A Content Analysis of Odor-evoked Involuntary Autobiographical Memory and Subjective Well-being in Young and Older People: Using Text Mining with Correspondence Analysis

YAMAMOTO Kohsuke†

Abstract

This study examined gender and generational differences in the content of odor-evoked autobiographical memory and subjective well-being. Two hundred young and two hundred older people were asked to record their memories of past events, that is, autobiographical memories, when they were recalled by odor cues in their daily lives using a diary method. The subjective well-being scale was also completed. As a result of the analysis with gender and generation as independent variables, the interaction tended to be significant for subjective well-being, with older people having higher subjective well-being than the young in males, but no such difference was observed in females. In addition, women had higher subjective well-being than men in younger people, but no difference was found among older people. A correspondence analysis of the memory contents by text mining suggested that recalled memory content may differ by gender and generation. In the future, it is necessary to aim for applied development, such as reminiscence therapy.

Keywords：odor, autobiographical memory, aging, subjective well-being,
キーワード：匂い，自伝的記憶，加齢，主観的幸福感

Introduction

The effectiveness of olfactory stimuli as a recall cue has been reported for autobiographical memory, which is the memory of past events (see review, Chu & Downes, 2000a; Hackländer, Janssen & Bermeitinger, 2019; Larsson & Willander, 2009;

† 大阪産業大学　国際学部国際学科准教授
草 稿 提 出 日　10月28日
最終原稿提出日　10月29日

Larsson, Willander, Karlsson & Arshamian, 2014; Saive, Royet & Plailly, 2014; Yamamoto, 2015). Several empirical studies have been published on the topic of odor-evoked autobiographical memory (e.g., Chu & Downes, 2000b, 2002; Herz, 2004; Herz & Cupchik, 1992; Herz & Schooler, 2002; Rubin, Groth & Goldsmith, 1984). Herz and Cupchik (1992), for example, reported that odor-evoked memories tended to be highly emotional, vivid, specific, rare, and relatively old. Rubin et al. (1984) provided odors, verbal labels, or photographs to participants and asked them to briefly describe and rate the retrieved autobiographical memories. Compared to the other cue types, odor-evoked memories were rated as more pleasant and were thought of and spoken of less often. Subsequent studies have found odor-evoked autobiographic memories to be more emotional and vivid and to be associated with a stronger feeling of being brought back in time to the occurrence of the event, compared to memories evoked by verbal labels or other modality cues (Chu & Downes, 2002; Herz, 2004; Herz & Schooler, 2002; Willander & Larrson, 2006, 2007). These studies indicate that emotion is one of the hallmarks of odor-evoked autobiographical memories.

The ARPE (age-related positivity effect) is a high-profile study with older adults regarding autobiographical memory (e.g., Gallo, Korthauer, McDonough, Teshale & Johnson, 2011; Kennedy, Mather & Carstensen, 2004). This effect refers to older adults tending to remember the events of their lives more positively than younger adults. When asked to generate autobiographical memories in response to retrieval cues, the number of positive events tends to increase with age, compared to negative events (Dijkstra & Kaup, 2005; Ros & Latorre, 2010). Older adults also tend to rate retrieved events more positively than younger adults (Comblain, D'Argembeau & Van der Linden, 2005; Rubin & Schulkind, 1997).

Does the ARPE occur during autobiographical memory recall by odor cue? Yamamoto and Sugiyama (2016) conducted a diary study in which older and young people were asked to rate the pleasantness or unpleasantness of autobiographical memories recalled by odor cues in their daily lives. The results showed that older adults recalled more positive memories than the young people, the so-called ARPE. In addition, older adults reported higher ratings of various memory characteristics, such as being emotional and vividness, than the young. Yamamoto (2021a) also found that positive memories were recalled by the ARPE, suggesting that positive memories also

affect subjective well-being. Participants were asked to evaluate the recall characteristics of autobiographical memories by odor cues using a diary method and administered a subjective well-being scale to examine the relationship between the two. The results showed that there were significant correlations between some autobiographical memory characteristics and the subjective well-being scale in both young and older subjects. Yamamoto (2021b) also examined gender differences and suggested that odor-evoked autobiographical memory characteristics may have different effects on subjective well-being in males and females for both young and older people.

Most previous studies have measured the characteristics of memories recalled by odor cues with only scales or ratings. However, when considering the development of applications such as reminiscence therapy for older adults, it is extremely important to clarify what types of content memories are recalled to enhance subjective well-being. Studies on the content analysis of involuntarily remembering autobiographical memories have revealed generational differences (e.g., Schlagman, Schulz & Kvavilashvili, 2006). In this study, I used a diary method to collect data on autobiographical memories involuntarily remembered due to odor cues in daily life and examined the contents of those memories. Specifically, by conducting correspondence analysis using text mining, I will examine whether there are gender and generational differences in autobiographical memories remembered due to odor cues. At the same time, I utilize a subjective well-being scale to confirm gender and generational differences.

Methods

Ethical considerations: The study was approved by the institutional and local research committee of Osaka Sangyo University. The study was performed in accordance with the ethical standards outlined in the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards as well as the code of ethics and conduct of the Japanese Psychological Association. When the participants were screened, the contents of the research were explained to them, and their voluntary consent to participate was obtained.

Participants: Participants were 200 young (100 females, M=24.86 years old, SD=2.63, range 20–29 years old) and 200 older adults (100 females, M=63.65 years old, SD=2.86,

range 60–69 years old). The two groups were recruited from a research firm. Reward points were given to participants in accordance with the regulations of the research firm.

Procedure: Based on previous studies (e.g., Berntsen, 1996; Berntsen & Hall, 2004), the diary method was used. All the instructions were provided online. Participants were asked to access the URL distributed by the research firm from their device (e.g., smartphone) and enter their responses if they recalled a past event unintentionally cued by a specific odor in their daily life. They then recorded the contents of their involuntary autobiographical memories and odor cues and completed 15 questions from the subjective well-being scale (e.g., "1=not at all," "4=very much") developed by Ito, Sagara, Ikeda & Kawaura (2003). The first case that occurred within two weeks of the implementation period was described.

Results and Discussions

The total number of memory descriptions was 200 (100 %) in the younger group and 200 (100 %) in the older group. Data were analyzed using SPSS ver. 27 and KH Coder (Higuchi, 2016).

Subjective well-being: *Means* and *SDs* of subjective well-being in each group were calculated: 39.11 (*SD*=8.62) for young males, 41.43 (*SD*=7.71) for young females, 43.37 (*SD*=6.53) for older males, and 42.86 (*SD*=6.18) for older females. A two-factor ANOVA was conducted with gender and generation as independent variables, and the total score on the subjective well-being scale was the dependent variable. A significant main effect of generational differences was confirmed ($F(1,396)=14.93$, $p<.001$), indicating that the older adults had a higher sense of subjective well-being than the young among men. In addition, the interaction tended to be significant ($F(1,396)=3.69$, $p<.10$), indicating that subjective well-being was higher in older adults than in the young in men, but the difference was not confirmed in women. In addition, women had higher subjective well-being than men in the younger age group, but no difference was observed in the older age group.

Odor Cue: Text mining was conducted based on the descriptions to clarify the content of the odor cues. First, the frequency of occurrence was calculated, and the

total number of extracted words was 1316. In the calculation of the extracted words, words such as "smell," "fragrance," and "odor" were not used, and words such as "金木犀" and "キンモクセイ" were adjusted as synonyms in advance. The top 10 words in the list of extracted words were "Osmanthus" (55), "Softeners" (16), "Flowers" (14), "Shampoo" (11), "Sweet" (9), "Rice" (7), "Incense" (7), "Curry" (6), "Rain" (6), and "Lavender" (5).

The results of the correspondence analysis based on the frequency of occurrence in the four categories of older, young, male, and female are shown in Figure 1. As a result of the analysis, the first axis (component 1) has a contribution rate of 52.34%, which is a dimension that discriminates between older people and young people to a certain extent. However, the second axis (component 2) has a rather low contribution rate of 25.88%, which makes it difficult to interpret by gender. Therefore, in this study, the characteristics of the first axis, which has a relatively high contribution rate and can be interpreted, are examined in relation to gender differences. The distance between men and women tended to be greater among young people, and gender differences were observed. Among young males, items such as "lavender," "shampoo," and "coffee" were distributed in a characteristic manner. For young females, items such as "softener," "outside," and "use" were distributed, and specific cases such as "when I use perfume outside" were confirmed. In older adults, the distance between men and women was close, and there was no clear gender difference. For older adults as a whole, items such as "soy sauce," "incense," "flowers," and "soap" were distributed in a characteristic manner. These results suggest that although there is no gender difference in odor cues among older people, there may be gender differences among the young.

Contents of Autobiographical Memory: Next, to examine whether there are generational and gender differences in the autobiographical memory content recalled by odor cues, text mining was conducted based on the recalled content. First, the frequency of occurrence was calculated, and the total number of extracted words was 7578. Unnecessary words and synonyms were set in the same way as for the analysis of odor cues. First, the top ten occurrences of the extracted words were "nostalgic" (79), "especially" (73), "think" (61), "feel" (39), "action" (38), "myself" (34), "go" (23), "eat" (17), "now" (15), and "then" (15). In this study, I did not summarize the differences between "子ども" and "子供" because I understood them as differences in

expression. The results of the correspondence analysis are shown in Figure 2.

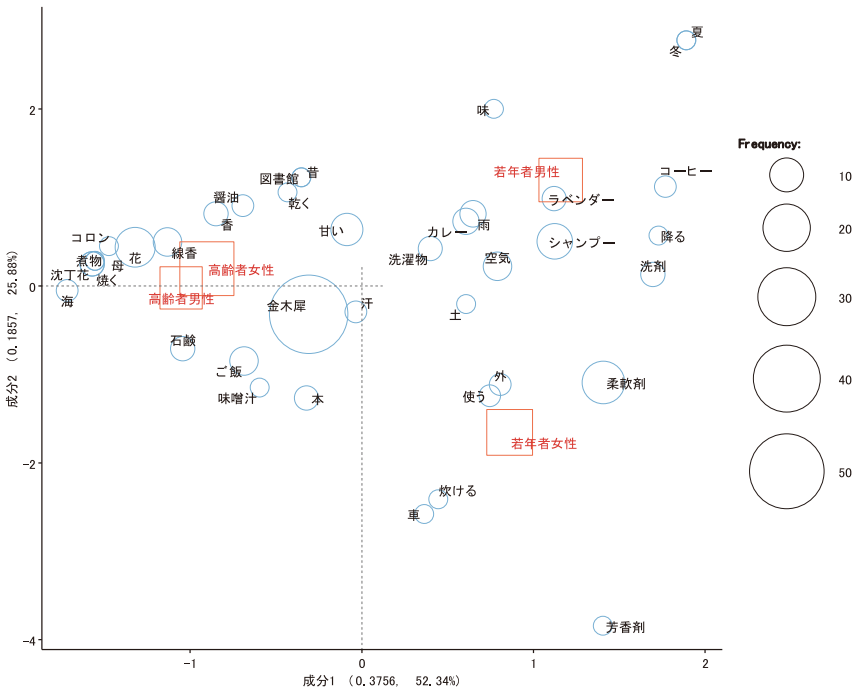

Figure 1　Results of Correspondence Analysis on Odor Cues

Figure 2 shows the results of a correspondence analysis based on the frequency of occurrence in the four categories of older, young, male, and female. The analysis shows that the first axis (component 1) has a contribution rate of 51.29%, which is a dimension that discriminates between older adults and the young to a certain extent, while the second axis (component 2) has a slightly lower contribution rate of 29.60%. However, the contribution rate of the second axis (component 2) was low, at 29.60%. In this study, the characteristics of the first axis, which has a relatively high contribution rate and can be interpreted as a dimension, will be examined in relation to gender differences. The distance between males and females tended to be greater in young people, and gender differences were observed.

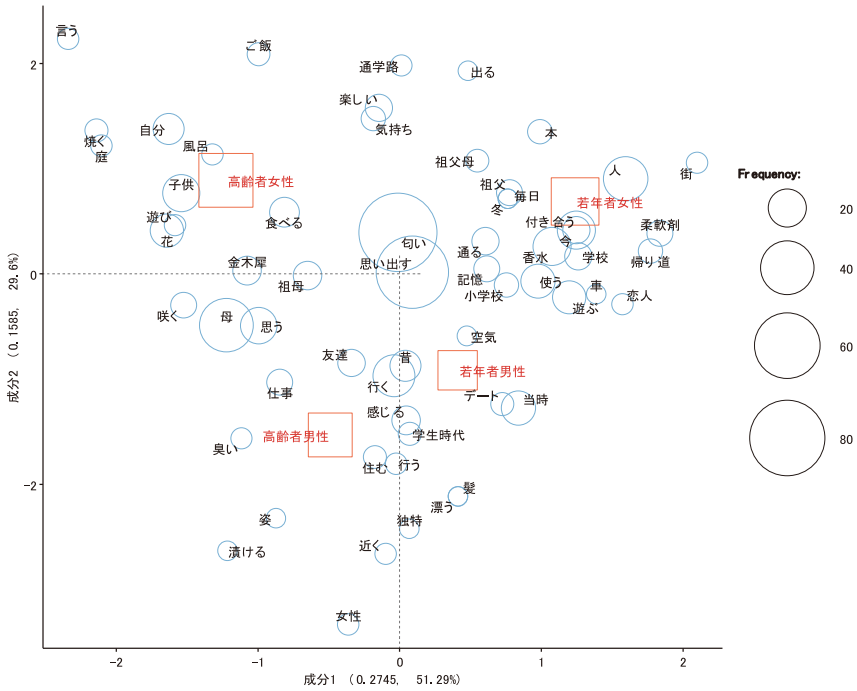

Figure 2　Results of Correspondence Analysis on Autobiographical Memory Cued by Odor

In the case of young men, items such as “dating” and “at that time” were distributed, and specific episodes were characterized by memories of romantic relationships, such as an incident with the first woman they went out with. It can be inferred that young females, as well as males, recall events related to romantic relationships during their school years, such as “going out,” “lover,” and “school.” In addition, “grandparents” and “grandfather” were also distributed, and specific episodes were characteristic of events with grandparents, such as “being taught to study and write calligraphy while sitting under a kotatsu at my grandparents’ house in winter.”

On the other hand, even among older people, there was a relative distance between men and women, indicating a gender difference. In the case of older males, items such as “work,” “pickling,” and “appearance” were distributed, and looking at the specific cases of recall content, events at work and mother-related memories such as “I remember my mother wearing pickles before she died” were characteristic. On the other hand, in the case of older women, items such as “children” and “bath” were distributed, and specific episodes such as “I was given a bath for my child” were

provided. In terms of specific episodes, "I had my child bathed," "I had my mother prepare a bath for me when I went back to my hometown to give birth to my child," and "I had my wife prepare a bath for me" were given. In addition, the item "eating" was also distributed, and episodes related to eating were characteristic. These results suggest that there may be differences in the content of memories recalled by odor stimuli between older and young men and women.

In the present study, subjective well-being was measured in older and young people, and content analysis of involuntary autobiographical memories evoked by odor cues was conducted. The subjective well-being of older people was higher than that of the young in men, but no difference was observed in women. In addition, the subjective well-being of young women was higher than that of men. There was a gender difference in the odor cues for the younger participants but no clear gender difference for the older participants. The characteristics of generational and gender differences were confirmed in regard to the memory content recalled by odor cues. If, as Yamamoto (2021a, 2021b) noted, autobiographical memories remembered due to odor cues affect subjective well-being, the following hypotheses can be made, considering the application to reminiscence therapy by older people. In the case of older men, the autobiographical memories of their working years are more likely to be related to their happiness. Asking them to recall events at work during their working years or events related to their mothers is expected to increase their subjective well-being. On the other hand, it is predicted that asking older women to recall events related to their child-rearing experiences and events related to meals will lead to subjective well-being. In the future, I would like to develop further applications based on these findings.

References

Berntsen, D. (1996). Involuntary autobiographical memories. *Applied Cognitive Psychology, 10*, 435–454.

Berntsen, D. & Hall, N. M. (2004). The episodic nature of involuntary autobiographical memories. *Memory & Cognition, 32*, 789–803.

Chu, S., & Downes, J. J. (2000a). Odour-evoked autobiographical memories: Psychological investigations of Proustian phenomena. *Chemical Senses, 25*, 111–116.

Chu, S., & Downes, J. J. (2000b). Long live Proust: The odour-cued autobiographical memory bump. *Cognition, 75*, 41–50.

Chu, S., & Downes, J. J. (2002). Proust nose best: Odors are better cues of autobiographical memory. *Memory & Cognition, 30*, 511–518.

Comblain, C., D' Argembeau, A., & Van der Linden, M. (2005). Phenomenal characteristics of autobiographical memories for emotional and neutral events in older and younger adults. *Experimental Aging Research, 31*, 173–189.

Dijkstra, K., & Kaup, B. (2005). Mechanisms of autobiographical memory retrieval in younger and older adults. *Memory & Cognition, 33*, 811–820.

Gallo, D. A., Korthauer, L. E., McDonough, I. M., Teshale, S., & Johnson, E. L. (2011). Age-related positivity effects and autobiographical memory detail: evidence from a past/future source memory task. *Memory, 19*, 641–652.

Hackländer, R. P. M., Janssen, S. M. J., & Bermeitinger, C. (2019). An in-depth review of the methods, findings, and theories associated with odor-evoked autobiographical memory. *Psychonomic Bulletin & Review, 26*, 401–429.

Herz, R. S., & Cupchik, G. C. (1992). An experimental characterization of odor-evoked memories in human. *Chemical Senses, 17*, 519–528.

Herz, R. S. (2004). A naturalistic analysis of autobiographical memories triggered by olfactory visual and auditory stimuli. *Chemical Senses, 29*, 217–224.

Herz, R. S., & Schooler, J. M. (2002). A naturalistic study of autobiographical memories evoked by olfactory and visual cues: Testing the Proustian hypothesis. *American Journal of Psychology, 115*, 21–32.

Higuchi, K. (2016). A Two-Step Approach to Quantitative Content Analysis: KH Coder Tutorial Using Anne of Green Gables (Part I). *Ritsumeikan Social Science Review, 52*, 77–91.

Ito, Y., Sagara, J., Ikeda, M., & Kawaura, Y. (2003). Reliability and validity of Subjective Well-Being Scale. *The Japanese Journal of Psychology, 74*, 276–281.

Kennedy, Q., Mather, M., & Carstensen, L. L. (2004). The role of motivation in the age-related positivity effect in autobiographical memory. *Psychological Science, 15*, 208–214.

Larsson, M., & Willander, J. (2009). Autobiographical odor memory. *Annals of the New York Academy of Sciences, 1170*, 318–323.

Larsson, M., Willander, J., Karlsson, K., & Arshamian, A. (2014). Olfactory LOVER: Behavioral

and neural correlates of autobiographical odor memory. *Frontiers in Psychology, 5*, 1–5.

Ros, L., & Latorre, J. M. (2010). Gender and age differences in the recall of affective autobiographical memories using the autobiographical memory test. *Personality and Individual Differences, 49*, 950–954.

Rubin, D. C., Groth, E., & Goldsmith, D. J. (1984). Olfactory cuing of autobiographical memory. *American Journal of Psychology*, *97*, 493–507.

Rubin, D. C., & Schulkind, M. D. (1997). The distribution of autobiographical memories across the life-span. *Memory & Cognition*, *25*, 859–866.

Saive, A. L., Royet, J. P., & Plailly, J. (2014). A review on the neural bases of episodic odor memory: From laboratory-based to autobiographical approaches. *Frontier in Behavioral Neuroscience*, *8*, 1–13.

Schlagman, S., Schulz, J., & Kvavilashvili, L. (2006). A content analysis of involuntary autobiographical memories: Examining the positivity effect in old age. *Memory*, *14*, 161–175.

Willander, J., & Larsson, M. (2006). Smell your way back to childhood: Autobiographical odor memory. *Psychonomic Bulletin & Review*, *13*, 240–244.

Willander, J., & Larsson, M. (2007). Olfaction and emotion: The case of autobiographical memory. *Memory & Cognition*, *35*, 1659–1663.

Yamamoto, K. (2015). A review of the relationship between olfaction and autobiographical memory: Reconsideration of the remembering process. *Japanese Psychological Review*, *58*, 423–450.

Yamamoto, K. (2021a). Influences of aging on odor-evoked involuntary autobiographical memory and subjective well-being. *32nd International Congress of Psychology*.

Yamamoto, K. (2021b). Gender and generational differences in odor-cued autobiographical memory and subjective well-being. *The 55th Annual Meeting of the Japanese Association for the Study of Taste and Smell*, 49.

Acknowledgements: This work was supported by JSPS KAKENHI Grant Number 17K13924.