extension of the study due to the SARS-Cov2 epidemic.

#### A. Participants

The number of subjects to be included was estimated at 30, considering the diversity of older people's profiles. The inclusion criteria for the project were: age  $\geq 80$  years old, living at home or in a senior residence, assessed as 'robust' or 'pre-frail' according to Fried's frailty phenotype. The criteria for non-inclusion were: hospitalization in the month preceding the first visit, cognitive impairment prohibiting proper use of the system, inability to give consent to participate in the study, or being subject to legal protection [25]. If the person is classified as 'frail' (3, 4 or 5 Fried's criteria) during the follow-up, the health monitoring is concluded so we can analyze his/her frailty trajectory and the criteria that could indicate the onset of frailty at an early stage.

#### B. Calendar of home visits

We propose a set of 10 home visits over 2 years. The first inclusion took place on September 2020. In the framework of the SARS-Cov2 pandemic, the barrier measures were respected during home visits. It included the wearing of masks for investigators and respondents, washing hands with a hydro-alcoholic solution before and after handling objects, physical distancing avoiding close contacts and room ventilation for the duration of the visit.

#### C. The collection of data for the *a priori* acceptability study

The quantitative part of the *a priori* acceptability study presented here is based on four self-evaluation questionnaires constructed from data in the literature, in particular Bel's integrative model of behavioral prediction of the use of an unknown technology, and reflections of our research team [19-22]. These questionnaires include 46 items grouped into eight themes. The items are assessed using a 7-point Likert scale. The first 15-item questionnaire explores three themes: the person's prior experience and attitudes towards information and communication technologies, and prior experience with health

monitoring technologies. The second questionnaire of 12 items explores three themes: the 'expected values of the use of the object' also called *a priori* utility; the 'subjective norms', meaning the influence of family and friends in initiating ICTs' health monitoring; and the *a priori* intentions to use the system. The third 9-item questionnaire explores one theme, the *a priori* comfort of use. Eventually, the fourth questionnaire of 10 items explores one theme, the 'perceived behavioral control' also called the *a priori* usability of the system. The seven possible response options cover the spectrum of opinions, from 'strongly disagree' to 'strongly agree'. For each item, a score is obtained, ranging from 1 for 'strongly disagree' to 7 for 'strongly agree'. For negative sentences, the score is reversed. Then, the participant is asked to give an overall rating of the system out of 10 at the time of inclusion. The scores' means ( $\pm$  standard deviation) were calculated. The closer the mean score is to 1, the more negative the assessment is considered to be. The closer the mean score is to 7, the more strongly the assessment is considered to be positive. About the last item, the participant is asked to give a rate of recommendation of the system to his/her family members and friends at the time of inclusion. The data were recorded using Microsoft Excel (2010) ® software.

#### IV. RESULTS

##### A. Characteristics of the population

As of 1 March 2021, twenty-two volunteers have been included in the study. The mean age was 87.0 years ( $\pm$  3.7). There were sixteen women and six men. Ten participants lived in their own house and twelve in a senior residence. The majority of the participants belonged to a higher socio-professional category. Most of them had, personally or through their children, a link with the health professional or academic environment.

##### B. Questionnaires on the *a priori* acceptability

On average, volunteers were not very familiar with information and communication technologies (mean score for prior experience towards ICTs = 3.7 ( $\pm$  1.1); mean score for prior experience towards health monitoring technologies = 3.9 ( $\pm$  1.3)). While they all had a mobile phone, they did not all have a computer or a tablet at home. Older adults living in their own homes were more often equipped with ICTs than individuals living in a senior residence. Overall, attitudes (mean score = 4.8 ( $\pm$  1.3)) and *a priori* usability of the device (mean score = 5.0 ( $\pm$  0.9)) were rated moderately by volunteers, whereas *a priori* comfort of use (mean score = 5.8 ( $\pm$  1.2)), *a priori* utility (mean score = 6.0 ( $\pm$  1.0)) and *a priori* intention to use (6.1 ( $\pm$  0.8)) were better rated. The influence of family members and friends in initiating ICTs' health monitoring was evaluated moderately (mean score = 5.5 ( $\pm$  1.5)). At the end, the overall score out of 10 (average score = 8.0 ( $\pm$  1.4)) and the rate of recommendation of the system to family members and friends at the time of inclusion (83.0 % ( $\pm$  17.7)) were favorable to the

system, despite a moderate evaluation of the *a priori* acceptability. This could be explained by the positive feeling of participating in a research protocol, and the excitement of novelty and discovery [26]. The results of the *a priori* acceptability of the system are summarized in Table I.

TABLE I. *A PRIORI* ACCEPTABILITY OF THE SYSTEM

<i>A priori</i> acceptability themes	Questionnaires' scores	
	Mean scores (SD)	Min-max scores
Prior experience towards ICTs	3.7 ( $\pm$ 1.1)	1 - 7
Prior experience towards health monitoring technologies	3.9 ( $\pm$ 1.3)	1 - 7
Attitudes towards ICTs	4.8 ( $\pm$ 1.3)	1 - 7
<i>A priori</i> utility of the system	6.0 ( $\pm$ 1.0)	1 - 7
<i>A priori</i> usability of the system	5.0 ( $\pm$ 0.9)	1 - 7
<i>A priori</i> comfort of use	5.8 ( $\pm$ 1.2)	1 - 7
Influence of family members and friends in initiating ICT's health monitoring	5.5 ( $\pm$ 1.5)	1 - 7
<i>A priori</i> intention to use the system	6.1 ( $\pm$ 0.8)	1 - 7
Overall rating of the systems at the time of inclusion	8.0 ( $\pm$ 1.4)	1 - 10
Rate of recommendation of the system to family members or friends at the time of inclusion	83.0 ( $\pm$ 17.7)	0 - 100

ICTs: Information and communication technologies  
SD: Standard deviation

#### V. DISCUSSION

This study underlines the modulation of the *a priori* acceptability of an information and communication technology, according to different factors as presented in the 2016 Bel's study. Indeed, according to Bel: "prior experience towards known generic objects indirectly predicted the intention to use the unknown object, via mediation by attitudes towards generic objects, prior experience with specific objects and value/expectations towards the use of the unknown object". Conversely, we reported in the present study that poor or moderate rating of prior experience with known generic and specific objects and attitudes towards ICTs did not appear to alter participants' intention to use it. Besides as reported in Bel's study, our results also highlighted the indirect influence of the subjective norm [mainly the influence of the social environment] on the intention to use of this developing technology [20].

The strengths of this study lie firstly in the assessment of the acceptability of an information and communication technology in a population of people aged 80 and over, rarely explored in the literature [24]. Furthermore, the system is unique in that it is evaluated immediately with the target audience. Indeed, in 2013 Quiguer explained that "by remaining 'impervious to the reasoning that can be deployed in an ecological environment'

(Reerink-Boulanger, 2012, p.104), the knowledge developed through the completion of these questionnaires does not provide the critical content on which to act in order to allow effective appropriation of the systems, which remains the goal of any technological implementation” [21]. Overall, user involvement from the start of the design phase of a new technology is essential, so designers can improve the development of the technology at the very beginning of the developing process. Moreover, in this way, older users can develop empowerment and so their well-being [26, 27]. Thus, the acceptability of interventions in health promotion would be improved by the integration of individuals throughout the project process [23].

The main limit of this study is the intrinsic limits of acceptance theoretical models that helped to develop the acceptability questionnaires. According to Bobillier-Chaumon and Dubois in 2009, “new technologies include change factors that cannot always be anticipated *a priori*”. The use of quantitative questionnaires alone does not always reflect real-life situations, and the mean scores obtained from the questionnaires do not usually reflect the reality of the heterogeneity of people, particularly older adults [19, 28]. Therefore, we decided to lead a parallel prospective qualitative study assessing acceptability of the system to obtain new perspectives of this topic. Results are in progress.

Finally, if the system under study is scientifically validated in the future, the platform would integrate the 'healthy ageing' strategy [29, 30, 31]. However, the right to know a level of risk to one's health should not oblige individuals to use this tool. The "agentisation process" triggered by public health policies [32] must not, in our view, be a source of guilt for individuals, whether or not they take advantage of this system. Similarly, the right to incompetence remains a right and the empowerment of individuals must not be the only response to improve the individuals' well-being. It must be part of a global health promotion project, via its five areas of reflection, at the risk of increasing social health inequities [25, 33, 34, 35].

## VI. CONCLUSION

The results shown in this study are encouraging and in favor of an intention to use rather favorable to the developing system, despite an *a priori* acceptability judged rather moderate, probably due to the numerous connected devices to use. Simplicity of use and perfect technical condition seem to be other very important factors for its acceptability. Whereas they are not totally consistent with the literature, those results allow the study to be continued by enriching Bel's model used as a reference in this project and to better understand the actual use of the system beyond its *a priori* acceptability.

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