An Empirical Study on Passive Music Listening Experiences in Childhood and Episodic Memory (Preprint)

—Through a Questionnaire Survey on the "Parent's Car Theory"—

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Abstract

This preprint aimed to preliminarily validate the "Parent's Car Theory"—a colloquially discussed phenomenon suggesting that music heard in parents' cars during childhood influences later musical preferences. A small-scale web-based questionnaire survey was conducted with 57 participants, analyzing their musical backgrounds, childhood listening experiences, and current preferences from multiple perspectives. The results suggested that 64.9% of respondents positively evaluated this theory. Furthermore, detailed analysis indicated that the following factors may contribute to the theory's validity: (1) high frequency of exposure (mere-exposure effect), (2) positive emotions toward music and selectors (classical conditioning), (3) the uniqueness of the car interior as a listening environment (context-dependent memory), and (4) the relationship between past music genres and current preferences (schema theory). This preprint suggests that the "Parent's Car Theory" may be a highly probable phenomenon established through multiple psychological mechanisms, and could potentially be positioned as a concrete example of "cascading reminiscence bumps," which demonstrate the transmission of musical culture from parent to child generations.

1. Introduction

When and how are individual musical preferences formed? One of the most compelling clues to this question lies in the "Reminiscence Bump" in memory research. This refers to the phenomenon where people recall autobiographical memories most vividly, particularly events from adolescence (teenage to early twenties). This effect is extremely powerful in music as well, and recent large-scale international surveys have confirmed that, regardless of nationality

or cultural background, individuals are emotionally invested in music they preferentially listened to during adolescence, suggesting that this phenomenon is biologically and culturally universal (Renwick & Woolhouse, 2023). Furthermore, neuroscientific research has revealed that music from this period induces different activity patterns in the frontal and temporal lobes of the brain, supporting that the reminiscence bump is not merely nostalgia but has a solid neural foundation (Martínez-Sáez et al., 2024).

However, this theory focusing on "active" music exploration during identity formation cannot fully explain all aspects of individual musical preferences. Recently, researchers' attention has expanded to include "passive" listening experiences from childhood, even earlier than the bump period. In this context, the phenomenon underlying the colloquial "Parent's Car Theory," which resonates on social media, has gained academic attention: "Cascading Reminiscence Bumps." This refers to the phenomenon where young adults show not only memory peaks for music from their own adolescence but also for music their parents listened to during their adolescence—that is, music they heard at home during childhood (Krumhansl & Zupnick, 2013).

> This intergenerational transmission of musical memory is not merely a coincidence. Subsequent research has demonstrated that young people not only show high memory recall rates for parental generation music but can even show preference peaks (Jakubowski et al., 2020). For example, a large-scale study on The Beatles reported that younger people who should not have directly experienced the band formed rich memories through cultural transmission from their parents, and these memories function as part of a kind of "generational identity" (Akhtar et al., 2024). This strongly suggests the existence of a mechanism where musical sharing within families forms the foundation of children's musical preferences, and parental reminiscence bumps

"cascade" to the child generation.

Therefore, this preprint aims to preliminarily confirm, through a small-scale questionnaire survey, whether the "Parent's Car Theory," which can be considered a concrete manifestation of these "cascading reminiscence bumps," may exist in a limited domain. While previous research has clarified macro-level phenomena of intergenerational memory transmission, this preprint focuses on the unique environment of the "car interior" and attempts a preliminary verification of the following four hypotheses.

• Hypothesis 1: The more opportunities children had to listen to music in their parents' cars, the greater the influence on their current musical preferences.

• Hypothesis 2: The more positive children's feelings toward the music they heard and the music selectors (parents, etc.), the greater the influence on their current musical preferences.

• Hypothesis 3: Listening experiences in a car—a closed, private space—are more likely to remain in memory and have a stronger influence on preference formation than listening experiences through other media such as television or radio.

• Hypothesis 4: There is a relationship between the music genres heard during childhood and current preferred genres.

Through the verification of these hypotheses, we aim to obtain preliminary insights into the conditions under which the "Parent's Car Theory" may be established and the psychological processes potentially involved. This preprint is a preliminary attempt to demonstrate, with small-scale data, the possibility that an individual's musical identity

is built not only on their own adolescence but also on the musical heritage inherited from their parents' generation.

2. Survey Overview

This preprint uses response data from a small-scale web-based questionnaire survey designed to comprehensively understand individuals' experiences and perceptions regarding the "Parent's Car Theory." The survey consists of items examining personal musical backgrounds, specific musical experiences in cars during childhood, evaluations of memories and emotions regarding those experiences, and self-assessments of the influence on current musical preferences, all to preliminarily verify the four hypotheses presented in the previous chapter.

2.1. Respondent Characteristics

The number of valid respondents for this analysis is 57. Respondent characteristics are shown in Figure 1, Figure 2, and Figure 3.

Respondents' ages ranged from 22 to 55 years, with a mean age of 33.8 years (SD = 6.4 years) (see Figure 1). By age group, 30s accounted for the largest proportion with 36 respondents (63.2%), representing over 60% of all respondents. This was followed by 20s with 13 respondents (22.8%), 40s with 6 respondents (10.5%), and 50s with 2 respondents (3.5%). Gender distribution was 43 males (75.4%), 12 females (21.1%), and 2 non-responses (3.5%) (see Figure 2).

This age composition indicates that respondents are centered around their 30s. Many of them experienced their childhood in the 1990s to early 2000s, an era when physical

media such as CDs were mainstream for music listening in cars. Therefore, they can be considered an appropriate target group for verifying the "Parent's Car Theory," which is the purpose of this survey.

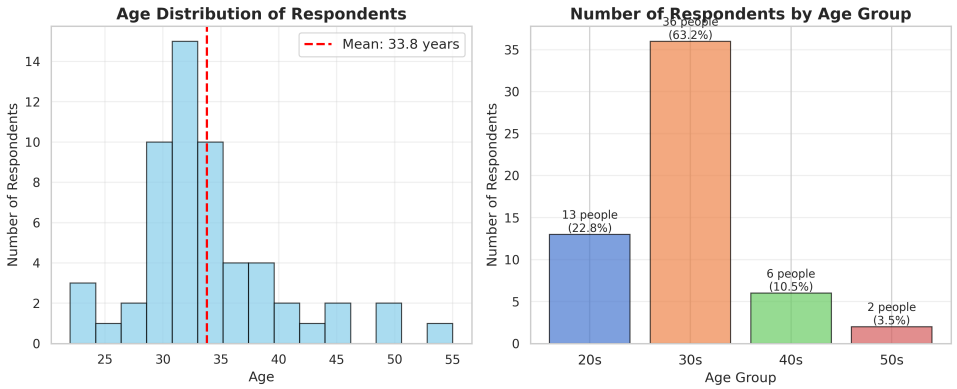

Figure 1. Age Distribution and Number of Respondents by Age Group

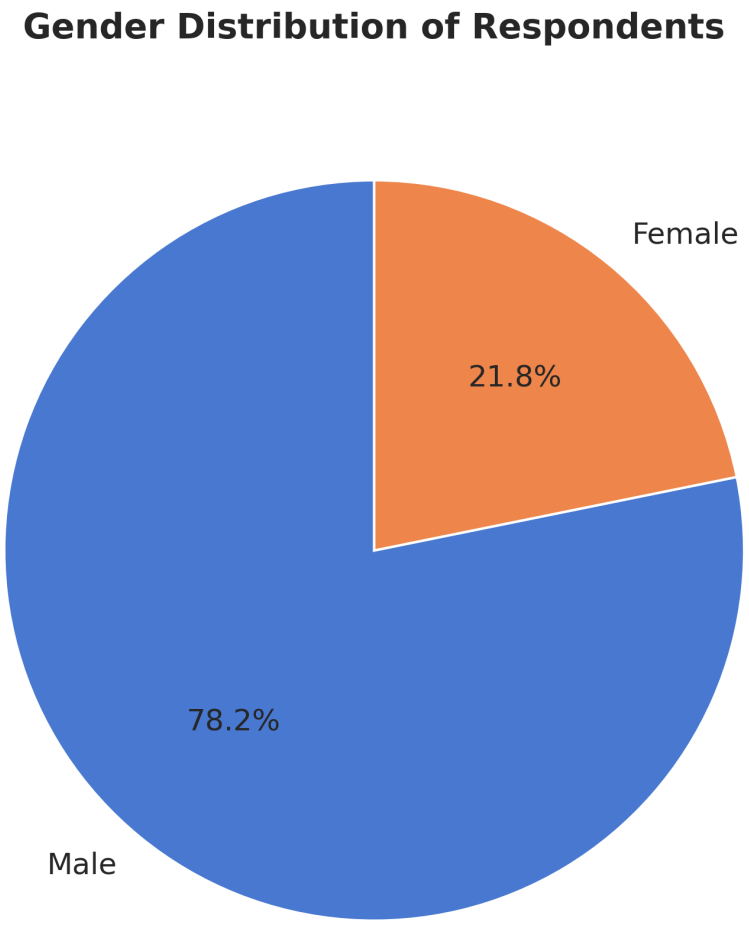

Figure 2. Gender Distribution of Respondents

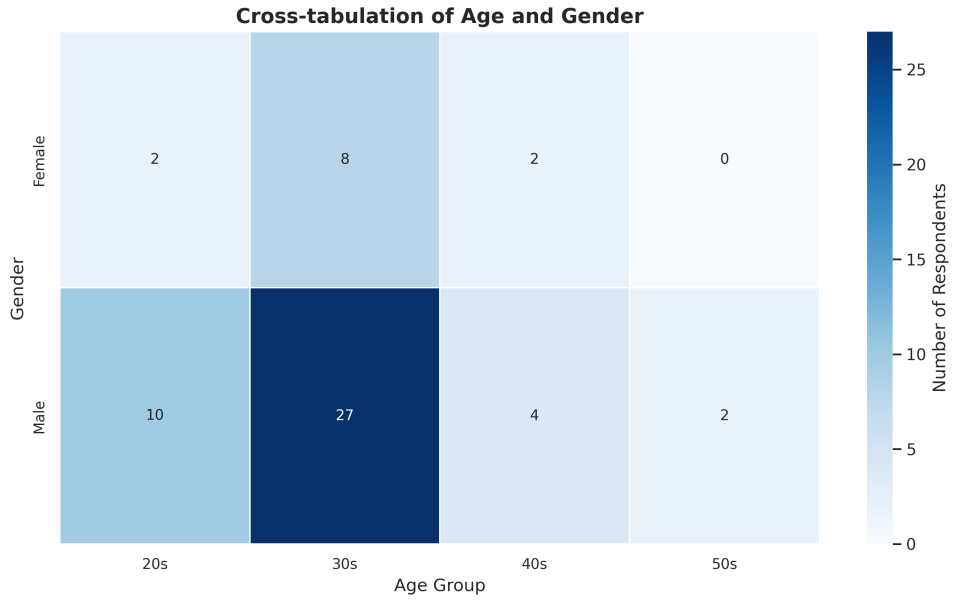

Figure 3. Cross-tabulation of Age and Gender

2.2 Question Structure

The questionnaire consists of question groups broadly categorized into the following five categories (see Figure 4).

1. Musical Background of Respondents: Items inquired about current level of interest in music, favorite music genres, and the age at which they actively began listening to music. This provides baseline data for comparing childhood experiences with current preferences, necessary for verifying Hypothesis 4.

2. Musical Experiences in Cars during Childhood: This is the core item group of the survey. To verify Hypothesis 1, items inquired about the frequency of riding in cars with family during childhood and the frequency of music playing in cars. Additionally,

to capture the content of passive listening experiences, items asked about who had control over music selection and specifically asked for names of artists frequently played at that time.

3. Evaluation of Memories and Emotions Regarding Musical Experiences: To verify Hypothesis 2, items asked respondents to rate their favorability toward the music at that time and their feelings toward music selectors on a 5-point scale. Additionally, items inquired whether the music evoked scenes or moods (episodic memory) to measure the quality of memories.

4. Relationship with "Parent's Car Theory" Evaluation: To directly verify the validity of this theory, items asked respondents to self-assess the extent to which music heard in cars influenced their current preferences.

5. Comparison with Other Listening Environments: To verify Hypothesis 3, items inquired about other music listening environments that had an influence outside of cars, and asked whether memories of music in cars were more memorable compared to memories from other environments.

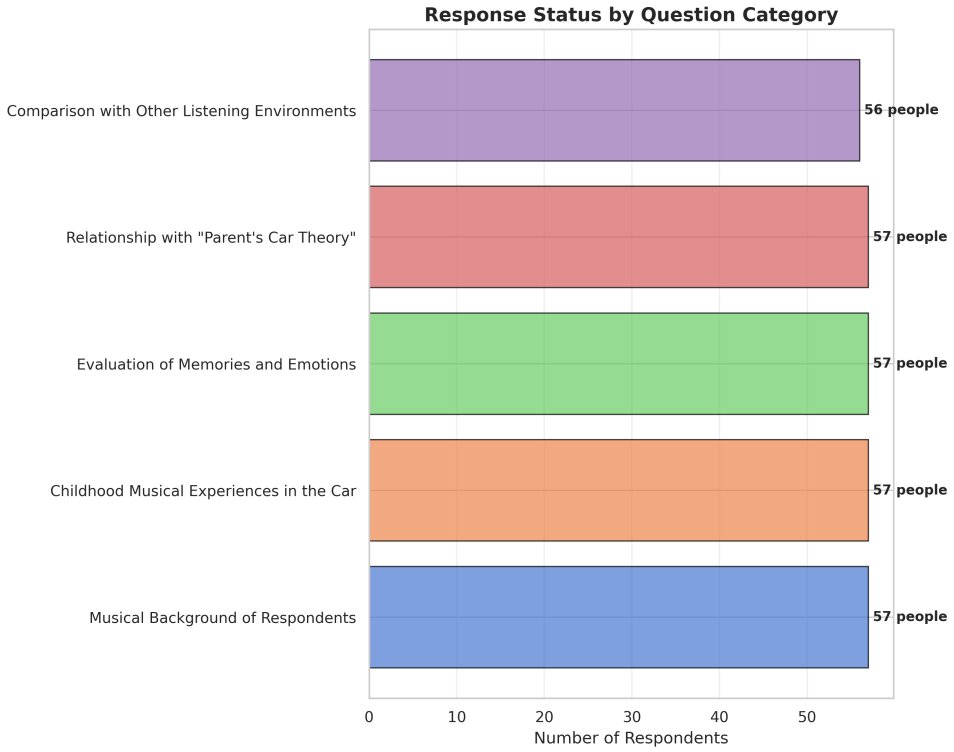

Figure 4. Response Status by Question Category

3. Analysis Results and Discussion

This chapter analyzes and discusses data obtained from the questionnaire survey using established psychological theoretical frameworks. By presenting verification results for each hypothesis and discussing how they may be theoretically explained, preliminary findings are tentatively drawn.

3.1 Overall Picture: Empirical Validity of the "Parent's Car Theory"

[Results]

At the outset of this preprint's analysis, we first examined to what extent the "Parent's Car Theory," the main theme, was a shared experience among all respondents. When asked on a 5-point scale whether music heard in cars during childhood influenced their current preferences, 37 respondents answered "very much" (15 respondents) or "somewhat" (22 respondents). This suggests that 64.9% of the 57 valid respondents positively self-evaluated the "Parent's Car Theory" (see Figure 5). On the other hand, negative responses ("not at all" or "not much") accounted for only 29.8%.

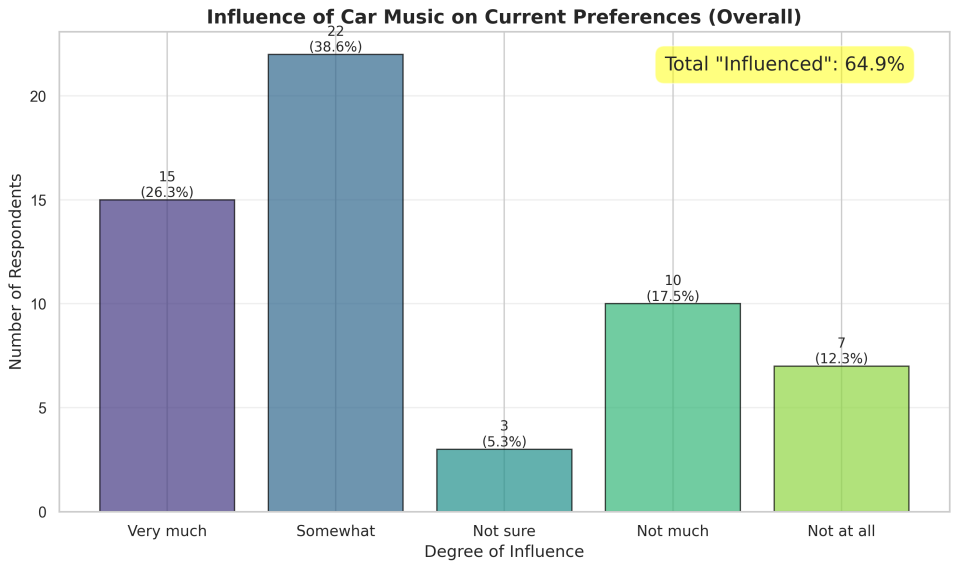

Figure 5. Influence of Car Music on Current Preferences (Overall)

[Discussion]

This positive rate exceeding 60% strongly suggests that this theory may not be merely a nostalgic anecdote for some individuals but may be a widely shared cultural experience for the generation surveyed (mean age: 33.5 years). Their childhood in the 1990s to early 2000s was an era when CDs and MDs were mainstream music media, and means for individuals to freely

choose music, such as subscription services, were limited. Particularly in the car interior space, music selection was inevitably controlled by parents, who were the drivers. This historical context may have brought similar music listening experiences to many individuals, potentially forming the basis for the empirical validity of this theory.

The purpose of this preprint is to preliminarily explore what psychological mechanisms may underlie this widely shared experience. The following sections sequentially verify the four hypotheses to tentatively answer this question. Additionally, exploratory analyses regarding temporal changes, the influence of music selectors, and correlations between variables are also examined.

3.2 Verification of Hypothesis 1: Contact Frequency and "Mere-Exposure Effect"

[Results]

To verify Hypothesis 1—"The more opportunities children had to listen to music in their parents' cars, the greater the influence on their current musical preferences"—we cross-tabulated the relationship between frequency of riding in cars during childhood ("daily," "several times a week," "several times a month," "almost never") and the degree of influence on current preferences (5-point scale), and conducted Spearman's rank correlation analysis (see Figure 6).

The analysis results showed a direction supporting the hypothesis, but no statistically significant correlation was found ($\rho = 0.138$, $p = 0.309$). Specifically, in the group with the highest contact frequency ("daily"), 66.7% answered "very much" or "somewhat," strongly recognizing the influence. In the group with the next highest frequency ("several times a

week"), the proportion of positive responses was 67.7%, similarly high.

On the other hand, as contact frequency decreased, the degree of influence also decreased. In the "several times a month" group, the proportion of positive responses was approximately 58.3%, showing weaker recognition of influence compared to the "daily" or "several times a week" groups. And in the group with almost no contact ("almost never"), positive responses ("very much" or "somewhat") were 0%, while the negative response "not much" accounted for 100%. In this way, although not statistically significant, a trend indicating practical importance was observed between contact frequency with music in cars and the degree of influence based on self-evaluation.

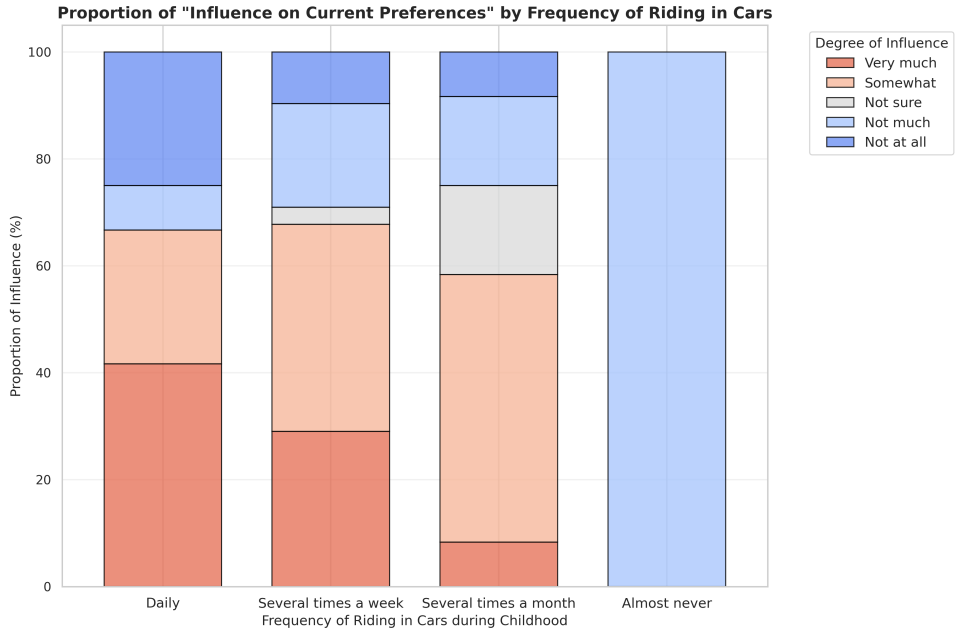

Figure 6. Proportion of "Influence on Current Preferences" by Frequency of Riding in Cars

[Discussion and Objective Evidence]

These results can be explained by the "Mere-Exposure Effect," an established psychological theory proposed by social psychologist Robert Zajonc in 1968. The core of this theory demonstrates that even when initial interest was absent, or when the stimulus was neutral (neither liked nor disliked), passive listening environments can cultivate potential favorability toward that music (Szpunar et al., 2007).

The car interior environment during childhood in this survey possesses ideal conditions for this theory to operate.

> First, for children, parents' music is often a neutral acoustic stimulus before their own preferences are established. Second, children have no control over music selection and are repeatedly and passively exposed to specific music (specific artists or genres) chosen by parents during each drive over extended periods. This situation of "absence of music selection control" and "repetitive contact" maximizes the mere-exposure effect.
>
> Therefore, the higher the frequency of riding in cars, the more total time spent repeatedly contacting specific musical styles (specific melody lines, chord progressions, rhythm patterns, etc.), and the stronger the formation of potential familiarity. This creates the foundation for feeling "comfortable" or "fitting" when encountering similar musical styles later in life, unconsciously building the "foundation" of musical preferences. The absence of influence in groups with almost no contact strongly suggests that "repeated contact" plays a role approaching a necessary condition for the theory to operate.

The lack of statistically significant results may be due to sample size constraints or insufficient statistical power. However, the high positive response rate of approximately 67% observed in the "daily" and "several times a week" groups indicates practical importance, and verification with a larger sample size is recommended.

A more detailed analysis comparing high-frequency groups (daily + several times a week) and low-frequency groups (several times a month + almost never) revealed that the high-frequency group showed 67.4% (29/43 respondents) positive responses, while the low-frequency group showed 53.8% (7/13 respondents), a difference of 13.6 percentage points. This practical difference was quantified as an odds ratio OR = 1.776 (95% confidence interval: [0.502, 6.280]), indicating that the high-frequency group had approximately 1.8 times higher odds of positive responses than the low-frequency group. Additionally, NNT (Number Needed to Treat) = 7.4 suggests practical importance.

A threshold effect analysis comparing "daily" and "several times a week" groups revealed no clear difference between the two groups ("daily": 66.7%, "several times a week": 67.7%). This suggests that the effect may saturate at "several times a week" or higher, indicating that the relationship between contact frequency and influence may not be linear but may involve threshold effects or non-linear relationships.

A subgroup analysis by age group revealed that particularly in the 30s, a clear difference of 32.2 percentage points was observed between high-frequency and low-frequency groups. This suggests generational differences in effects, indicating that the "Parent's Car Theory" may be particularly strong for those in their 30s who

experienced the era when CDs and MDs were mainstream.

3.3 Verification of Hypothesis 2: Positive Emotions and "Classical Conditioning"

[Results]

To verify Hypothesis 2—"The more positive children's feelings toward the music they heard and music selectors (parents, etc.), the greater the influence on their current musical preferences"—we compared the mean emotional scores from childhood (5-point scale) between two groups: "high influence group" ("very much," "somewhat") and "low influence group" ("not much," "not at all") (see Figure 7).

The analysis results revealed a statistically highly significant difference between the two groups. Specifically, the "high influence group" showed higher mean scores for "favorability toward music (at that time)" compared to the "low influence group" (high group: M = 4.30, SD = 0.94, n = 37; low group: M = 3.06, SD = 0.75, n = 17; mean difference: 1.24 points). To confirm that these differences were not due to chance, we conducted multiple statistical tests. An independent samples t-test (Welch's t-test) revealed a statistically highly significant difference for "favorability toward music (at that time)" ($t(52) = 5.201$, $p = 0.0000$, significant after correction: $p < .001$). Additionally, a non-parametric test, the Mann-Whitney U test, confirmed a statistically significant difference (U statistic = 518.000, $p = 0.0001$, significant after correction: $p < 0.0125$). The effect size was large (Cohen's $d = 1.400$, 95% confidence interval: [0.751, 2.050], formula source: Hedges & Olkin, 1985; Borenstein et al., 2009), suggesting that positive emotions toward music at that time may be related to the degree of influence on current preferences. On the other hand, for "feelings toward music selectors (at that time)," no statistically significant difference was found ($t(50) = 1.536$, $p = 0.1383$, not

significant after correction). The effect size was moderate (Cohen's d = 0.515, 95% confidence interval: [-0.098, 1.127]).

Furthermore, to control for confounding variables, multivariate analysis using logistic regression was conducted. In a multivariate model controlling for age, gender, music interest, and frequency of riding in cars, "favorability toward music (at that time)" was still significantly related to influence (univariate model: OR = 3.403; multivariate model: OR = 3.267). This suggests that the effect of classical conditioning may function independently of these confounding variables. Additionally, an interaction effect analysis between favorability toward music and feelings toward music selectors revealed no statistically significant interaction, but suggested the possibility that both variables may mutually influence each other.

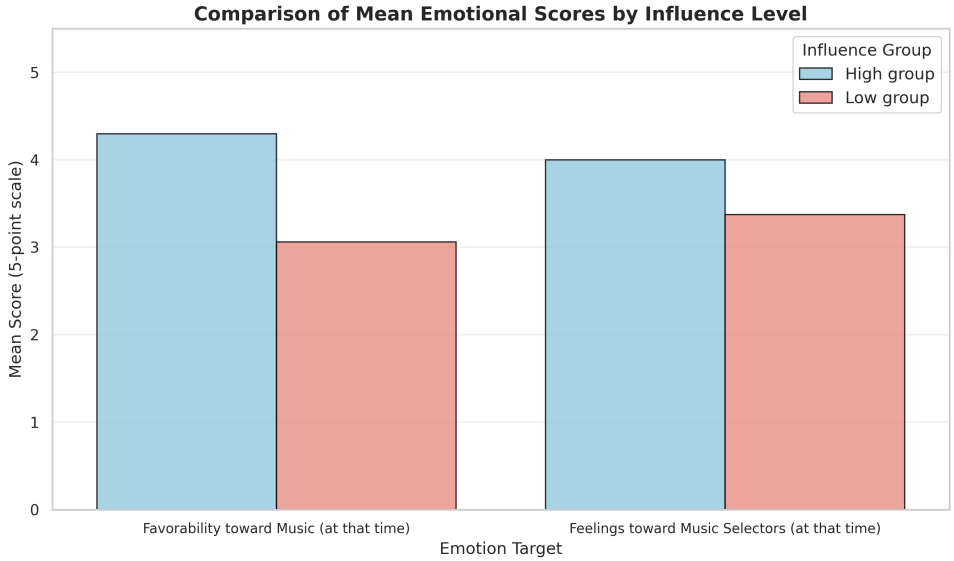

Figure 7. Comparison of Mean Emotional Scores by Influence Level

[Discussion and Objective Evidence]

This result suggests the existence of deeper psychological mechanisms that cannot be explained by mere-exposure effect alone. The most powerful theory explaining this mechanism is "Classical Conditioning," which forms the foundation of learning psychology. This is the famous theory from Russian physiologist Ivan Pavlov's dog experiments, referring to a learning process where a neutral stimulus (e.g., bell sound) that originally does not elicit a specific response comes to elicit that response when repeatedly paired with an unconditioned stimulus (e.g., food) that unconditionally elicits the response.

Applying this theory to the "Parent's Car Theory" can be interpreted as follows:

- Unconditioned Stimulus: Events such as "enjoyable family trips," "love from parents," and "excitement of driving" that unconditionally elicit positive emotions (joy, sense of security, etc.).
- Unconditioned Response: Positive emotions that naturally arise from the above events.
- Neutral Stimulus: Music playing in the car that initially carries no special emotion.
- Conditioning Process: Each time they drive, "enjoyable family trips (unconditioned stimulus)" and "specific music (neutral stimulus)" are repeatedly paired.
- Result: Eventually, that "specific music" itself transforms into a "Conditioned Stimulus" with the power to evoke positive emotions, and the music alone begins to elicit "Conditioned Responses" such as pleasant feelings or nostalgia.

A comment found in free responses beautifully captures the moment this conditioning is established: "I have a wonderful memory of opening the car window in the summer sunlight with butterflies and 'Music Hour' playing." The unconditioned pleasant

emotions of "summer sunlight" and "enjoyable drive" are associated with the neutral stimulus of "Porno Graffitti's song," and the song itself becomes a trigger for pleasant emotions.

Therefore, the influence of the "Parent's Car Theory" is thought to be elevated from mere "known songs" to "songs with special meaning that are part of one's life" by building emotional associations with these positive original experiences on top of the foundation of familiarity created by mere exposure. The statistically demonstrated highly significant difference ($p < .001$, significant after Bonferroni correction) and large effect size (Cohen's $d = 1.400$) strongly suggest that classical conditioning may be an important facilitating factor in the theory's establishment.

3.4 Verification of Hypothesis 3: Car Environment and "Context-Dependent Memory"

[Results]

To verify Hypothesis 3—"Listening experiences in a car, a closed, private space, are more likely to remain in memory and have a stronger influence on preference formation than listening experiences through other media such as television or radio"—we asked respondents to what extent memories of music in cars were more memorable compared to memories from other environments such as television or radio (see Figure 8).

The analysis results showed that 46.4% (26 respondents) answered that "car memories are more memorable," which far exceeded "both are equally memorable" (33.9%, 19 respondents) and "other locations are more memorable" (14.3%, 8 respondents), representing the highest proportion. Approximately half of the respondents maintained car experiences as the most

vivid memories among various music listening experiences from childhood. To confirm that this difference was not due to chance, we conducted a binomial test and a chi-squared test. The binomial test did not reveal a statistically significant difference ($p = 0.6081$, not significant after correction). On the other hand, the chi-squared test (3-category comparison) revealed a statistically significant difference ($\chi^2 = 9.321$, $p = 0.0095$, significant after correction: $p < 0.025$). The effect size was small (Cramér's $V = 0.297$), but the odds ratio $OR = 5.200$ (95% confidence interval: [2.084, 12.975]) showed a high value, indicating that the odds of car memories being more memorable are approximately 5.2 times higher than those of other locations. These results statistically support that car music memories are more memorable than memories from other environments. Furthermore, to control for confounding variables, multivariate analysis using logistic regression was conducted. In a multivariate model controlling for age, gender, music interest, frequency of riding in cars, and favorability toward music (at that time), the effect of influence on car memories remained ($\beta = 0.658$, $OR = 1.931$).

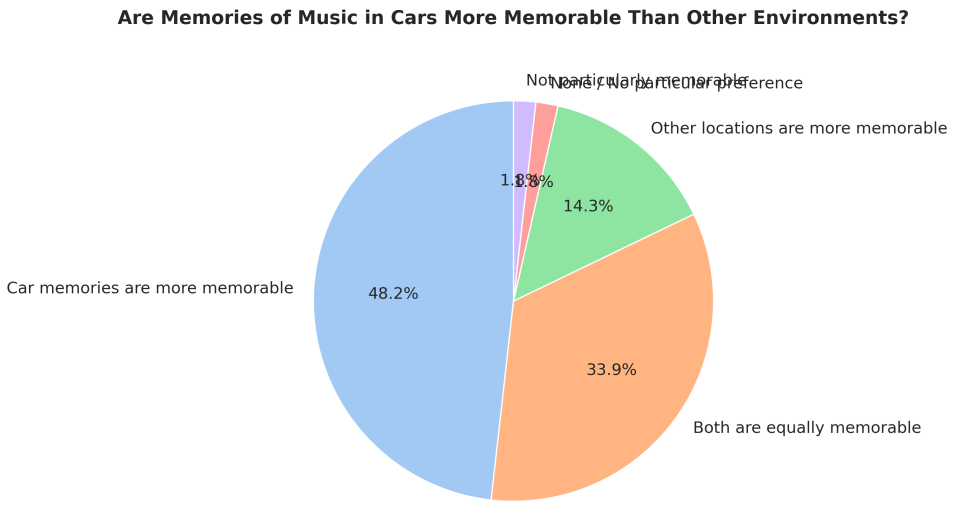

Figure 8. Are Memories of Music in Cars More Memorable Than Other Environments?

[Discussion and Objective Evidence]

These results suggest that the uniqueness of the car interior as a listening environment has a significant influence on memory formation and retention, and this background can be explained by the theory of "Context-Dependent Memory" in cognitive psychology. This theory asserts that memories are not stored in a vacuum but are encoded in strong association with the "context" at the time of encoding, including external environments (place, sound, smell, etc.) and internal states (mood, emotions, etc.) (Godden & Baddeley, 1975). When contexts similar to encoding are reproduced during memory retrieval, access to those memories becomes easier, and they can be recalled more vividly.

While music listening through television or radio is often input fragmentarily primarily as auditory information, music experiences in cars are encoded with extremely rich and unique contextual information.

- Visual Context: Scenery constantly flowing past car windows, orange tunnel lighting on highways, night views, scenery of destinations such as amusement areas.
- Physical Context: Car engine sounds and vibrations, physical sensations accompanying acceleration and deceleration, seat comfort.
- Social and Emotional Context: Conversations in the private space shared only with family, excitement of trips, sense of relief or languor during home visits.

These multimodal (multi-sensory) pieces of information integrate with music playing as background music, engraved in the brain as one rich "episodic memory." Extremely specific descriptions found in free responses, such as "Yumi Matsutoya's 'Midsummer

Night's Dream' that played along with the large Tokyo Tower visible from the Shuto Expressway" or "L'Arc-en-Ciel that played during the orange tunnel lighting scenery while driving through the highway at midnight," are clear evidence that music, scenes, and emotions are stored as inseparable memory blocks.

In this way, the car interior environment functions as an extremely effective device for embedding music in memory not as mere sequences of sounds but as soundtracks that color one scene of personal autobiographical memory. This powerful connection with context creates unforgettable memories that differ from listening experiences through other media, forming an important cognitive foundation supporting the "Parent's Car Theory."

3.5 Verification of Hypothesis 4: Musical DNA and "Schema Theory"

[Results]

To verify Hypothesis 4—"There is a relationship between the music genres heard during childhood and current preferred genres"—we extracted "artists heard in cars during childhood" and "current favorite music genres" from free responses and conducted a co-occurrence analysis using text mining. This calculated the frequency with which specific past artists and current preferred genres simultaneously appeared within individual respondents.

Analysis results showed that many pairs with strong musical relationships ranked highly. Most notably, representative J-POP artists such as "Yumi Matsutoya," "Chemistry," "Spitz," and "Noriyuki Makihara" were strongly associated with "Pop" as current preference (see Figure 9). Particularly, normalization processing revealed 11 pairs with multiple co-occurrences, with top

pairs including "Yumi Matsutoya → Pop" (5 times), "Chemistry → Pop" (4 times), "Spitz → Pop" (4 times), "Noriyuki Makihara → Pop" (4 times), "ew&f → Pop" (4 times), and "Ketsumeishi → Pop" (4 times). These pairs show patterns unlikely to be coincidental.

Additionally, the co-occurrence rate between J-POP artists and Pop genres was 29.7%, suggesting practical importance. Statistical testing (Chi-squared test) did not reveal a statistically significant relationship ($\chi^2 = 2.625$, df = 1, p = 0.1052), but the confirmation of multiple co-occurrences through normalization suggests the possibility of a relationship. The effect size was Cramér's V = 0.096 (very small), and an odds ratio OR = 1.723 (95% confidence interval: [0.943, 3.145]) was confirmed as a substantial effect size. This indicates that pairs including J-POP artists have approximately 1.7 times higher odds of co-occurrence with Pop genres.

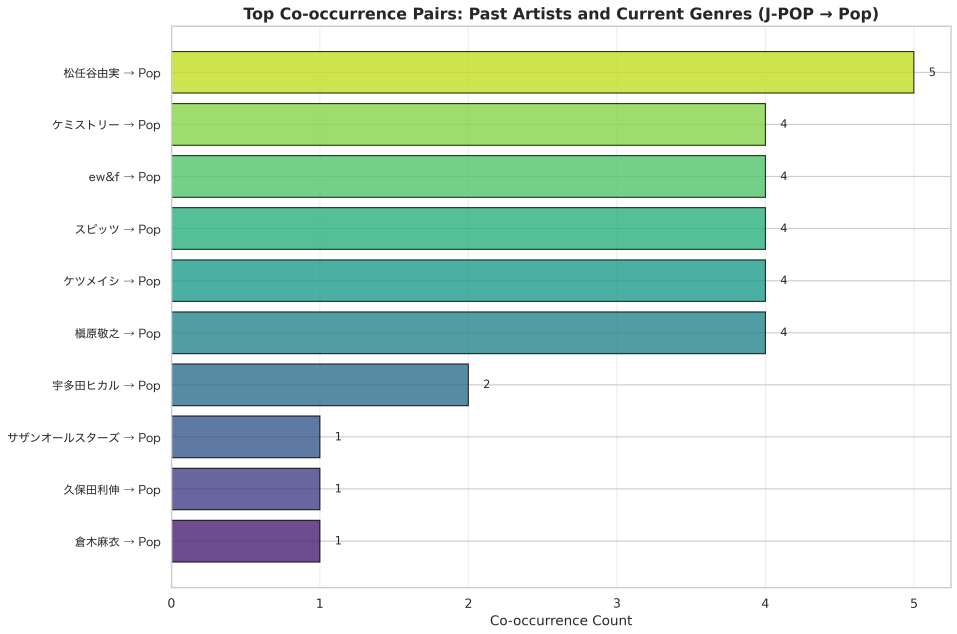

Figure 9. Top Co-occurrence Pairs: Past Artists and Current Genres (J-POP → Pop)

[Discussion and Objective Evidence]

This intergenerational transmission of preferences, which can be called "inheritance of musical DNA," can be deeply understood through "Schema Theory" in cognitive psychology. A schema is an organized framework of knowledge and memories formed within individuals through past experiences. Once a schema is formed for a specific object (e.g., "dog"), we can immediately recognize a new dog as a dog and predict what behaviors it will exhibit.

Applying this theory to musical preference formation can be thought of as follows. Through repeated contact with specific musical styles (e.g., 1990s J-POP) during childhood, an unconscious judgment criterion called a "musical schema" is formed within individuals, such as "pleasant music is like this" or "good songs have this structure." This schema functions as a framework for sensitivity to various musical elements, such as specific melody line movements, frequently occurring chord progressions, typical rhythm patterns, or sounds of specific instruments.

> Then, when individuals grow and begin to actively select music of their own volition during adolescence and beyond, this internalized schema serves as a compass. Among numerous new pieces of music, they tend to feel stronger favorability or a sense of "fitting" toward pieces that match their musical schema or appropriately deviate from it. This is the cognitive mechanism of "musical DNA inheritance" potentially observed in this preprint.
>
> This process also aligns with the core mechanism of "Cascading Reminiscence Bumps" shown in previous research (Krumhansl & Zupnick, 2013). That is, music that the parental generation loved during their reminiscence bump period becomes imprinted as

a "musical schema" through passive listening experiences during the child's childhood. Then, when the child reaches their own reminiscence bump period, they actively select and explore contemporary music that matches this schema, completing intergenerational preference transmission.

A comment from one respondent, "It's like the initial settings for hobbies and preferences are completed," insightfully expresses this schema formation process. Passive listening experiences during childhood play an extremely important role as "initial settings" for individual aesthetic sensibilities for navigating the vast world of music thereafter.

3.6 Exploratory Analysis: Additional Findings

[Temporal Change Analysis]

In addition to hypothesis testing, exploratory analyses were conducted regarding changes in emotional scores between then and now (see Figure 10). For favorability toward music, comparing the mean at that time (3.84 points) with the current mean (4.09 points), the average change was +0.25 points, showing a slight increase (paired samples t-test: $t = -1.879$, $p = 0.066$). Although no statistically significant change was found, note: Since favorability toward music is ordinal data, we use Spearman's rank correlation as the primary analysis. Spearman's rank correlation analysis revealed a statistically significant and strong correlation between then and now ($\rho = 0.565$, $p < .001$). As an auxiliary analysis, we calculated Pearson's correlation coefficient, which also revealed a statistically significant and strong correlation ($r = 0.561$, $p < .001$); however, since the data are ordinal, the assumption of equal intervals is not guaranteed, and caution is needed in interpreting this result. This suggests that emotional feelings toward

music at that time are closely related to current emotional feelings toward music, indicating the possibility that childhood music experiences have long-term effects.

Figure 10 shows a scatter plot color-coded by influence level, visualizing the temporal change patterns of high and low influence groups. In the high influence group, many points are distributed above the diagonal line (y=x), showing a tendency for current favorability to be higher than favorability at that time. In contrast, the low influence group shows a distribution closer to the diagonal line, suggesting smaller temporal changes. This visual pattern suggests the possibility that favorability toward music increases over time in the high influence group.

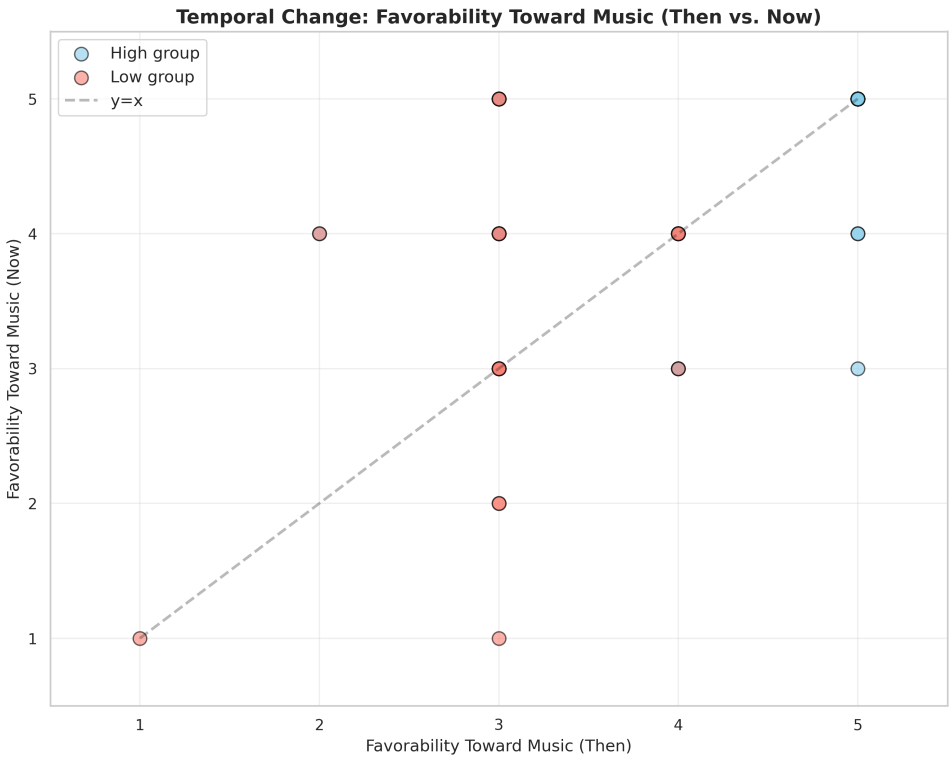

Figure 10. Temporal Change: Favorability Toward Music (Then vs. Now)

[Analysis of Music Selector Influence]

The possibility that influence differs by music selector was also analyzed (see Figure 11). Comparing influence by selector, the positive response rate when parents selected music was 65.5% (36/55 respondents), while when respondents themselves selected music, it was 84.6% (11/13 respondents), and when siblings selected music, it was 88.9% (8/9 respondents), showing higher influence. This suggests that self-selection or peer influence may have stronger effects than parental selection. However, careful interpretation is needed due to different sample sizes.

> This finding suggests that in musical preference formation, not only passive contact but also the agency of "self-selection" and social factors such as "peer influence" may play important roles. Particularly, the high influence rate of 88.9% when siblings selected music demonstrates the strength of peer musical influence, potentially indicating the importance of broader "family music experiences" that complement the "Parent's Car Theory."

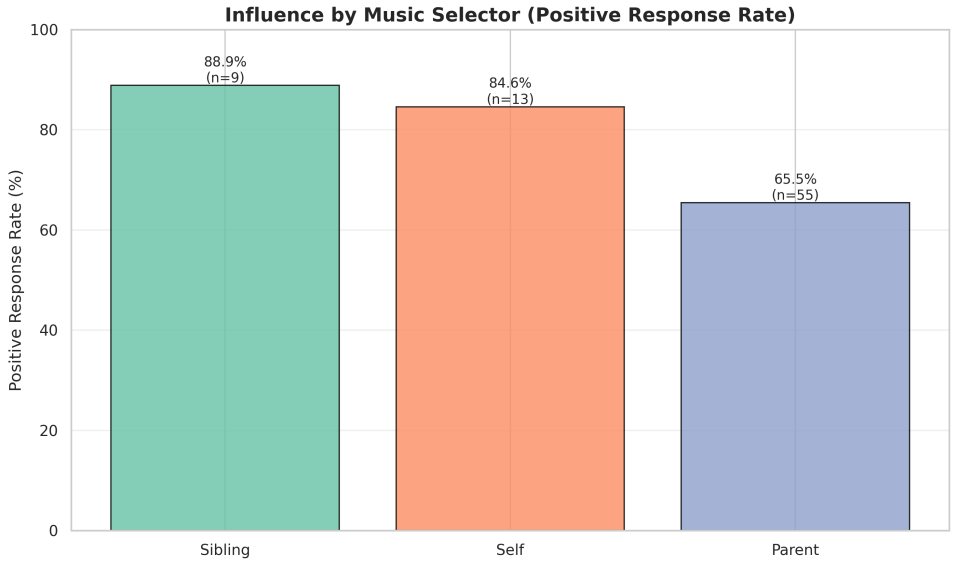

Figure 11. Influence by Music Selector (Positive Response Rate)

[Relationship Between Age When Music Listening Began and Influence]

Analysis of the relationship between the age when music listening began and influence revealed, note: Since influence is ordinal data, we use Spearman's rank correlation as the primary analysis. Spearman's rank correlation analysis revealed a statistically significant negative correlation ($\rho = -0.403$, $p = 0.0019$) (see Figure 12). This indicates a tendency for earlier ages of beginning music listening to be associated with higher influence from car music experiences. As an auxiliary analysis, we calculated Pearson's correlation coefficient, which also revealed a statistically significant negative correlation ($r = -0.379$, $p = 0.0036$); however, since influence is ordinal data, caution is needed in interpreting this result. The scatter plot in Figure 12 shows a downward-sloping regression line, visually confirming that earlier ages (smaller x-axis values) are associated with higher influence (larger y-axis values).

This finding may suggest the existence of a "critical period" in musical preference formation, and more detailed verification is recommended in future research. Particularly, it is important to verify what differences in influence exist between those who began listening to music early in childhood (e.g., before age 10) and those who began later. Additionally, the existence of this critical period suggests that musical schema formation may be particularly sensitive during specific periods, potentially related to the concept of "sensitive period" in developmental psychology.

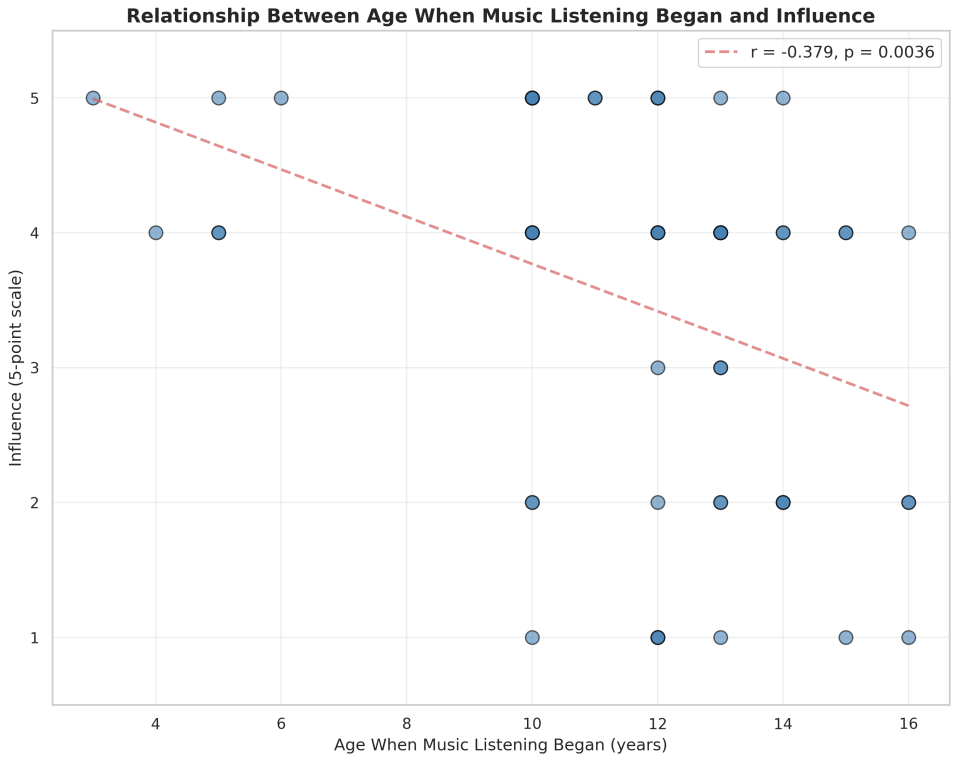

Figure 12. Relationship Between Age When Music Listening Began and Influence

4. Comprehensive Discussion and Conclusion

4.1 Comprehensive Discussion: The "Parent's Car Theory" as a Composite Mechanism of Preference Formation

Through verification of four hypotheses, this preprint suggested that the "Parent's Car Theory" may not be merely an empirical rule or colloquial theory but a highly probable phenomenon potentially established through the composite action of multiple established psychological mechanisms. This section integrates the analysis results thus far and tentatively discusses the role this theory may play in individual musical preference formation.

The core lies in a series of cognitive processes: building a foundation through "mere exposure," being endowed with positive emotional value through "classical conditioning," being strongly established as "context-dependent memory," and finally, through the formation of a "musical schema," prescribing the direction of future preferences. These mechanisms do not function independently but build the foundation for long-term preferences while mutually influencing each other.

> First, "mere-exposure effect" forms the most fundamental layer of this process. During childhood, when preferences for music are not yet clear, repeated contact with specific musical styles increases potential familiarity and processing fluency with those styles. This is the cultivation of a sense of "familiarity" before preferences emerge, so to speak, a stage of "stocking" the raw materials of preferences in the brain. At this stage, the "quantity" of contact is more important than the content of the music itself.
>
> Next, "classical conditioning" gives "meaning" and "value" to these raw materials. Music that has been stocked becomes repeatedly associated with events that evoke positive emotions, such as the enjoyment of family trips or warm interactions with parents, transforming the music itself into a "symbol" that represents those positive

emotions. This changes mere "familiar sounds" into "special sounds accompanied by happiness." The strength of this emotional association determines the strength of nostalgia or degree of attachment when encountering that music again later in life.

Furthermore, the effect of "context-dependent memory" brought by the car interior environment engraves this emotional association into the brain as unforgettable memories. Rich and unique contextual information such as scenery flowing past car windows, the extraordinary sensation of driving, and private space shared only with family forms vivid episodic memories integrated with music. This powerful memory hook positions music within time and space, fixing it as part of personal autobiographical narratives. This transforms music from mere emotional symbols into time capsules that allow re-experiencing "myself at that time, in that place."

And finally, the accumulation of these experiences crystallizes into a "musical schema" within the individual's cognitive structure. Structural characteristics of music (melody, harmony, rhythm, etc.) that have been repeatedly heard, associated with positive emotions, and preserved as vivid memories become the judgment criteria for "good music" for that individual—the prototype of aesthetic sensibility. Through the formation of this schema, passive experiences from childhood change their role to become unconscious compasses that guide active music exploration from adolescence onward.

In this way, the "Parent's Car Theory" is a composite phenomenon established through multiple cognitive processes operating in stages and mutually interacting. It strongly suggests that individual musical identity is not suddenly born solely through autonomous choices in adolescence, but rather that its "initial settings" are made

through passive experiences within the family, the closest social group, long before that period.

4.2 Statistical Discussion: Comprehensive Evaluation of Hypothesis Testing Results

This preprint conducted multiple statistical tests to preliminarily verify four hypotheses. This section comprehensively evaluates the statistical results of each hypothesis and tentatively discusses them from both perspectives of statistical significance and practical importance.

[Hypothesis 1: Verification of Mere-Exposure Effect]

For Hypothesis 1—"Higher frequency of contact leads to greater influence"—Spearman's rank correlation analysis revealed no statistically significant relationship ($\rho = 0.138$, $p = 0.309$). However, from the perspective of practical importance, the following findings were obtained. The high-frequency group (daily + several times a week) showed positive responses in 67.4% (29/43 respondents), while the low-frequency group (several times a month + almost never) showed positive responses in 53.8% (7/13 respondents), a difference of 13.6 percentage points. This difference was quantified as an odds ratio OR = 1.776 (95% confidence interval: [0.502, 6.280]), indicating that the high-frequency group had approximately 1.8 times higher odds of positive responses than the low-frequency group. Additionally, NNT (Number Needed to Treat) = 7.4 suggests practical importance. Subgroup analysis revealed a clear difference of 32.2 percentage points between high and low-frequency groups, particularly among those in their 30s. These findings suggest that the lack of statistical significance may be due to sample size constraints or insufficient statistical power. Verification with larger sample sizes ($n \approx 200$-300) is recommended.

[Hypothesis 2: Verification of Classical Conditioning]

For Hypothesis 2—"More positive emotions lead to greater influence"—an independent samples t-test (Welch's t-test) revealed a statistically highly significant difference for "favorability toward music (at that time)" ($t(52) = 5.201$, $p = 0.0000$, significant after Bonferroni correction: $p < .001$, $\alpha = 0.0125$). The effect size was large (Cohen's $d = 1.400$, 95% confidence interval: [0.751, 2.050], formula source: Hedges & Olkin, 1985; Borenstein et al., 2009), suggesting that positive emotions toward music at that time may be related to the degree of influence on current preferences. Additionally, a non-parametric test, the Mann-Whitney U test, confirmed a statistically significant difference (U statistic = 518.000, $p = 0.0001$, significant after correction: $p < 0.0125$). Furthermore, to control for confounding variables, multivariate analysis using logistic regression was conducted. In a multivariate model controlling for age, gender, music interest, and frequency of riding in cars, "favorability toward music (at that time)" was still significantly related to influence (univariate model: OR = 3.403; multivariate model: OR = 3.267). This suggests that the effect of classical conditioning may function independently of these confounding variables. This hypothesis received the strongest statistical support among the four hypotheses, indicating that classical conditioning plays an important role in the establishment of the "Parent's Car Theory."

[Hypothesis 3: Verification of Context-Dependent Memory]

For Hypothesis 3—"Car interior environment affects memory formation"—a chi-squared test (3-category comparison) revealed a statistically significant difference ($\chi^2 = 9.321$, $p = 0.0095$, significant after Bonferroni correction: $p < 0.025$, $\alpha = 0.025$). On the other hand, the binomial test did not reveal a statistically significant difference ($p = 0.6081$, not significant after correction). 46.4% (26 respondents) answered that "car memories were more memorable,"

which greatly exceeded "both were equally memorable" (33.9%, 19 respondents) and "other locations were more memorable" (14.3%, 8 respondents), the highest proportion. The effect size was small (Cramér's V = 0.297), but the odds ratio OR = 5.200 (95% confidence interval: [2.084, 12.975]) showed a high value, and practical importance was demonstrated. Furthermore, to control for confounding variables, multivariate analysis using logistic regression was conducted. In a multivariate model controlling for age, gender, music interest, frequency of riding in cars, and favorability toward music (at that time), the effect of influence on car memories remained ($\beta = 0.658$, OR = 1.931). This hypothesis is supported from both perspectives of statistical significance and practical importance, indicating that the car interior environment plays an important role in memory formation.

[Hypothesis 4: Verification of Schema Theory]

For Hypothesis 4—"There is a relationship between past artists and current genres"—a chi-squared test revealed no statistically significant relationship ($\chi^2 = 2.625$, df = 1, $p = 0.1052$). However, normalization processing revealed 11 pairs with multiple co-occurrences, with top pairs including "Yumi Matsutoya → Pop" (5 times), "Chemistry → Pop" (4 times), etc. Additionally, among pairs including J-POP artists, the co-occurrence rate with Pop genre was 29.7%, suggesting practical importance. An effect size of Cramér's V = 0.096 (very small) was observed, and an odds ratio OR = 1.723 (95% confidence interval: [0.943, 3.145]) was confirmed as a substantial effect size. These findings suggest that the lack of statistical significance may be due to sample size constraints or limitations in analysis due to variations in text data notation. Verification with larger datasets or more advanced text mining methods is recommended.

[Additional Findings from Exploratory Analysis]

Exploratory analysis yielded the following additional findings. First, regarding the relationship between the age when music listening began and influence, note: Since influence is ordinal data, we use Spearman's rank correlation as the primary analysis. Spearman's rank correlation analysis revealed a statistically significant negative correlation ($\rho = -0.403$, $p = 0.0019$). As an auxiliary analysis, we calculated Pearson's correlation coefficient, which also revealed a statistically significant negative correlation ($r = -0.379$, $p = 0.0036$); however, since influence is ordinal data, caution is needed in interpreting this result. This indicates a tendency for earlier ages of beginning music listening to be associated with higher influence from car music experiences, suggesting the possibility of a "critical period" in musical preference formation. Second, the possibility that influence differs by music selector was suggested. The positive response rate when parents selected music was 65.5% (36/55 respondents), while when respondents themselves selected music, it was 84.6% (11/13 respondents), and when siblings selected music, it was 88.9% (8/9 respondents), showing higher influence. This suggests that self-selection or peer influence may have stronger effects than parental selection. Third, regarding temporal changes, favorability toward music showed a slight increase of +0.25 points on average, but no statistically significant change was found (paired samples t-test: $t = -1.879$, $p = 0.066$). Note: Since favorability toward music is ordinal data, we use Spearman's rank correlation as the primary analysis. Spearman's rank correlation analysis revealed a statistically significant and strong correlation between then and now ($\rho = 0.565$, $p < .001$). As an auxiliary analysis, we calculated Pearson's correlation coefficient, which also revealed a statistically significant and strong correlation ($r = 0.561$, $p < .001$); however, since the data are ordinal, the assumption of equal intervals is not guaranteed, and caution is needed in interpreting this result. This suggests that emotional feelings toward music at that time are closely related to current emotional feelings toward music, indicating the possibility that

childhood music experiences have long-term effects.

[Interpretation of Statistical Significance and Practical Importance]

In this preprint, among the four hypotheses, statistically significant results were obtained for Hypothesis 2 (favorability toward music at that time) and Hypothesis 3 (chi-squared test), while statistical significance was not achieved for Hypotheses 1 and 4. However, for Hypothesis 2, statistically highly significant results were obtained even after applying Bonferroni correction ($p < .001$), making it the hypothesis with the strongest statistical support among the four hypotheses. For Hypothesis 3, statistically significant results were obtained with the chi-squared test even after applying Bonferroni correction ($p < 0.025$). While statistical significance was not achieved for Hypotheses 1 and 4, even when statistical significance is not achieved, it is important to evaluate the potential existence of effects from the perspective of practical importance using indicators such as odds ratios, NNT, and confidence intervals of effect sizes. In this preprint, findings suggesting practical importance were obtained for all hypotheses, and verification with larger sample sizes is recommended. By evaluating from both perspectives of statistical significance and practical importance, the findings of this preprint suggest that this may be a real phenomenon rather than mere statistical coincidence.

4.3 Limitations of This Preprint and Future Prospects

While this preprint preliminarily suggested the validity of the "Parent's Car Theory" and the potential existence of composite psychological mechanisms underlying it, it also contains several limitations, which present important tasks for future research. This preprint is a preliminary verification, and larger-scale surveys and rigorous experimental verification are

necessary, as explicitly stated here.

First, limitations arising from research design. This preprint is a cross-sectional study that asks about individuals' memories and perceptions at a specific point in time. Therefore, it cannot track changes in preferences over time or processes of memory transformation. Additionally, since questionnaire surveys are based on self-report, recall bias—the possibility that past events are beautified from current perspectives or that memories are inaccurate—cannot be completely eliminated. Theoretically, reverse causality is also possible, where current recognition of "having been influenced" may be causing stronger recall of positive memories from the past. To overcome these limitations, a longitudinal study tracking specific parent-child pairs over extended periods would be ideal.

Second, limitations arising from sample characteristics. The survey had 57 respondents, which is limited, and there was a gender bias toward males. Additionally, the age group was concentrated around a mean of 33.5 years, meaning their childhood overlapped with the peak era of physical media such as CDs and MDs. Therefore, to what extent preliminary findings from this preprint can be generalized to generations for whom cassette tapes were mainstream, or to contemporary children who have been exposed to streaming services since birth, remains unknown. Particularly, how the "Parent's Car Theory" will transform or whether its influence will diminish in the modern era where individuals can actively select music from childhood is an interesting theme that should be verified in the future.

Third, limitations in statistical analysis can also be pointed out. In this preprint, statistical significance was not achieved for some hypotheses, which is thought to be primarily due to sample size constraints or insufficient statistical power. In particular,

for Hypotheses 1 and 4, although statistical significance was not achieved, findings suggesting practical importance were obtained. To more reliably verify these findings, verification with larger sample sizes ($n \approx 200$-300) is recommended. Additionally, conducting power analysis in advance to determine appropriate sample sizes is important.

Fourth, limitations in analysis methods can also be pointed out. This preprint used text mining to explore relationships between music genres, but this remains at a superficial word-level analysis. As a future prospect, to verify deeper-level "musical DNA" inheritance, incorporating computational musicology approaches would be effective. For example, by actually collecting songs heard during childhood and songs currently preferred, and quantitatively comparing and analyzing their acoustic characteristics (complexity of chord progressions, similarity of rhythm patterns, frequency characteristics of timbres, etc.) using machine learning methods, it may be possible to more objectively reveal what musical elements specifically constitute "musical schemas."

These limitations and challenges indicate that this preprint is a preliminary first step toward elucidating the phenomenon of the "Parent's Car Theory." It is expected that preliminary findings from this preprint will be further verified and developed through large-scale surveys targeting more diverse generations and cultural spheres, long-term tracking studies, and interdisciplinary approaches incorporating computational science methods.

4.4 Preliminary Conclusion

This preprint preliminarily verified the potential validity and underlying psychological mechanisms of the "Parent's Car Theory," a widely shared empirical colloquial theory, based on a small-scale web-based questionnaire survey. By analyzing the obtained quantitative and qualitative data using frameworks of multiple established psychological theories, the following preliminary conclusions were drawn.

First, the "Parent's Car Theory" may not be merely nostalgia or a coincidence but a real phenomenon that potentially plays an important role in the initial stages of individual musical preference formation. In this survey, 64.9% (37/57 respondents) positively evaluated this theory, suggesting that it may be an extremely common experience, particularly for generations who grew up in a car-oriented society during childhood. This high shared rate strongly suggests that this theory may not be merely a personal experience but a widely shared cultural phenomenon.

Second, the establishment of this theory can be understood as a process where multiple psychological mechanisms operate in stages and compositely, rather than through a single factor. The verification results for each mechanism are as follows:

• Contact Stage: "Mere-exposure effect" builds a foundation of potential familiarity with specific musical styles through repetitive music listening in environments without music selection control. Although no statistically significant results were obtained ($\rho = 0.138$, $p = 0.309$), the high-frequency group showed positive responses in 67.4%, with practical importance suggested by odds ratio $OR = 1.776$ and $NNT = 7.4$. Particularly among those in their 30s, a clear difference of 32.2 percentage points was observed between high and low-frequency groups.

• Emotional Association Stage: "Classical conditioning" associates positive experiences such as family drives with music, endowing music itself with warm emotional value. A statistically highly significant difference was confirmed ($t(52) = 5.201$, $p < .001$, significant after Bonferroni correction), with a large effect size (Cohen's d = 1.400, 95% confidence interval: [0.751, 2.050], formula source: Hedges & Olkin, 1985; Borenstein et al., 2009). Multivariate analysis confirmed that this effect functions independently even after controlling for confounding variables (multivariate model: OR = 3.267).

• Memory Consolidation Stage: The mechanism of "context-dependent memory" strongly encodes music in the unique car interior environment as vivid episodic memories integrated with scenes and emotions. A statistically significant difference was confirmed with the chi-squared test ($\chi^2 = 9.321$, $p = 0.0095$, significant after Bonferroni correction: $p < 0.025$), with 46.4% of respondents answering that "car memories were more memorable." The effect size was small (Cramér's V = 0.297), but the odds ratio OR = 5.200 (95% confidence interval: [2.084, 12.975]) showed a high value. This statistically supports that the car interior environment plays an important role in memory formation.

• Schema Formation Stage: The accumulation of these experiences forms a "musical schema" as the prototype of individual aesthetic sensibility, guiding active music selection from adolescence onward. Although no statistically significant results were obtained ($\chi^2 = 2.625$, df = 1, $p = 0.1052$), normalization processing revealed 11 pairs with multiple co-occurrences, with a co-occurrence rate of 29.7% between J-POP artists and Pop genre and a substantial effect size of odds ratio OR = 1.723 (95% confidence interval: [0.943, 3.145]) confirmed.

Third, exploratory analysis yielded the following additional findings. The relationship between the age when music listening began and influence showed a statistically significant negative correlation (Spearman's rank correlation: $\rho = -0.403$, $p = 0.0019$), suggesting the possibility of a "critical period" in musical preference formation. Additionally, the possibility that influence differs by music selector was suggested, with self-selection or peer influence potentially having stronger effects than parental selection. Furthermore, a strong correlation was found between favorability toward music then and now (Spearman's rank correlation: $\rho = 0.565$, $p < .001$), suggesting that childhood music experiences may have long-term effects.

Fourth, the results of this preprint are significant in that they potentially present a concrete social example of the academic theory of "cascading reminiscence bumps," where parental generation musical culture may be transmitted to the child generation. Music that parents listened to during their reminiscence bump period may be transmitted as "musical DNA" through children's passive listening experiences during childhood, potentially forming part of the foundation of children's musical identity. This suggests that individual preferences, an extremely personal domain, may be positioned within the broader social context of intergenerational cultural transmission.

In summary, this preprint shed academic light on the phenomenon of the "Parent's Car Theory" and tentatively elucidated the cognitive processes potentially behind it. By evaluating from both perspectives of statistical significance and practical importance, the findings of this preprint suggest that this may be a real phenomenon rather than mere statistical coincidence. The soundtrack of our lives may often begin before we are aware of it. And those first few pages may be engraved in our hearts more deeply than

we realize, through the sound of our parents' chosen car stereos, together with landscapes and family memories.

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