Theory to health and peace avoiding wars: Maximizing preference and minimizing stress of life

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A variety of "stressors" set into motion defense reactions mediated through the nervous and the hormonal systems (Selye, The physiology and pathology of exposure to stress, 1950). The word "stress" was not used until the 1950s, and the number of existing central hospitals was considerably lower. Nowadays, it is normative that human life is so occupied by a wide range of stressors including due to ill human relations that the pleasure derived from the process of living is regretfully often drained away by stress. This article has been written in support of healthy peaceful living avoiding ill treatment and further wars. We shall discuss how to maximize a preference for human life in terms of environmental conditions (Ando, Brain-Grounded Theory of Temporal and Spatial Design in Architecture and the Environment. Springer Tokyo, 2016), and, accordingly, how to minimize stress. Our preferences that shape into creations in the third stage of our lives carry within them the most survival power because they can self-sustain as culture. In short, the first stage in the evolution of life is the physical body, and the second stage is the mind. These two stages are common to all animals. These two levels of existence are never free from worry or ill treatment between individuals, further ethnic conflict or even war between nations. Any tiny creative actions with affection, on the other hand, are indicative of human behavior and they are driven by preferences. The third stage refers to that part in the evolution of life whose influence spans across time-space and may, therefore, contribute to the health, happiness and overall conditions of future generations. Every creation is an extension of a person's unique personality and genetic code (DNA). DNA in its calculable forms has been developing since the Big Bang. As a phenomenon, it has undergone a fairly long-term life. Perhaps we can stretch the idea of a finite number of DNA to where it bears artistic and scientific works that are infinite in nature, and, therefore, contributing to human life as culture ad aeternum. In our context, the third stage stems from the body of our creations. Hopefully, an infinite countable number of unknowns may be tackled with a limited number of principles and theories created.

Keywords: Stress, subjective preference, the first stage of life (body), the second stage (mind), the third stage (personality based creations), preference associated with brain activities, auditory and visual percepts.

1. INTRODUCTION

We conducted studies on the theory of subjective preference for the sound field in a concert hall, which led to a theory of general architectural design [4, 5, 6, 10, 16]. As far as the details of room shapes are concerned, a number of concert halls seem to have been designed by the theory in recent years. Examples have been set by the leaf-shaped design of the Kirishima International Music Hall (Miyama Conceru), built in 1994 with a seat selection system testing individual subjective preference to enhance listener satisfaction [9, 10], and Tsuyama Music Cultural Hall (Belle Forêt Tsuyama), built in 1999 with 52 columns, 30 cm in diameter each, placed around the hall in front of the walls [11].

The brain-grounded theory that is specifically based on the auditory brain system and which covers temporal and spatial aspects of environmental design is meant to support the development of unique personality traits, which are described alongside the theory of subjective preference. The underlying research works were initiated in 1977 to attain knowledge of subjective preference for sound fields in concert halls. The research has spun out in various directions ever since and investigated environments of different types for the same qualities in both auditory and visual sensory modalities [13]. Brain responses, related to and indicative of subjective preference, have been documented in the slow vertex response (SVR), as well as in electroencephalographic (EEG) and magnetoencephalographic (MEG) recordings. It is remarkable that subjective preference is associated with the α-wave in EEG and MEG recordings, particularly with the extended period of time that the rhythm repeats itself under preferred conditions. This is why the theory regards preferences as the base of aesthetics and art [14]. An integration of such creations is called "culture". Due to the innate priority that life holds over disease, preferences may eliminate the phenomenology of stress, from cognitive impairment to other illnesses. The preference for life in an organism is what maintains health by avoiding stress and related illnesses. Most generally, subjective preference is regarded as the primitive response of a living creature that entails judgments that steer an organism in the direction of maintaining life, so as to enhance its prospects for survival as illustrated in Fig. 1 (left). We have proposed an approach called "temporal design" in addition to spatial design in the field of architecture and the human environment [http://www.jtdweb.org/ 2001; 8, 12, 14, 15, 17].

With regard to this approach, what can be seen as the three stages of human life have been identified (Fig. 2, [17]). The first stage of life is the body, the second stage is the mind, and the third is the legacy that a person leaves behind in the form of their creations. The latter is intimately based on individual personality and may have a much longer life-span than just the individual physical and mental life (Table 1). On the contrary, any kind of long-term stressor may yield an illness such as cognitive impairment as indicated in Fig. 1 (right) and Table 2.

It is interesting to observe the communication between three camphor trees in Fig. 3. In the center, the branches of each tree have grown not to cross over each other, as if they are realizing each other's presence without any stress. The branches on the outer perimeter go up and wide according to their preference. We can adapt this analogy of preference-driven activity to the third stage of human life, and the most powerful of our creations, culture.

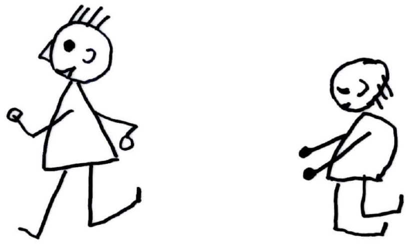

Fig. 1 - (a) A life of expressed creativity based upon individual personality (DNA) and maximized preference that receives affection from nature and keeps good health till the end of life. (b) A life of stress stemming from an excessive desire to obtain material gains and higher positions resulting in serious illness.

Fig. 2 - Three camphor trees communicating with each other by radiating chemical substances. Branches of trees have bifurcated, avoiding stress, and have not crossed over each other. Branches on the outer perimeter go up and wide according to their preference, and the overall form created by the three trees conveys beauty.

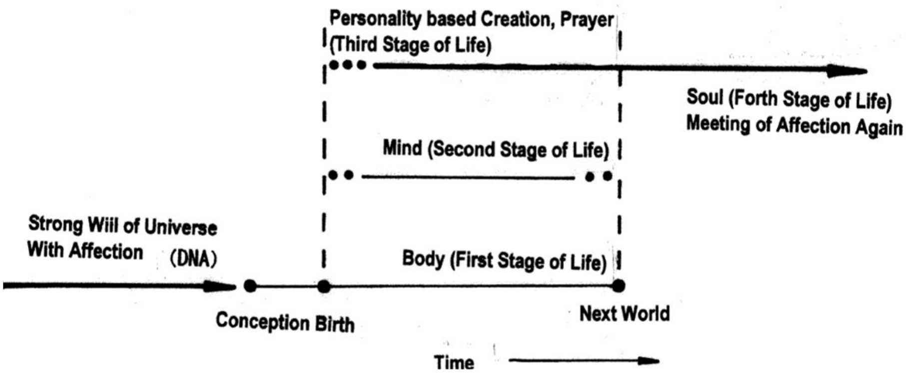

Fig. 3 - Definition of the three stages of human life that are considered when planning the temporal and spatial environment [17]. Human life consists of: 1) life of body, 2) life of mind, and 3) life of creation, which is based on the unique personality of the individual that persists long after the individual has passed away. The third stage of life includes creations based on personality together with the awakening of refined perception, which might continue to the fourth stage of life known as soul in the afterlife [19]. This concept is similar to the well known "analytic continuation" in the field of complex analysis (mathematics); it means the continuity from the third stage of life to the forth stage of life without any singularity.

2. TWILIGHT OF INDIVIDUAL THIRD STAGE OF LIFE

The choices we make based on preferences are present at each of the three stages of individual life. We select a partner in hopes of a good DNA match. Before conception, parents should be careful for infections (the first stage) for the sake of the healthy mind and personality of the neonate (the second and third stages). To sustain the mother's health during pregnancy, the first stage is supported by walking, swimming and eating, avoiding any infections; the second stage develops by listening to preferred music without any environmental noise, walking, drawing and reading, and the third stage can manifest by enjoying preferred creative works (Fig. 4), drawing, and making clothes for the coming baby.

After the birth, the preferences of the three stages of life can be incorporated into the design of the living environment, which consists of the house and the rooms, according to the design theory built on temporal and spatial factors associated with the left and right hemisphere, respectively (Fig. 5: Ando, 2016). Parents can provide a space for doing physical exercises (first stage), looking at photographs of animals, trees and flowers (second stage), painting and modeling clay works (third stage), according to the preferences of each child. We recommend to implement the concept of a miniature creative workspace (CWS: [12, 13, 17]) to support cerebral development during the different activities.

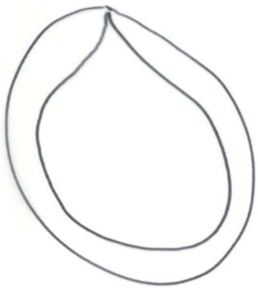

Fig. 4 - "Seed" as DNA that has developed since the Big Bang, which may germinate in the "soil" of individual preference and preferred environment [17].

The twilight of individual personality is the time between the beginning of life and starting kindergarten or elementary school. The author once asked a three-year-old girl what her favorite playtime activity was. She said it was drawing. The author then asked her to make a drawing for him. A week later she gave him two sketches of the faces of the author and his wife (Fig. 6 (a) and (b)). This illustrates the twilight of an individual third stage of life based on personal preference. We propose an approach where all useful creations based on the unique personality of the individual continue to contribute to human society long after the first and second lives have passed.

Therefore, we recommend to design the human environment according to preferences for all three stages of life, since the environment is plausibly a most important factor in the development of an individual's personality.

Table 1 - Examples of preferred activities in the three stages of life.

Stage of Life	Almost every day	About once a week	Works throughout life
First Stage (Body)	Physical warm-up exercises, swimming, walking, jogging, running, fresh air, breeze.		
Second Stage (Mind)	Cooking, observing water flow, fire flame, contemplating nature, the diurnal and nocturnal sky, listening to music and related performances.	Going to concerts and opera, art museums, designing clothes, furniture, shopping, gardening, singing.	
Third Stage (Creations due to Personality)	Play in early childhood, art works including fine art.	Performing art, children's meetings.	Science and art creations for peace and sustaining the environment, writing books, papers, articles, drawing, Interpreting music, composing music and poetry, designing architecture and the environment, fashion design.

Table 2 - Examples of stressors in the first, second and third stages of life. Continual killing of living creatures ultimately results in extinction.

Stage of Life	Individual activities	Physical, chemical and social environment
First Stage (Body)	Jobs, alcohol, cigarettes, medicine, scarcity of food, inflammation, infection.	Radiation, organic solvent, noise (for effects on unborn babies and children see Section 3).
Second Stage (Mind)	Mindlessness, anger, strain, anxiety, fretfulness, fear, cruelty.	Noise, bad vision, light pollution, extremities in temperature, overload of information, strained human relationships, extra work, economic problems, political problems.
Third Stage (Creations due to Personality)	Weapons, atomic bomb.	Killing living creatures.

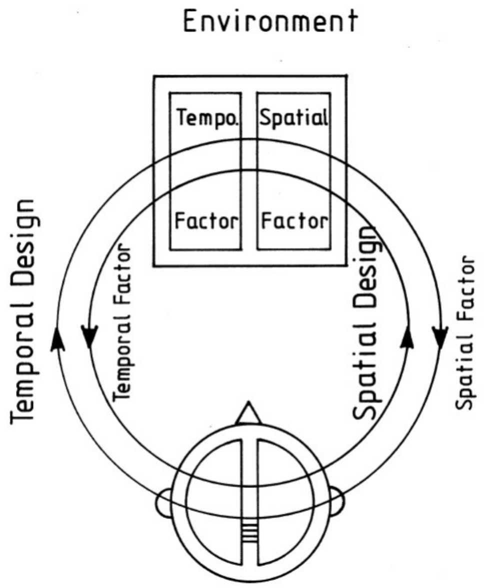

Fig. 5 - Interaction between the environment, consisting of temporal and spatial factors, and the left and right human cerebral hemispheres, respectively. This is the ground of the theory for designing architecture and the environment as well as artistic works. A well designed environment realized by the subjective preference theory induces further creations by supporting the development of individual personality [13, 17].

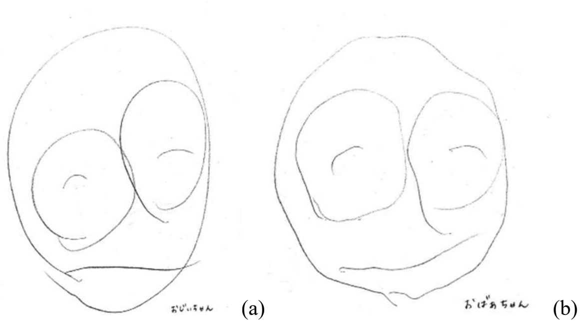

Fig. 6 - Sketches of faces made by a 3-year-old girl in 2016 during the most important period in early life before starting school. Parents should provide an environment for the child that is realized by the subjective preference theory to develop individual personality and to induce further creations. (a) The author. (b) Keiko.

Temporal and spatial factors associated with the left and right cerebral hemispheres, respectively (Fig. 5), can be incorporated into design that blends individual personality, the built environment, and nature. Smart environmental design in the room of a newborn supports the development of the child's hemispheres, especially during the period before attending kindergarten and/or elementary school. In this period almost the entire brain is formed [17]. The soul of a child at the age of three is the same at 100.

On the contrary, intensely noisy environments in the vicinity of international airports in this early period may cause serious stress and result in loss of energy on account of the development of the first stage (body), second stage (mind), and consequently, the third stage of life (personality based creations) – an effect spanning across a life-time. Effects suffered during fetal life and in the early stages of human life that remain till the end of life are discussed in Appendix I.

3. EEG AND MEG CORRELATES OF SUBJECTIVE PREFERENCE OF SOUND FIELDS

3.1 Magnitude of Interaural Crosscorrelation (IACC)

Listening music is very useful for realizing preferred life and minimizing stress of life in the second stage of life. It has been no theory realizing excellent concert hall based on subjective preference theory before 1983 [6]. Therefore, few concert halls built before 1983 had been not existing, for example, the New York Philharmonic Hall opened in 1962 was not accepted by New Yorkers unfortunately, and it was rebuilt as Avery Fisher Hall in 1978, but again it was not satisfied by people.

In order to find EEG response correlating to subjective preference, in change of the IACC of the sound field were investigated. Eight student subjects participated in the paired-comparison experiment [29]. Music motif B (Sinfonietta by Arnold) was applied as the stimulus.

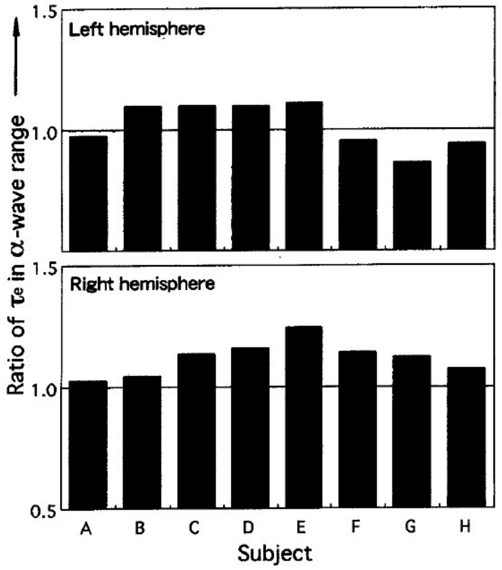

Fig. 7 - Ratio of ACF τ_e values of the EEG α–wave from the left hemisphere (T3) and the right hemisphere (T4) for each of 8 subjects, A-H: [τ_e value at IACC = 0.30]/[τ_e value at IACC = 0.95]. Ratio of ACF τ_e values are greater on the right hemisphere than on the left except for subject B [29].

Changes in the IACC reflected clearly in right hemisphere dominance. The effective duration τ_e of α-band activity was found to be substantially longer in the preferred condition (IACC = 0.30). A significant difference was achieved in the right hemisphere for the pair of sound fields with IACC = 0.95 and 0.30 ($p < 0.01$) as shown in Fig. 7.

1. In seven of eight subjects except for Subject B, the ratios of effective durations τ_e for α-band responses to IACC change, [τ_e (IACC = 0.3) / τ_e (IACC = 0.95)], in the right hemisphere were greater than in the left hemisphere except for subject B (Fig. 7). Thus, as far as the IACC is concerned, the more preferred condition with a smaller IACC is related to longer α-rhythm effective durations in the right hemisphere in most of the tested subjects .
2. As shown most clearly in Fig. 8, α-wave of alpha rhythm activity in the right hemisphere (T4) at IACC = 0.3 later propagates toward the left hemisphere (T3).
   Additionally, experiments using MEG measurements tested the effects of a speech signal that was altered by changes to the IACC (0.27, 0.61 and 0.90). The results reconfirmed that effective duration τ_e in individuals and the maximum amplitude of the CCF (crosscorrelation function) increased when the IACC decreased in the right hemisphere [29].

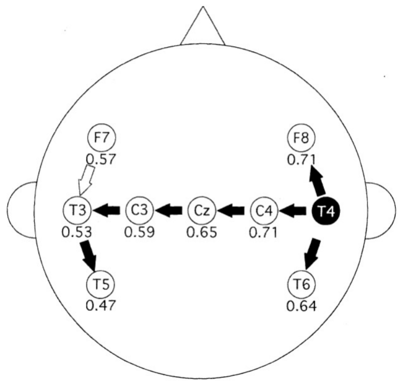

Fig. 8 - Propagation of the α-wave flow from the right hemisphere to the left in response to a small value of IACC (the preferred condition of the sound field). Real numbers reflect the median values of α–rhythm correlation magnitudes (maximum absolute values) between alpha band EEG signals from electrode T4 and the indicated electrodes [29]. Such a preferred condition resulting in full α-wave throughout the brain may maintain life by eliminating stress.

3.2 Initial Delay Gap between the Direct Sound and the First Reflection (Δt_1)

3. When the time delay between the direct sound and the single reflection was changed applying the speech signal, an almost direct relationship between individual scale values of subjective preference and the τ_e values over the left hemisphere was found in each of the eight subjects. Results for each of 8 subjects are shown in Fig. 9. Remarkably, the correlation coefficient, r, reached more than 0.94 for all subjects. Most remarkably, however, there was weak correlation between the scale values of subjective preference and the amplitude of the α-wave, $\Phi(0)$, in both hemispheres ($r < 0.37$). The value of τ_e represents the degree of similar repetitive features in the alpha waves that the brain repeats in a similar rhythm under the preferred conditions. This tendency for a larger τ_e under the preferred condition is much more significant than the results from the EEG α-waves mentioned above.
4. Table 3 summarizes hemispheric dominance results obtained by analysis of the effective durations τ_e of α-rhythms, with respect to changes in listening level LL, first reflection time Δt_1, reverberation time T_{sub} , and the magnitude of interaural crosscorrelation IACC. This finding suggests that the value of τ_e in the α-band is an objective index for subjective preference and thus designing excellent human acoustic environment.

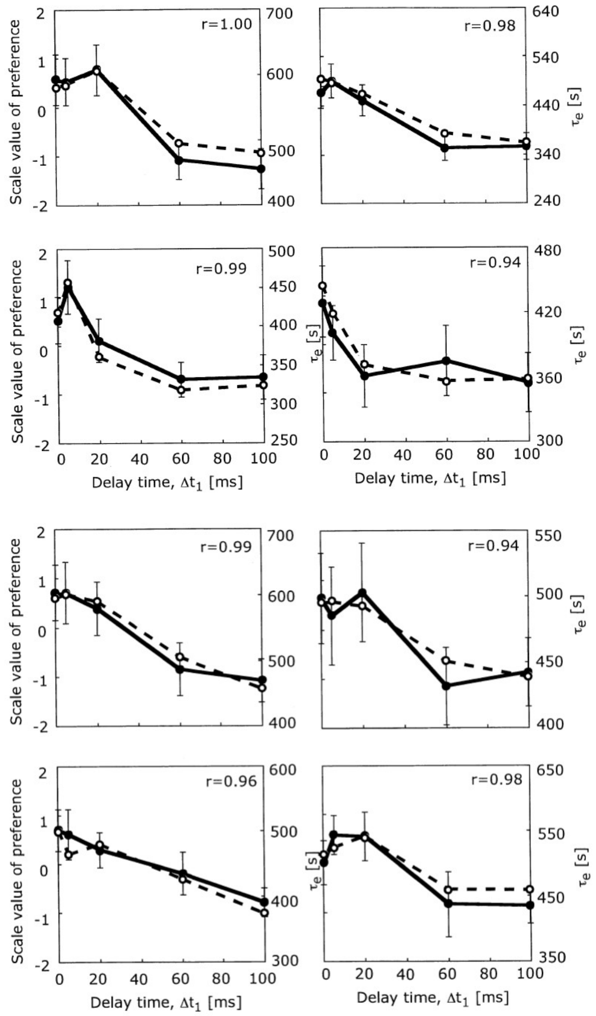

Fig. 9 - Good correspondence between the scale value of subjective preference and the averaged ACF τ_e value of the MEG α–wave over the left hemisphere of individual subjects (8 subjects). The averaged τ_e value and the scale value of preference are in the highest correlation over the eight channels [27, 28]. ○: scale values of subjective preference; ●: averaged τ_e values of MEG α–wave, error bars being standard errors.

4. EEG CORRELATES OF SUBJECTIVE PREFERENCE OF FLICKERING LIGHT IN VISION

Soeta et al [27, 28] recorded the EEG correlates of subjective preference for flickering light from both the left and right cerebral areas of the subjects' scalps by using silver electrodes (7-mm diameter) at points T_3, T_4, T_5, T_6, O_1, O_2, and in addition C_z (Fig. 10). Note that the most preferred period of flickering light is around 1.2 s. The normalized CCF between the alpha waves measured at electrode positions O_1 or O_2 (reference electrodes) and those at the other electrodes (test electrodes) were analyzed.

Subjective preference corresponded well to the effective duration of the ACF, τ_e, at both O_1 and O_2. The integration interval for the CCF was the same (2.5 s) as had been used in the ACF (autocorrelation function) analysis. An example of the normalized CCF is shown in Fig. 10.

A positive lag ($\tau > 0$) means that the activity at the reference electrode was delayed relatively to that at the test electrode. $|\phi(\tau)|_{max}$ was defined as the maximum value of the CCF in the range of $\tau = \tau_m$ that was defined as its delay time.

Results clearly indicated that $|\phi(\tau)|_{max}$ values were significantly related to the subjective preference when the period alone was varied and when both the period and the mean luminance were varied. When the period was varied, the value of $|\phi(\tau)|_{max}$ was significantly greater for the most preferred stimulus than for the less preferred one.

When the period is varied, the preferred stimulus induces a significantly greater value of the absolute value of the normalized ACF$|\phi(\tau)|_{max}$ of the α-waves than the less preferred stimulus.

Table 3 Hemispheric specializations determined by analyses of AEP (SVR), EEG and MEG.

Factors changed	AEP (SVR) A(P_1 – N_1)	EEG, ratio of ACF τ_e values of α-wave	AEP (MEG) N1m	MEG, ACF τ_e value of α-wave
		Temporal		
Δt_1	L > R (speech)[1]	L > R (music)		L > R (speech)
T_{sub}	---	L > R (music)	---	
		Spatial		
LL	R > L (speech)	---	---	
IACC	R > L (vowel /*a*/)	R > L (music)[2]	R > L (band noise)[3]	
	R > L (band n.			
τ_{IACC}			R > L (band noise)[3]	
HRTF			R > L (vowels)[4]	

[1] Sound source used in experiments is indicated in brackets.
[2] The flow of EEG □-wave from the right hemisphere to the left hemisphere for music stimulus in change of the IACC was determined by the CCF $|\phi□\tau)|_{max}$ between α-waves recorded at different electrodes (Fig. 7).
[3] [30].
[4] [23].

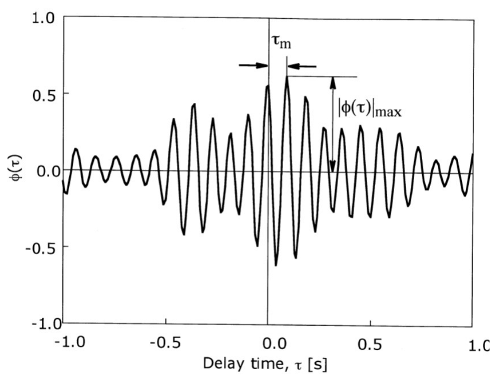

Fig. 10 - An example of the normalized cross correlation function (CCF) of EEG α–waves from different electrodes and definitions of the magnitude $|\phi(\tau)|_{max}$ and its delay time τ_m.

Significantly greater values of $|\phi(\tau)|_{max}$ for the α-wave indicate that the brain is repeating a similar rhythm over a wider area under a preferred condition (Fig. 11). As we have discussed in previous sections, a number of studies have found greater τ_e values of the ACF of the alpha wave at the preferred stimulus than at a relatively less preferred one. Significantly larger values of τ_e that appear for the alpha wave indicate that the brain is repeating a similar rhythm under these preferred conditions. Thus, the brain repeats a similar rhythm over a wider range in both brain area and time, under a preferred condition. This physiological tendency to react to a favorable environment would effectively decrease the experience of stress in the three stages of life (Fig. 12).

The preference for life in the first and second stage of life normally leads to maintaining individual life and preference-based creations in the third stage of life that integrate with culture hopefully maintain the environment and support lasting peace (Fig. 13).

On the contrary, Fig. 14 illustrates how the stress of life caused by, for example, the ill concept of "time is money," which essentially hinders a person's innate tendency to enjoy the passage of time, may result in wars or even extinction. The CCF of the alpha wave showed the movement of the alpha wave over the scalp from the occipital area (O_1, O_2) to the temporal area (T_3, T_4) and to the vertex area (C_z).

The flow of the alpha waves in relation to $|\phi(\tau)|_{max}$ and τ_m under a preferred condition. It is clear that the alpha wave propagated from the reference electrode O_1 to other regions.

A similar tendency was found when the reference electrode was at O_2. The values of $|\phi(\tau)|_{max}$ and of τ_m, therefore, depend on the distance between the reference and test electrode.

The results here lead us to the following conclusions:

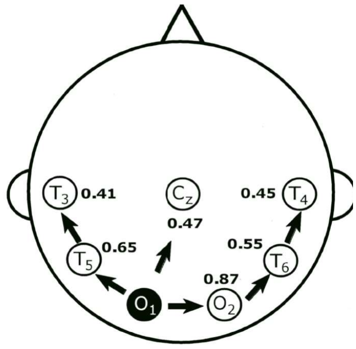

Fig. 11 - Flow of the EEG α–wave in both hemispheres from the reference to O_1 for variation of period under a preferred condition of flickering light. (a) The averaged value of magnitude $|\phi(\tau)|_{max}$ [28].

	Preferred sound and visual fields	Stress by noise of 80 dBA	Creative activities	Singing
Value of τ_e of α-wave of the brain [1]	⊕	– –	⊕⊕	⊕
Vital power of the third stage (personality)	⊕	– –	⊕⊕	⊕
Life force of the second stage (mind)	⊕	– –	⊕⊕	⊕
Survival power of the first stage (body)	⊕	– –	⊕⊕	⊕

Fig. 12 - Three stages of life according to preferred human activities and stress of noise in terms of the value of τ_e extracted from the α-wave.

1) When the period of the flickering light is varied, the preferred stimulus has significantly greater values of $|\phi(\tau)|_{max}$ than the less preferred stimulus. Together with the result shown above, we conclude that in the preferred condition, the α-rhythm repeats itself over a certain time and this activity spreads over a certain area of the brain.
2) The value of $|\phi(\tau)|_{max}$ decreases with the increasing of distance between the reference and test electrode.
3) The value of τ_m increases in a stepwise fashion with the distance between the reference and the test electrode. This suggests that there are discrete nuclei in the central system.

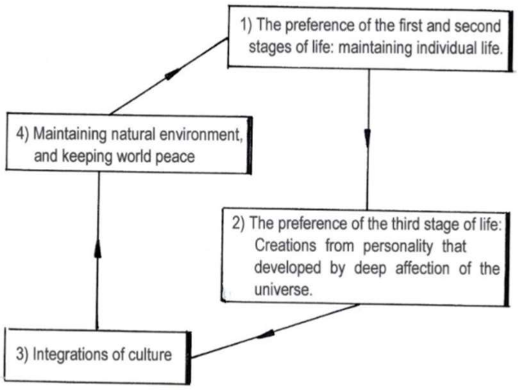

Fig. 13 - The preference for life in the first and second stages of life normally leads to maintaining individual life, and preference-based creations in the third stage of life that integrate with culture hopefully maintain the environment and support peace ad aeternum.

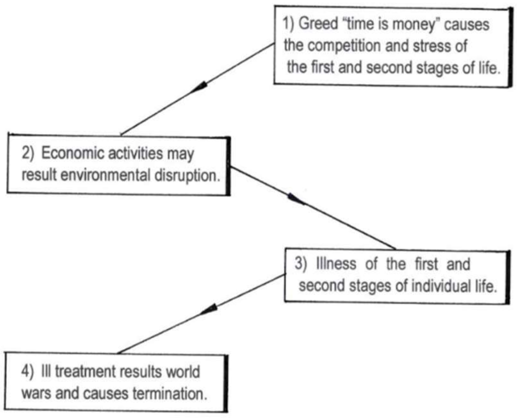

Fig. 14 - The stress of life caused by, for example, the ill concept of "time is money," potentially resulting in wars or even extinction.

5. APPLICATIONS OF SUBJECTIVE PREFERENCE THEORY FOR SEAT SELECTION

The minimum unit of society to be satisfied by the environment is one individual, which leads to a unique personal existence [10]. Here, we demonstrate that the individual subjective preferences of each listener may be described by the preference theory as well described in Appendix II, which ensued from observing a number of subjects.

5.1 Individual Subjective Preference of Each Listener

In order to enhance individual satisfaction for each individual, a special facility for seat selection, testing each listener's own subjective preference [24] was introduced at the Kirishima International Concert Hall in 1994. The sound simulation system employed multiple loudspeakers. It used arrows for testing the subjective preference of four listeners at the same time. Since the four orthogonal factors of the sound field influence the preference judgment almost independently [10], each single factor was varied, while the other three were fixed at the preferred condition for the average listener.

5.2 Individual Preference and Seat Selection

The music source was orchestral, the "Water Music" by Handel; the effective duration of the ACF was 62 ms. The total number of listeners participating was 106. Typical examples of the test results for listener BL as a function of each factor are shown in Fig. 15.

Scale values of this listener were rather close to the averages for subjects previously collected: the most preferred $[LL]_p$ was 83 dBA, the value $[\Delta t_1]_p = (1 - \log_{10}A)\ (\tau_e)_{min}$ was 26.8 ms (the global preferred value calculated with the total simulated sound pressure A = 4.0 is 24.8 ms [10]. The most preferred reverberation time was 2.05 s (the calculated global preferred value is 1.43 s). The center seat area was preferable for listener BL (Fig. 16). Results revealed that for all listeners the scale value of preference increased with decreasing IACC value. Since listener KH preferred a very short delay time of □t1, his preferred seats were located close to the boundary wall as shown in Fig. 17. Listener KK indicated a preferred listening level exceeding 90 dBA. For this listener, the front seating area close to the stage was preferable, as shown in Fig. 18. For listener DP, whose preferred listening level was rather weak (76.0 dBA) and preferred initial delay time short (15.0 ms), the preferred seat was in the rear part of the hall as shown in Fig. 19. The preferred initial time delay gap for listener CA exceeds 100.0 ms, but was not critical. Thus any initial delay times were acceptable, but the IACC was critical. Therefore, the preferred areas of seats were located as shown in Fig. 20. The three-dimensional plots in Fig. 21 are a limited range of individual preferences and average values are listed in Table A.1 for design purposes. It is worth noticing that the factor IACC is excluded from the Fig. because the preference of all subjects was always for smaller values, or dissimilarity, of binaural signals.

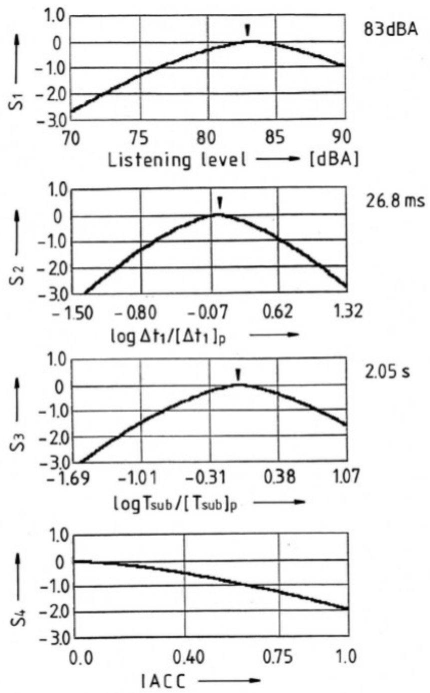

Fig. 15 - Examples of the scale value of subjective preference obtained by the PCT for each of the four orthogonal factors of the sound field (subject BL, [10]). (a) The most preferred listening level was 83 dBA, the individual weighting coefficient $\alpha_1 = 0.06$. (b) The preferred initial time delay gap between the direct sound and first reflection was 26.8 ms, the individual weighting coefficient $\alpha_2 = 1.86$, where $[\Delta t_1]_p$ calculated with $\tau_e = 62$ ms for the music used (A = 4) is 24.8 ms. (c) The preferred subsequent reverberation time was 2.05 s, □$\alpha_3 = 1.46$, where $[T_{sub}]_p$, calculated with $\tau_e = 62$ ms for the music used, is 1.43 s. (d) $\alpha_4 = 1.96$.

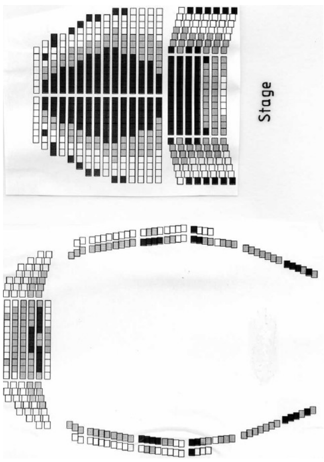

Fig. 16 - Preferred seating area calculated for subject BL [10]. The seats are classified in three parts according to the scale value of preference summating S_1 through S_4. The black portion of seats indicates preferred areas, about one third of all seats in this concert hall, for subject BL.

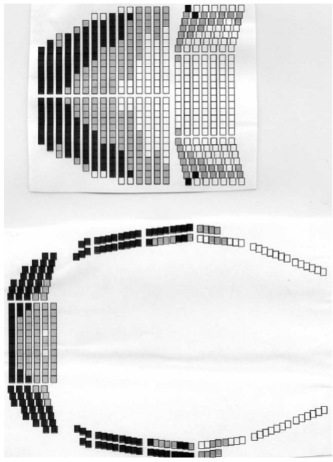

Fig. 17 - Preferred seat area calculated for subject KH.

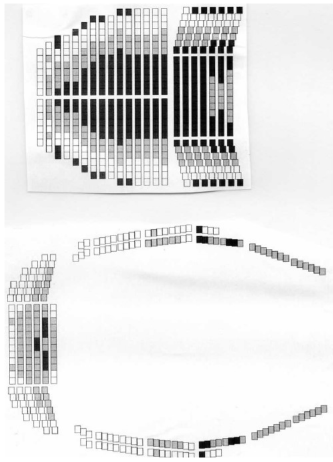

Fig. 18 - Preferred seat area calculated for subject KK.

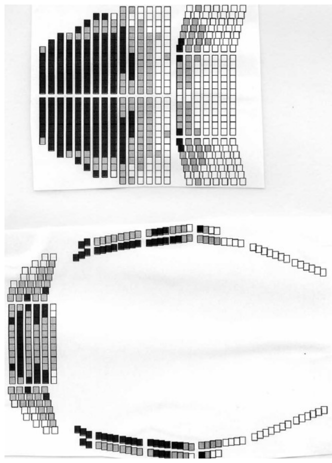

Fig. 19 - Preferred seat area calculated for subject DP.

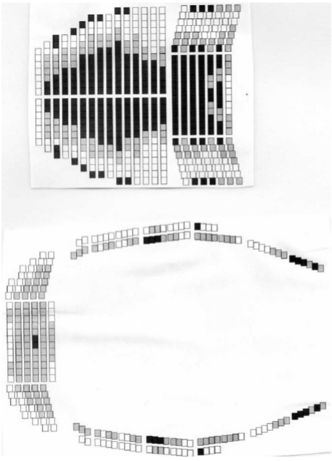

Fig. 20 - Preferred seat area calculated for subject CA.

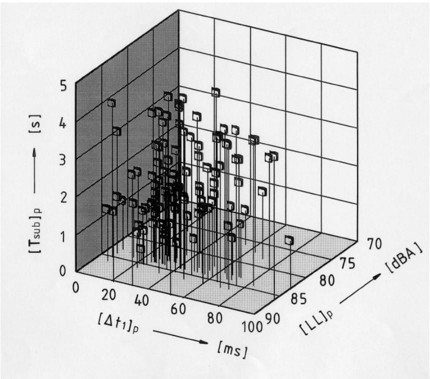

Fig. 21 - Three-dimensional illustration of preferred factors, $[LL]_p$, $[\Delta t_1]_p$ and $[T_{sub}]_p$ of the sound field for each individual subject. Preferred condition for the factor IACC is excluded, because no fundamental individual differences could be observed. Preferred conditions are distributed in a certain range of each factor, so that subjects could not be classified into any specific groups [10].

6. REMARKS ON THE ROLE OF THE THIRD STAGE OF LIFE

We aim to forward a hope for each individual to be surrounded by their preferred environment so that the three stages of life according to the theory of preference [17] could flourish. The development of a creative and sustainable personality can be realized by maximizing preference and minimizing stress throughout a lifetime (Fig.s 12 through 14).

1) Maintaining our environments in the long haul can be achieved by a variety of creations springing from the actions of a variety of unique personalities, which ultimately integrate as culture (Fig. 13).
2) On the contrary, individuals endorsing a particular value or idolatry such as money, status, academic background or winning prizes will result in a group or a nation being terminated (Fig. 14). In other words, a universal education and a globalization based upon the concept of "time is money" is subject to suffering stress and consecutive illnesses.

Objectives of the third stage of any tiny creations with affection for human life are health, peace and maintaining the environment. It is worth noticing that verbal communications is associated with the left hemisphere, so that the right hemisphere is almost sleeping during verbal communication, and subject to misunderstand in the whole brain. Utilizing a nonverbal communication associated with right hemisphere is of another important manner. International and intergenerational languages, for example, "fist bump" of 0.1 s duration is a simple greeting expressing "affection." The author greeted participants with it during the international symposium (8the ISTD) held at University of Bologna. It may perform without any infection of the handshake bacteria, thus it is the most effective and joyful greeting method. Without two hemispheric communications, i.e., a lack of non-verbal communication system established, it subjects to misunderstand between individuals. Such an ill human relation may cause serious diseases ex. cancers and kidney troubles (Ando, 2017). Such brain activities and a lack of right hemisphere-communication system had been one of reasons at least occurring wars between nations. Another important design is environment applying the theory of subjective preference for all people (7.26×10^9) living in this world might be satisfied avoiding war [17].

APPENDIX I EFFECTS OF ENVIRONMENTAL NOISE IN PRENATAL AND POSTNATAL PERIODS

Our brain vividly and instantaneously responds to changes in environmental noise within a period of less than about 1.0 s. However, we should be aware of the "long-term integrated effects" that environmental noise has on unborn babies through maternal placenta over the course of about one year. On one hand, exposure to noise qualifies as a psychophysiological stressor, on the other, environmental noise is a representative measure of quality of an urban environment. A noisy environment affects the development of the first through third stage of life.

Results clearly indicate:

1). Effects on the first stage (body): Integrated effects of aircraft noise in a living area were described in terms of human placental lactogen (HPL) as shown in Fig. 22 and Fig. 23 [3]. Moreover, the development of unborn babies as demonstrated by the number of low-birth-weight-babies in relation to the number of jet planes is shown in Fig. 24 [7]. A detrimental postnatal effect on the development of height of children has been discussed [25].

2) Effects on the second stage (mind): Postnatal effects of aircraft noise on the sleep of newborns are dependent on the period during which their mothers entered the noise area in reference to the period of pregnancy as shown in Fig. 25 [2]. It is remarkable that only less than 30% of the babies whose mothers had moved into the aircraft noise area before conception or during the first half of pregnancy reacted to noise during their sleep, even though the peak level was 80 dBA. On the contrary, of the babies whose mothers had moved into the noise area in the later half of pregnancy or after giving birth, as well as those living in a quiet area throughout, 100% reacted to a 80 dBA noise level. Fig. 26 (a) and (b) demonstrate the development of hemispheric specialization in children under long-term exposure to noise based on results from testing two different types of mental work associated with the left and right hemispheres [1,7].

3) Effects on the third stage (creations): It is not clear yet how environmental noise affects creativity, however, the integrated effects that environmental noise has on the specialization of cerebral hemispheres as discussed above may influence the development of individual personality as the source of creations.

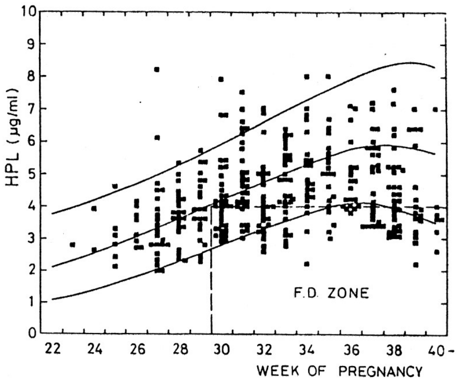

Fig. 22 - HPL levels of 343 mothers living in Itami City located near the Osaka International Airport [3].The three lines show the mean and ±2SD values for normal HPL levels and the area within the dashed line indicates fetal danger zone[21].

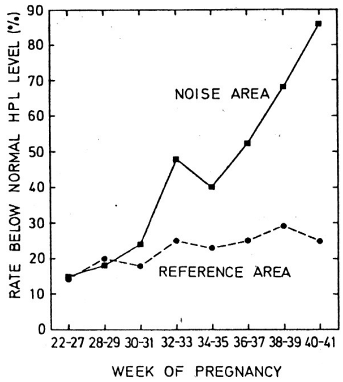

Fig. 23 - Percentage of subjects with HPL levels more than 1SD below the mean by stage of pregnancy. About 85% of mothers showed a rate below the normal HPL [3].

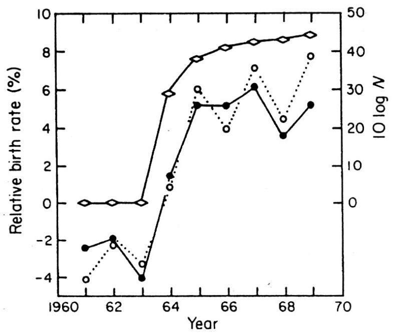

Fig. 24 - Birth rates below 3000 g as a function of year of living in Itami City, in reference to neighboring cities without aircraft noise. Jet planes were regularly flying over the city after 1963 [7]. ●: Male. ○: Female. Rhomb: Number N of jet planes flying over Itami City plotted in a scale of 10logN.

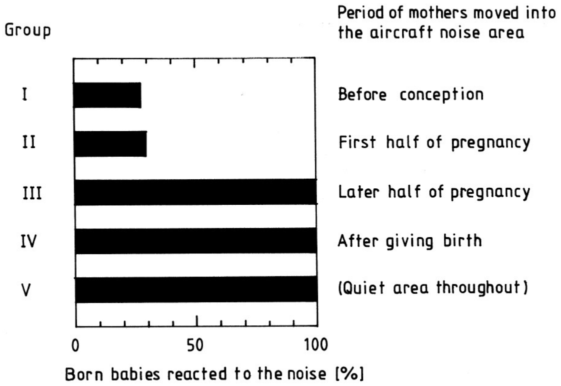

Fig. 25 - Reactions to the noise below 80 dBA recorded by PLG for each group. About 70% of the babies born to mothers who had been living in the noisy area from the first half of pregnancy did not even react to jet plane noise at 80 dBA during sleep [2].

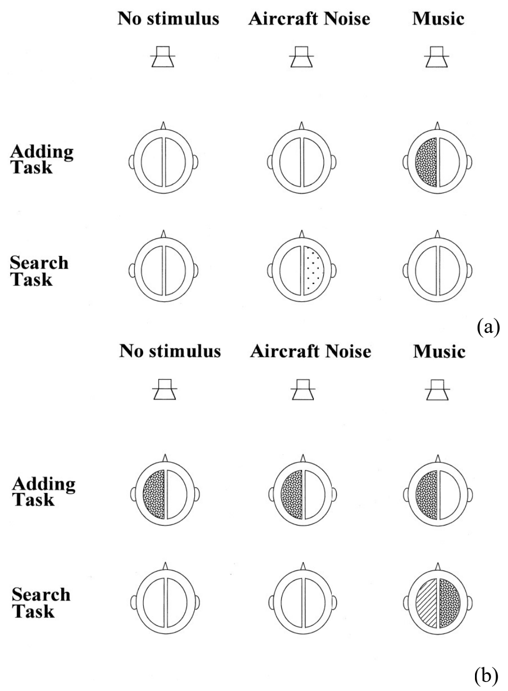

Fig. 26 - (a) Explanations for the interference between mental tasks and sound stimuli for children from a quiet living area. Interference effects shown by shaded areas differ remarkably from noisy and quiet living areas. The hemispheres marked were disordered due to a sudden drop of the mental tasks showing a sudden abandonment, so that tasks could not be continued [7]. According to the auditory-brain system model, noise and music are associated with the right and left hemisphere, respectively. The adding task and the search task are associated with the left and right hemisphere, respectively. (b) Explanations for the interference between mental tasks and sound stimuli for children from a noisy living area. The hemispheres marked were disordered due to a sudden drop of the mental tasks showing a sudden abandonment, so that tasks could not be continued due to a lack of mental power by long-term effects of the noise.

APPENDIX II THEORY OF SUBJECTIVE PREFERENCE FOR THE SOUND FIELD

Since the number of orthogonal acoustic factors of the sound field which are present in the sound signals at both ears is limited [6, 10], the scale value of any one-dimensional subjective response may be expressed by:

$$S = g(x_1, x_2, \ldots x_I). \qquad \text{(A.1)}$$

It has been verified by a series of experiments that four objective factors act independently on the scale value when changing two of four factors simultaneously. Results indicate that units of the scale value of subjective preference derived by a series of experiments with different sound sources and different subjects have appeared to be constant [10] so that we may add scale values to obtain the total scale value:

$$S = g(x_1) + g(x_2) + g(x_3) + g(x_4)$$

$$= S_1 + S_2 + S_3 + S_3 \qquad \text{(A.2)}$$

where S_i (i = 1, 2, 3, 4) is the scale value obtained by the paired comparison tests, relative to each objective parameter. Equation (A.2) indicates a four-dimensional continuity. The scale value of each objective parameter is shown graphically in Fig. 27 (a–d). From the nature of the scale value, it is convenient to put a zero value at the most preferred conditions, as shown in the Fig.s. The results of the scale value of subjective preference from different test series, obtained by using different music programs, yield the following common formula:

$$S_i \approx - \alpha_i \,|\, x_i \,|^{3/2}, \ i = 1, 2, 3, 4 \qquad \text{(A.3)}$$

where values of α_i are weighting coefficients as listed in Table 3 that were obtained from a number of subjects. These coefficients depend on the individual. If α_i is close to zero, then a lesser contribution of the factor x_i on subjective preference is signified. The factor x_1 is given by the sound pressure level (SPL) difference, measured by the A-weighted network, so that

$$x_1 = 20\log P - 20\log[P]_p \qquad \text{(A.4)}$$

where P is the sound pressure at a specific seat and $[P]_p$ is the most preferred sound pressure that may be assumed at a particular seat position in the room under investigation. Also,

$$x_2 = \log (\Delta t_1 / [\Delta t_1]_p) \qquad \text{(A.5)}$$

$$x_3 = \log (T_{sub} / [T_{sub}]_p) \qquad \text{(A.6)}$$

$$x_4 = \text{IACC} \qquad \text{(A.7)}$$

Thus, scale values of preference have been formulated approximately in terms of the 3/2 power of the normalized objective parameters, expressed as a logarithm for the parameters x_1, x_2 and x_3. Therefore, scale values are not greatly changed in the neighborhood of the most preferred conditions, but decrease rapidly outside of this range. The remarkable fact is that the spatial binaural parameter x_4 is expressed in terms of the 3/2 power of its real value, indicating a greater contribution to the preference scale value than the temporal parameters.

Table 3 - Four orthogonal factors of the sound field, and its weighting coefficients α_i in Equation (A.2), which were obtained with a number of subjects [6, 10].

i	x_i	α_i $x_i > 0$	α_i $x_i < 0$
1	$20\log P - 20\log[p]_p$ (dB)	0.07	0.04
2	$\log(\Delta t_1/[\Delta t_1]_p)$	1.42	1.11
3	$\log(T_{sub}/[T_{sub}]_p)$	0.45+0.75°	2.36-42A
4	IACC	1.45	---

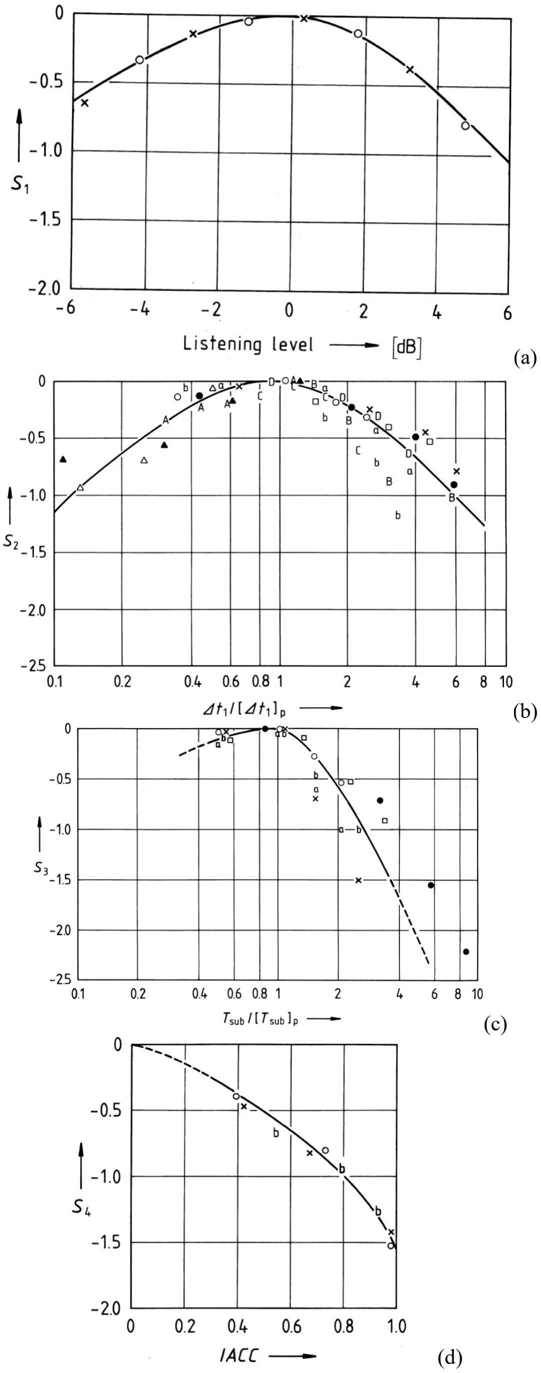

Fig. 27 - Scale values of subjective preference obtained for simulated sound fields in a listening room, as a function of four normalized orthogonal factors of the sound field. Different symbols indicate scale values obtained from different source signals [6, 10]. Even if different signals are used, a consistency of the scale value as a function of the normalized factor is observed, fitting a single curve. (a) As a function of listening level, LL. The most preferred listening level, $[LL]_p = 0$ dB. (b) As a function of $\Delta t_1/[\Delta t_1]_p$. (c) As a function of $T_{sub}/[T_{sub}]_p$. (d) As a function of IACC. The most preferred values $[\Delta t_1]_p$ and $[T_{sub}]_p$ may be calculated [6, 10].

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REFERENCES

[1] Ando, Y., Nakane, Y., and Egawa, J. (1975). Effects of aircraft noise on the mental work of pupils. Journal of Sound and Vibration, **43**, 683-691.

[2] Ando, Y., and Hattori, H. (1977a). Effects of noise on sleep of babies. Journal of the Acoustical Society of America, **62**, 199-204.

[3] Ando, Y., and Hattori, H. (1977b). Effects of noise on human placental lactogen (HPL) levels in maternal plasma. British Journal of Obstetrics and Gynaecology, **84**, 115-118.

[4] Ando, Y. (1977). Subjective preference in relation to objective parameters of music sound fields with a single echo. Journal of the Acoustical Society of America, **62**, 1436-1441.

[5] Ando, Y. (1983). Calculation of subjective preference at each seat in a concert hall. Journal of the Acoustical Society of America, **74**, 873-887.

[6] Ando, Y. (1985). Concert Hall Acoustics. Springer-Verlag, Heidelberg.

[7] Ando, Y. (1988). Effects of daily noise on fetuses and cerebral hemisphere specialization in children. Journal of Sound and Vibration, **127**, 411-417.

[8] Ando, Y., Johnson, B., and Bosworth, T. (1996). Theory of planning environments incorporating spatial and temporal values. Memoirs of Graduate School of Science and Technology, Kobe University, **14-A**, 67-92.

[9] Ando, Y. and Noson, D. (1997). Editors. Music and Concert Hall Acoustics, Conference Proceedings of MCHA 1995. Academic Press, London.

[10] Ando, Y. (1998). Architectural Acoustics, Blending Sound Sources, Sound Fields, and Listeners. AIP Press/Springer-Verlag, New York.

[11] Suzumura, Y., Sakurai, M., Ando, Y., Yamamoto, I., Iizuka, T., and Oowaki, M. (2000). "An evaluation of effects of scattered reflections in a sound field," J. Sound and Vib. **232,** 303-308.

[12] Ando, Y. (2004). On the temporal design of environments. Journal of Temporal Design in Architecture and the Environment, **4**, 2-14. (http://www.jtdweb.org/journal/).

[13] Ando, Y. (2009a). Auditory and visual sensations, Springer-Verlag, New York.

[14] Ando, Y. (2009b). Theory of temporal and spatial environmental design, in McGraw-Hill Yearbook of Science & Technology 2009, McGraw-Hill, New York, p. 384-389.

[15] Ando, Y. (2013). Environmental design for the third stage of human life (persistence of individual creations). Journal of Temporal Design in Architecture and the Environment, **12** 1-12, http://www.jtdweb.org/

[16] Ando, Y. (2015). Opera House Acoustics Based on Subjective Preference Theory. Springer, Tokyo.

[17] Ando, Y. (2016). Brain-Grounded Theory of Temporal and Spatial Design in Architecture and the Environment. Springer Tokyo.

[18] Ando, Y. (2018). Stress and preference factors determining the dialysis introduction age. Journal of Temporal Design in Architecture and the Environment. To be published.

[19] Danjo, K. (2014). An introduction to the third and fourth stages of human life: Recovering from difficulties and illness. Journal of Temporal Design in Architecture and the Environment, **12**, 25-33. (http://www.jtdweb.org/).

[20] Kitamura, T., Shimokura, R., Sato, S., and Ando, Y. (2002). Measurement of temporal and spatial factors of a flushing toilet noise in a downstairs bedroom, Journal of Temporal Design in Architecture and the Environment, **2**, 13-19. (http://www.jtdweb.org/)

[21] Lindberg, B. S., and Nilsson, B. A. (1973). Variation of maternal plasma levels of human placental lactogen (HPL) in normal pregnancy and labour. Journal of Obstetrics and Gynaecology of the British Commonwealth, **80**, 616-626.

[22] Merthayasa, I Gde N., and Ando, Y. (1996). Variation in the autocorrelation function of narrow band noises: their effect on loudness judgment. Japan and Sweden Symposium on Medical Effects of Noise.

[23] Palomaki, K., Tiitinen, H., Makinen, V., May, P., Alku, P., (2002). Cortical processing of speech sounds and their analogues in a spatial auditory environment. Cognitive Brain Research, **14**, 294-299.

[24] Sakai, H., Singh, P. K., Ando, Y. (1997). Inter-individual differences in subjective preference judgments of sound fields. Music and Concert Hall Acoustics, Conference Proceedings of MCHA 1995, Eds.

[25] Y. Ando, D. Noson (Academic Press, London, Schell, L. M., and Ando, Y. (1991). Postnatal growth of children in relation to noise from Osaka International Airport. Journal of Sound and Vibration, **151,** 371-382.

[26] Selye, H. (1950). The physiology and pathology of exposure to stress.

[27] Soeta, Y., Nakagawa, S., Tonoike, M., and Ando, Y. (2002). Magnetoencephalographic responses corresponding to individual subjective preference of sound fields. Journal of Sound and Vibration, **258**, 419-428.

[28] Soeta, Y., Uetani, S., and Ando, Y. (2002). Propagation of repetitive alpha waves over the scalp in relation to subjective preferences for a flickering light. International Journal of Psychophysiology, **46**, 41-52.

[29] Soeta, Y., Nakagawa, S., Tonoike, M., and Ando, Y., (2003). Spatial analysis of magnetoencephalographic alpha waves in relation to subjective preference of a sound field, Journal of Temporal Design in Architecture and the Environment, **3**, 28-35. http://www.jtdweb.org/journal/

[30] Soeta, Y., and Nakagawa, S. (2006). Auditory evoked magnetic fields in relation to interaural time delay and interaural crosscorrelation, Hearing Research, **220**, 106-115.