Generating a new Interview Method by using Sensing Technology to Assess Human Emotions

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Abstract: This study aims at generating new interview methods for obtaining more detailed information regarding human emotional factors by utilizing sensing technology. It can improve the weaknesses of qualitative research past discussions have pointed out, and develop the validity of collected data and more objective analysis of collected data in qualitative research. As the first step for a new research method, the study uses two types of sensing device which assess the emotional condition of an interviewee. The first device is ST technology, voice analysis software and a system of emotion estimation. This device using voice analysis defines what emotional condition the interviewees have. When the interviewee makes a statement, the ST technology can investigate his-her emotional condition, such as whether the interviewee stated it disappointedly, delightly, or angrily, while the conventional coding simply relies on text data. The second device is WHS-1, portable sensing device. This device investigates whether the interviewee stated certain things in a relaxed or stressed condition by measuring heart rate and analysing the condition of autonomic nerves. The study finally adopts both devices to precisely assess the interviewee's emotional condition, and demonstrates that the two devices enable the researcher to obtain closer view of the interviewees. The study suggests that generally the two types of sensing device can play a supportive role in analysing emotional factors for interview research. While the researcher can only ascertain stressful or delightful factors based on coding analysis, using sensing devices enables the researcher to identify how stressful or joyful the interviewee is, and why they are in this state, ie. are they stressed due to anger or sorrow? It is expected to enable the researcher to more deeply consider the reason the interviewee is in a certain emotional condition, and also lead to contextual or theoretical discussion.

Keywords: interview method, qualitative research, sensing technology, emotional factor

1. Introduction

This study aims at generating a new interview method of qualitative research, by assessing interviewee's emotional condition in more detail than the conventional coding method. This method is expected to be used for improving various kinds of communities, and in particular, can be expected to help improve social interactions between elderly people and care providers. Several countries are now faced with an aging problem. In particular, the Japanese population took a downward turn in 2005, and Japanese society is now comprised of 21 per cent of over 65 year-old people, which Japan has never experienced. The working population of Japanese society is expected to decrease rapidly, and society will be largely occupied by elderly people in the near future. Discussion is now being held on how to generate a sustainable super-aging society. Due to this situation, the national government initiated public nursing care insurance ten years ago, and a large number of senior businesses have been generated, including elderly care services, hospices, nursing home services, and home help services. However, the care business for the elderly has the severe problem that a lot of care workers quit their jobs because of psychological stress. One of the reasons is that care workers are not motivated to provide better care services because they cannot interact with the care receivers very well. For example, care workers cannot understand whether the elderly really enjoy their current circumstances. The elderly who can express their intentions can enjoy their care services, such as listening to music. However, the care receivers may become unwilling or hesitant to make requests of those providing care, as they do not want to be thought of as troublesome or a nuisance. For example, the care receivers sometimes may not feel comfortable saying, "I want to go to bathroom. Please help me." In order to investigate this factor, interview or survey is regarded as an important method. However, several senior people cannot necessarily express their own opinions, and especially senior people who require nursing care might have difficulty in speaking.

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The care business for the elderly suffers the severe problem that a lot of care workers quit their jobs because of psychological stress. It is a huge problem for Japan, which expects to become a super-aging society in the near future. As the aging population grows rapidly, the short-handedness of care workers will also grow into a serious problem. Japanese society now needs to deal with this problem. The survey says that one of the main reasons that care providers feel stressed is that they cannot understand whether they are providing appropriate care services to care receivers and whether care receivers are really delighted by their services (Care Work Foundation, 2005). While *Veterans* take a seat-of-the-pants approach, a lot of care providers of several years experience still wonder what to do. On the other hand, as a Japanese sociologists points out based on her research (Ueno, 2011), care receivers may also hesitate to make requests of care workers. In other words, the care service needs to solve both sides of the misunderstandings and discrepancies, and promote human integration. Based on this situation, this study, considering the needs for improving the interaction between elderly people and their care providers, discusses the possibility of new methods of qualitative research by analysing emotional conditions of speakers. First, the study reviews past discussions on the analysis of emotional conditions of interviewees and digital tools for interviews and analysis. Next, the study introduces two sensing devices, ST and WHS-1, and demonstrates how these express emotional conditions when conducting interviews. Finally, the study conducts mixed analysis, conventional coding method, ST, and WHS-1, and shows how the two sensing devices enable the researcher to more accurately analyse interview data. In concluding section, the study summarizes the benefit of using the sensing devices and outlines necessary further development.

2. Research method

2.1 Analyzing emotional factors

In providing elderly care services and developing interaction between the elderly and care providers, understanding human emotional factors is paramount. Past literature claims that the qualitative approach is appropriate for an inquirer involved in sustained and intensive experience with participants, as it focuses on participants' perceptions and experiences by using multiple methods that are interactive and humanistic (Creswell, 2003; Fraenkel & Wallen, 1990; Merriam, 1998; Thomas, et al., 2005). In the process of qualitative research, several new aspects emerge by interpreting and analyzing data. This is because qualitative research develops a description of an individual or setting, and interprets and concludes personal or theoretical new meaning (Bogdan & Biklen, 2003; Thomas, et at., 2005). Thus, qualitative research requires the interpretation of the settings from multiple perspectives. Based on these arguments, in order for care providers to consider and sometimes create new services favorable for various types of elderly person, the qualitative approach is appropriate as it clarifies favorable care services for each elderly person.

In order to conduct qualitative research, the researchers collect data based on open-ended observations, interviews, documents, which include e-mails, scrap books, and audiovisual materials, including photographs, videotapes, computer software and film (Creswell, 2003). Among these data, qualitative researchers have often used written documents of interview data when they analyze when and how people think (Akiyama, et. al., 2006). When analyzing the interview data, qualitative researchers analyze the documents line by line, following the approach outlined by Strauss and Corbin (1998) (Easterby-Smith, 2008). Even when the voice of interviewees is recorded and researchers analyze the emotional state of the interviewees, analysis is mainly based on written records (Remenyi, et. al., 1998).

Past discussions point out there is a bias the qualitative researchers bring to the study (Creswell, 2003; Remenyi, et.al., 1998). The analysis of written accounts is not enough to understand interviewee's subjective experience, based on the argument that qualitative researchers seek to understand the context or setting of the participants through "visiting this context and gathering information personally" (Remenyi, et.al., 1998). For elderly care, researchers need to consider people's contextual differences, as some of the elderly may hesitate to clearly request what they really want to do. Sometimes, even if they do not enjoy care services, they may say, "I am enjoying this service." The problem is when a care receiver makes this statement, the interviewer cannot make the assessment that they are not as happy as they maintain. Therefore, researchers need to seek more multidisciplinary research methods in order to objectively analyze what people really think based on a multilateral approach. This problem may affect the subsequent interpretive processes where the researchers aim at understanding why certain things occur. In order to validate the accuracy, qualitative researchers have used member-checking and triangulation of different data sources. However, even these methods cannot

help avoiding subjective biases completely. When a researcher considers emotional factors in detail, more objective methods based on scientific research can provide further validation of accuracy.

There is a research tool for measuring human emotions, such as AdSAM. However, this tool is for marketing research, and mainly for measuring a large range of human emotions (AdSAM , 2010). In order to analyze human emotional factors, researchers mainly use written documents. For example, AsSAM can be used when analyzing whether targeted consumers make purchasing decisions and how they feel when they see an advertisement. On the other hand, nursing care for the elderly requires one-to-one based care and offers the elderly emotional support.

Zarit (1980, 1990) creates a specific scale for a care provider's burden, "Zarit Caregiver Burden Interview: ZBI", which includes physical, psychological, and economical burdens of care providers brought by supplying care services. This scale is composed of 22 questions regarding the burden of care services, and questionees choose one of the five scales. It is useful to clarify what kind of burden a care provider has and what factor is the most severe for care providers. However, in the super-aging society, interaction between care providers and care receivers is paramount (Ueno, 2011), and it is necessary to understand when and how people feel at a specific situation, such as during maintaining hygiene and meal time. This will bring about a more sustainable aging society, where both understand each other's feelings and are motivated to communicate.

Thus, in order to provide sustainable care services, it is necessary to collect data on how people feel in various situations. One-to-one care based on specific situations requires consideration of what senior people feel is different depending on individual experiences and emotional conditions which are socially and historically constructed through experience. For example, it depends on the social value they belong to whether senior people can easily express what they want. In some societies which value low-assertiveness, such as Japan, senior people may not be encouraged to express their needs for care services (Hartog, 2004). They may feel stressed to listen to music which they are not interested in every day and is different from their conventional life style.

2.2 Digital tool

Qualitative researchers have been discussing the utilization of various types of technological devices. Brown (2002) introduces multimedia databases which can capture, store and retrieve digital data. Several articles point out Maxqda, ATLAS-ti NUD*IST and NVivo as tools for digital data analysis (Bryman & Bell, 2007; Easterby-Smith, 2008; Lewins, et al., 2007). Knoblauch et al. (2008) discuss how the development of information technology enables researchers to generate new visual research methods, including interpretative analysis of video and photography.

However, there is little discussion among qualitative researchers regarding analysis of human emotional and physical condition by technological devices. Although audiovisual materials are convenient for researchers to directly understand their reality, problems have been pointed out, such as difficulty of interpretation (Creswell, 2003). This study aims at analyzing human emotional factors by adopting two technological devices. Both of them use advanced sensing technology and aim at analyzing emotional condition by collecting data inside the human body, such as human voice and heart beat during the interviews. The devices are developed based on scientific research. Thus, assessment of emotional condition is based on more objective data rather than a researcher's assessment, which is based on the researchers' skill.

3. Research method and analysis

Based on these arguments of the preceding section, this study aims at analyzing "*how they felt*?" more objectively by conducting interviews. The study focuses on the stages of collecting data and interpreting the collected data, and is just the first stage of generating new interview and analytical method. The study may enable researchers to offset the weakness of conventional qualitative researchers, which are pointed out in past discussions (Merriam, 1998), as it can enable the collection of more valid interview data and analyze interview data in a more objective way. In this section, researchers conduct case studies by using ST and WHS-1 and compare the interviewee's statements with their emotional conditions and support the information which written documents cannot assess. The study selects the interview data of general people who can express what they feel, as statement from interviewees who cannot express their opinions cannot be compared to their emotional conditions.

3.1 Sensibility technology ST emotion (ST)

The first device is a product of AGI Japan Inc. "Sensibility Technology ST Emotion", voice analysis software and system of emotion estimation, which measures emotional parameters in speech. This software assesses what emotional factor is prominent, anger, joy, sorrow, and calmness when a person states a certain thing. The software uses power, fundamental frequency (F0), and their transition as well as speed and intonation of speech to analyze the voice, as F0 and power refer to the vibration of vocal codes and may be an expression of natural human emotion (Mitsuyoshi et al., 2007). The system detects changes of feeling or emotion that a person does not notice, and it can detect more than 70% of human emotion (Tokuno et. al, 2011). The study analyzes interview data using ST technology and compares it with the analysis based on written documents of interviewee's statements. The researchers obtained guidelines from AGI for interpreting the outcome of the ST analysis. Based on Mitsuyoshi (2008) and the guidelines, the researchers interpreted the interview data.

3.1.1 Analysis based on coding

The researchers selected three interviewees. The first person is a male care worker, with a wife and 8 month old girl. The second person is his wife, who used to be a care worker. She quitted her job after marriage and childbirth. The third person is a female care worker, with a husband and a child. They were interviewed about how they feel about their present life.

On analysis of how a care provider and his wife think about their present situation, one theme emerged for each person,

1. Satisfied with his present life：interviewee 1

1-1. Satisfied with their daughter's smile.

> *Her smile is really great. I like both the smile of the elderly and children (Interviewee 1)*

1-2. Satisfied with the elderly smiles.

> *I like the elderly's smile. I see their smiles a number of times so I cannot quit my job. I like their smile. (Interviewee 1)*

2. Anxious about the future: interviewee 2

2-1 concerned about their daughter in the future: Interviewee 2

> *I am anxious about whether I will be able to do financially for my daughter what my parents did for me. (Interviewee 2)*

3. Satisfied with her present life: Interviewee 3

3-1: Satisfied with her job

> *I like the elderly. (Interviewee 3)*
>
> *I enjoy my work. I think this is my true vocation, because I enjoy my work.*
>
> *(Interviewee 3)*
>
> *My boss asked me, "Do you like your job?" and I said, "Yes. I like it." (Interivewee 3).*

Based on this initial coding, a researcher may think that interviewee 1 is satisfied with his present situation as he can look at his daughter's and elderly people's smiles, while his wife is financially concerned about her daughter because of her husband's low income. Interviewee 3 is satisfied with her present situation as she likes interaction with the elderly.

3.1.2 Analysis based on the ST technology

On the other hand, the ST displays the two people's feelings in more detail. Although interviewee 2 certainly talked about her concern about her daughter in the future, her emotional condition was "CALM" during this statement. Rather, she clearly presented "SORROW" when she explained about their financial situation.

Compared with people who graduated from university and work at a business office, in our work, care providers must work much harder.(CALM) But our income is too low. (SORROW).

We do not have discretionary money after childbirth. (SORROW). Our common hobby is bringing up our child. (CALM)

The ST can propose different messages from the analysis of interview documents. Based on the analysis of the written interview documents, a researcher cannot understand whether the interviewee 2 just told the truth about her financial situation, or is unsatisfied with her present life. On the other hand, the ST suggests that his wife is more disappointed about the situation due to her husband's low salary, as she does not have discretionary money. She certainly may have strong feelings about the low income of care providers despite their hard work. Tokuno et. al. (2011) show that strong stress increases the feeling of "sorrow" and decreases the feeling of "joy" Therefore, based on the ST analysis, it can be said that she may be stressed with her present financial situation rather than her daughter's future. On the other hand, interviewee 1 did not display "SORROW" during the interview, although he explained about his low salary. This implies that while his wife is highly concerned about her husband's low salary, he is not so disappointed and takes it coolly.

The ST also has the possibility to clarify the difference in human satisfaction between Interviewee 1 and Interviewee 3. Interviewee 1 consistently presented "CALM" whatever he was asked. Even when he explained about his job and his favorite elderly smile, his emotional condition was calm. This implies that he is very relaxed with the smile of the elderly and his daughter. The main reason that he continues to be a care worker was that he can be relaxed with their smile.

Interviewee 3 shows more "JOY" for the elderly. In particular, she felt delighted when she talked about how she decided on her job. She explained that as a high school student, she wanted to be a children's nurse, and changed her mind when she experienced voluntary practical training for elderly care. During this talk, she displayed JOY to a certain degree. After that, when she stated "I also like the elderly," she displayed a stronger joyful condition. This suggests that she may really like the elderly and her job. Furthermore, she displayed "JOY" when she stated, "I realized that there are many misunderstandings about my job," and talked about the process of how she attained her work-life balance from the initial biased idea that it is impossible to balance both. Based on analysis of documents, it is not clear whether she is satisfied with her working style, while the ST displays she is extremely satisfied with her work-life balance. This may imply that the main reason that she continues her job is that she is more motivated by interaction with the elderly under a work-life balance.

Table 1 summarizes the analysis of the three interviewees.

Table 1: summary of analytical difference between coding and ST

	Analysis based on statement	Analysis based on the ST device	Final analysis
Interviewee 1	Satisfied with his present life *I like the elderly's smile. I see their smiles numbers of times so I cannot quit my job. I like their smile.*	Neutral with his low salary. *We have not been purchasing clothes (CALM).*	He is satisfied with his present life, and not so stressed with his family's financial situation.
Interviewee 2	Concerned about her daughter in the future. *I am anxious about whether I will be able to do financially for my daughter what my parents did for me.*	Stressed with the husband's low salary. *We do not have discretionary money after childbirth. (SORROW).*	She is not satisfied with her present life. She is stressed with her husband's low salary and concerned about her daughter.
Interviewee 3	Satisfied with her present life, as she likes interaction with the elderly. *I think this is my true vocation, because I enjoy my work.*	Feel joyful to do her job. *I also like the elderly. (as well as children)(JOY)* *I realized I was being biased towards my job. (JOY)*	She is satisfied with her present life, as she enjoys her job and her present work-life balance.

3.2 WHS-1

The data shows that the ST software sometimes includes some errors. For example, when interviewee 1 looked at his daughter, the ST interpreted his sigh as “ANGER” and then his laughter as “JOY”. Based on his comments and smile, it is obvious that he feels JOY when he looks at his daughter. The ST also sometimes mistakenly interprets “STRESS” for a joyful condition, when people laugh in a loud voice. Thus, the ST cannot analyze all of the voice data. In order to analyze emotional condition during talking more precisely, this study adopts the second device, WHS-1, which is a small-sized portable sensing device. It measures human biological information, such as heartbeat, which includes wave shape and cycle of human heartbeat, temperature of human body surface, and triaxial rate of acceleration, and monitors a human biological condition based on specific analysis by PC software.

This sensing device is produced based on the past research which shows that LF/HF, Low Frequency / High Frequency, conducted by spectral analysis of heart beat variability, is high when sympathetic nerves activate (Takada, et.al., 2005). As this device mainly clarifies a general trend of emotional condition over several hours, while the ST assesses the emotional condition phrase by phrase, it has been mainly utilized for analysis of severe depression. Therefore it is necessary to clarify to what a degree this device shows emotional condition over a short period of time, such as 2-3 minutes. In order to assess the usefulness of this device as a complimentary source of interview data, the researchers measured a person’s heart beat and worked out LF/HF figures during the conversation and analyzed human emotional conditions. The examinee is female, 23 years old. She wore the sensing device, and talked with the researcher. The researcher sometimes had a very pleasant conversation with her, such as her hobbies and sometimes strongly ordered her to do so much work within a very short time.

Table 2 shows the difference of LF/HF figure among her calm condition, relaxed talking and stressful talking. It shows each average figure during a temporal sequence of three minutes. The comparison shows that the LF/HF figure is relatively higher at the stressful condition than relaxed talking and calm condition. During the calm condition, the LF/HF is lowest. The data shows that when the examinee enjoyed relaxed talking, she was in a certain level of excited condition. As the emotional trend is different between the three conditions even within 3 minutes, it can be useful to complement the analysis of interview documents.

Table 2: Comparison of LF/HF figure between calm, relaxed, and stressful conditions

	Calm condition	Relaxed talking	Stressful talking
average	3.36	6.56	8.52
Standard deviation	1.23	2.95	3.73

3.3 Mixed analysis

Finally, the researchers conducted an interview regarding when a care provider felt stressed and relaxed and analyzed the interview by coding, the ST device, and WHS-1 device. The interviewee is a female, 43 years old, used to be a care provider. The researcher asked her to look back at her job experience and explain about her stressful and relaxed experiences. Based on the initial coding, several codes which present stressful occasions and relaxed occasions came out. The researchers compare these codes with the ST results and WHS-1 results. Based on these results, the ST and WHS-1 well support stressful factors based on the coding. For each code, the result of the ST analysis will be explained in the following sections based on AGI’s guidelines and Mitsuyoshi (2008). Transition of LF/HF measured by WHS-1 during the interview is shown in Figure 1, while it is impossible to show the transition of all figures of the ST results due to space limitation. Figure 2 shows one part of the ST result. By and large, the ST displays “ANGRY” very frequently. This implies that the interviewee was very stressed about her experience as a care worker. During the interview, she looked back at her experience and presented stress, complaints and anger. On the other hand, the ST rarely displayed CALM while she was talking, while WHS-1 sometimes displayed a relaxed condition of the interviewee (Figure 1). The following explains several stressful and relaxing factors based on three types of analysis.

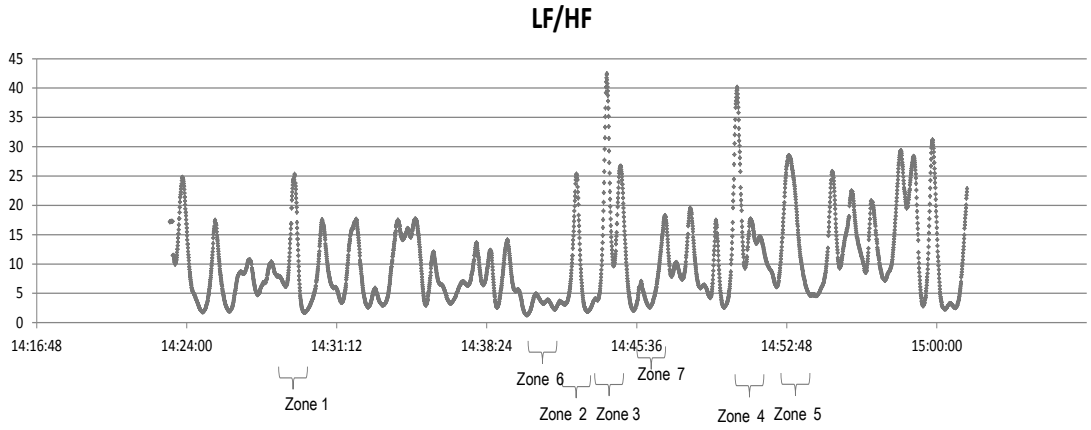

Figure 1: Transition of LF/HF during the interview

1. Stressful factors

1-1 Required heavy labor in order to avoid fatal accident despite insufficient physical ability

> *Giving a care receiver a bath is the heaviest labor among care work, such as standing the elderly and moving them to the wheelchair. I was scared to think if I mistakenly broke their clinical instruments, including the tube of respiratory apparatus. I was really scared to give these care receivers a bath. I was so scared and wondered what to do if I broke the instruments. I cannot do anything to avoid theses types of accidents as the elderly are so heavy.*

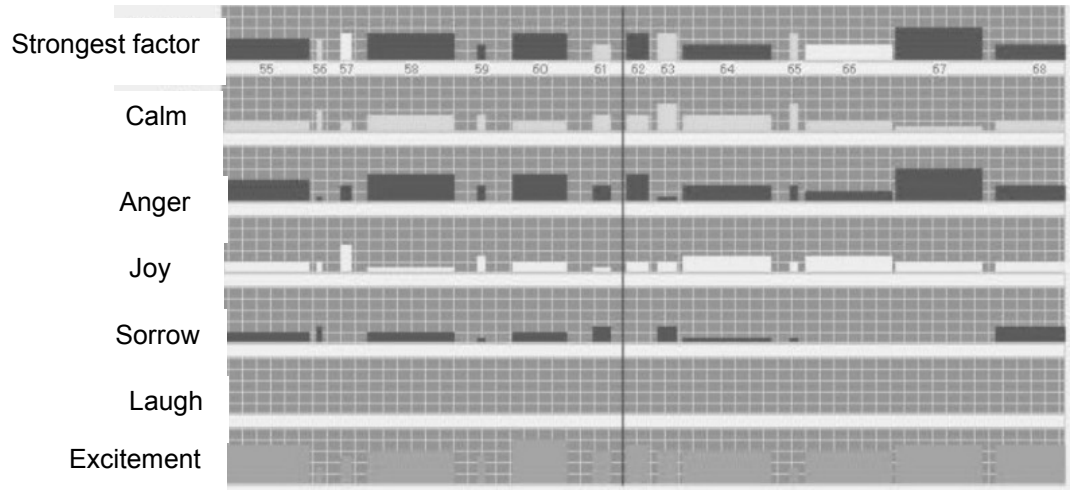

Figure 2: ST result which displays a stressful condition

The first stressful factor that came out during the interview was heavy labor required to avoid a fatal accident for the elderly. WHS-1 also displayed high LF/HF during this section of over 20 seconds (zone 1 in Figure 1). The second half of Figure 2 shows the ST result of this section. During this section, based on the ST, she felt angry with high excitement, but her joyful feeling was also sometimes high. Based on the AGI guideline, it can be said that the interviewee felt joyful as the interviewee listened to her and understood her difficulty. Considering the interviewee's statement it implies that she wanted to *emphasize* heavy labor, such as giving care receivers a bath.

1-2 Care receivers' negative reaction to her services

> *Giving the care receivers who hate taking a bath was really difficult. Some of them strongly refused and sometimes told lies that they took a bath yesterday. But their bodies smells badly. So I tried to persuade them to take a bath. But if they completely refused, I reported, "they refused."*

During this section, the ST displayed ANGRY and sometimes JOY with a certain level of excitement. Considering the interviewee's statement and AGI guideline, this implies that the speaker may be a little bit fed up with the situation and wanted the interviewer to understand her hardship. The LF/HF figure is also extremely high for 25 consecutive seconds (zone 2 in Figure 1). Thus, based on coding, it can be said that this care worker is stressed with the difficulty of persuading care receivers to do necessary things. Furthermore, the ST and WHS-1 suggest that she may also be fed up with the elderly.

1-3 human relationship with incompatible colleagues in her work site

> *Ummm…human relationship in the care home… Yes. There are several troublesome care providers. I think they started care provider jobs because they cannot be working people. I was fed up with them.…One of them talked about herself that she used to resist going to school in a meeting room where there were a lot of complete strangers existed.*

During this section, the ST displayed that the speaker felt ANGER and SORROW. This implies that the speaker sometimes felt angry and sometimes got bothered by the situation. The LF/HF figure was also extremely high and this condition continued over one minutes while talking about this topic (zone 3 in Figure 1)

1-4 Need to take a responsibility for the accident that could not be avoided

> *Even if I just observed the situation where care receiver exercised and fell down, I needed to take responsibility, and was required to write a report about why this happened. I was required to watch the care receiver at that time. But my colleague stood by me and said "Ah it cannot be avoided."*

Based on the analysis of the interview document, the next stressful factor for her can be necessity to take responsibility for an accident which could not be avoided. During this section, the ST displayed that the speaker mainly talked with ANGER, and sometimes also mixed with JOY. Based on the AGI analysis, this may imply that the speaker talked with anger and self-assertiveness. The WHS-1 shows that as LF/HF is very high and the high level continued for over 90 seconds (zone 4 in Figure 1), she may feel stressed.

1-5 not understanding care receiver's physical condition

> *I was disappointed when a care receiver discharged his bowels in the bath. I needed to restart the whole process of giving a bath from scratch, and washing the bath was also heavy work. I felt if they gave me even a small sign. Some of the elderly did this as a joke….I do not think they were malicious…ummm.*

During this section, based on the ST, the care worker felt angry and subsequently sorrowful. The LF/HF figure was also high and the high level continued for one minute (zone 5 in Figure 1) This implies that the care worker felt angry that the care receiver did what the care worker did not expect, but was stumped about not understanding the care receiver's condition, which brought about this situation.

2. Relaxing factors

2-1 communication with the care receivers

> *I was happy when I interacted and communicated with the elderly. The most delightful thing was that I was sometimes able to communicate with the care receivers, even if they suffered Alzheimer's disease. As they suffered from the disease, they sometimes forgot what they said just after speaking. But sometimes, I heard what I did not know, like a war story.*

During this section, LF/HF remained at a low level for one minute (zone 6 in Figure 1). This means that she was relaxed during talking about her delightful things. On the other hand, the ST suggests that she felt angry and joyful. During this section, she imitated the care receiver's voice or colleague's voice. Thus, this imitation may sometimes be interpreted as ANGRY.

2-2 human relationship with compatible colleagues in her work site

When our care center held a barbeque party, we saw a lot of beef on our table, even if the elderly would not eat beef. But after the party, the beef was gone…(laugh) Who ate it! Maybe the male care providers (Laugh)

During this section, the ST suggests that she sometimes felt JOY and sometimes ANGRY. But it was obvious for the interviewer that she talked about joyful experiences at her work site. Thus, it can be said that her laugh was interpreted as ANGRY. It was confirmed by the low LF/HF figure for one minute (zone 7 in Figure 1).

3. The result of the analysis

The result of the mixed analysis is summarized in Table 2. The results suggest that using sensing devices enables researchers to obtain a closer view of the reality of the interviewees.

Table 2: Summary of the mixed analysis

	Initial codes	ST analysis	WHS-1 analysis	The result of the analysis
1-1	Stressed with heavy labor required	Wanted to complain about the heavy labor to the interviewer	Highly stressful	Stressfully pleaded for understanding about her heavy labour
1-2	Stressed with negative reaction to her services	Wanted to complain about her difficulty and fed up with care receivers	Highly stressful	Stressfully made a plea to the interviewer to understand her situation
1-3	Stressed with human relationship with incompatible colleagues	Felt angry and got distracted	Highly stressful	Stressed and angry about being distracted by the human relationship
1-4	Stressed with need to take a responsibility for care receiver's accidents	Felt angry and sometimes self-assertive	Highly stressful	Highly stressful and angry about her responsibility system
1-5	Stressed with not understanding care receivers' physical condition	Felt angry and helpless about	Highly stressful	Highly stressed and felt helpless about her situation
	Initial codes	ST analysis	WHS-1 analysis	WHS-1 analysis
2-1	Communication with care receivers	Includes some errors	Highly relaxed	Felt relaxed on communication with the care receivers
2-2	Human relationship with compatible colleagues	Includes some errors	Highly relaxed	Felt relaxed with communication with compatible colleagues

When the interviewee made a negative statement about her work in 1-1 code, the ST indicated that the interviewee wanted to complain about her job. This implies that as the interviewee is open-minded to the interviewer, the interviewee expected the interviewer to understand her real situation. Also, considering that the WHS-1 showed that the interviewee was highly stressed, she was never in a calm state and stressfully pleaded for understanding of the fear of causing fatal accidents. In 1-2 code, it can similarly be said that she stressfully made a plea to the interviewer that she was fed up with the difficulty in persuading the elderly to receive necessary services. To understand that the interviewee is open-minded to the interviewer is highly helpful for effective interview research. As Easterby-Smith, et, al. (2008) discussed, it is necessary for an interviewer to understand what the interviewee wants to say, and what they do not want to say. Obtaining trust and constructing an open relationship with the interviewee are important but difficult interviewing skills in order to obtain from interviewees the data that an interviewer really wants to know (Easterby-Smith, et, al., 2008). In this study, considering the result of the ST device, it can be said that the interviewer was successful in obtaining detailed information on the interviewee.

This analysis also enables a researcher to consider the background context of why the interviewee stated certain things, as the data obtained by the sensor technology is expected to enable the researcher to analyse further why the interviewee stated certain things in certain emotional conditions. For example, the results of ST and WHS-1 suggest that she stressfully felt angry and distracted about human relationships and also self-assertively felt angry about the responsibility system in her organization

based on 1-3 and 1-4 codes. These imply that she were not satisfied with the management system of her organization. It can also be possible to think that the management of her organization was under stressful conditions. It can be thought that her organization forces the service providers to take all responsibilities and many care providers, may feel stressed. Furthermore, 1-5 code suggests that she was stressed and felt helpless about not understanding the care receiver's condition. These results may enable the researcher to consider the necessity of improving the management system of care provider's organization by supporting the care providers to help focus on constructing intimate relationships with care receivers rather than being distracted by human relationships with their colleagues.

On the other hand, the researcher needs to consider the possibility of errors which the devices may cause. For example, regarding delightful occasion, the ST sometimes sent confusing messages to the researcher, such as misinterpretation of imitation of other people's voice and laughing as ANGRY, while the rest of the statement showed JOY in code 2-1 and 2-2. The WHS-1 supported these, and it enabled the researcher to interpret that the interviewee felt relaxed and joyful about the communication with the elderly and her compatible colleagues.

4. Conclusion

This study discussed the possibility of analyzing emotional factors of interviewees by using sensing devices. In particular, the researchers focused on the stages of collecting data and analyzing interview data and discussed the possibility of generating new methods of collecting data based on higher levels of validity and interpreting human emotional conditions more objectively. The study suggests that utilizing the sensing devices enables more objective analysis regarding interviewee's emotional conditions, while conventional methods cannot avoid a certain degree of researcher's subjective bias. For example, when the interviewee complains about their jobs, the analysis results are different between the stressful and calm conditions. When the interviewee angrily complained about their jobs in a stressful condition, the data suggests that the interviewee has a certain ideal situation and finds the present work condition as a problem. On the other hand, when the interviewee complained about their jobs in a calm manner, it can be thought that the interviewee has an emotional detachment and views this as the nature of the job. Using these devices can contribute to the development of qualitative research in terms of strengthening validity of collected data and more objective data analysis. However, considering certain inconsistencies and sample size, further related discussions and detailed data are necessary for future research.

Based on the fact that the sensing devices can assess the human emotional condition in detail, they can be helpful for a wide range of business research including the fields of marketing and customer-satisfaction. Especially in Japan, the devices are expected to be used to investigate people who cannot clearly express their feelings and opinions, such as senior citizens, considering that Japan is approaching a super-aging society. By obtaining the emotional condition data of senior citizens, it becomes possible to generate business which senior citizens really want. Exploring the emotions of those in care in detail will connect the emotional gap between care receivers and care workers, and promote communications between each group. By focusing the service on what senior citizens want, sustainable senior businesses can be generated. High-end technology has struggled to accurately measure human emotional conditions. Further technology development can also be expected.

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