Development and Validation of a Multidimensional Aesthetic Response Scale for Interactive Art Installations

Folashade M. Oyeniran[1], Alaba A. Adediwura[2]

Department of Educational Foundations Faculty of Education Obafemi Awolowo University, Ile-Ife Nigeria

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ABSTRACT

The current study presents the development and validation of Aesthetic Response Scale for Interactive Art (ARSIA), which is an instrument designed to quantify aesthetics in interactive art installations using multiple dimensions. Using sequential mixed methods design, the process involved creation and generation of 60 initial items, followed by expert validation, piloting, exploratory factor analysis (EFA) and confirmatory factor analysis (CFA). The outcome indicated that the items loaded significantly under five factors including sensory engagement, emotional resonance, cognitive interpretation, interactivity and agency, and immersion. With good model fitness and validity measures, the scale proved to be consistent and reliable with high validity and reliability coefficients.

INTRODUCTION

There have been great advancements in the empirical exploration of aesthetic experiences within the last few years due to advances in cognitive science, human-computer interaction (HCI), and computational modeling in the arts. Modern-day research is shifting from the view that aesthetic experiences should be perceived as mysterious occurrences toward viewing them as quantifiable and operationalisable constructs (Pelowski et al., 2019; Vessel et al., 2021). In line with modern measurement, which involves quantifying abstract constructs, like emotions and engagement, aesthetic experiences are now measurable variables. But most of the aesthetics measuring devices that are available today have been designed with regard to static art or non-interactive art forms like painting, photography, and sculpture. According to Bilda et al., (2020), they tend to focus on perception ease, valence, and interpretation without considering the interactive elements that make up contemporary interactive art. This is because interactive art incorporates responsiveness, embodied interaction, and immersive space in the art form.

Research on the aesthetic experience has become a multidisciplinary field comprising psychology, neuroscience, HCI, and aesthetics. It can be noticed from the current literature that the notion of the aesthetic experience is seen more as a quantifiable construct and not merely a subjective or philosophical phenomenon. The importance of this perspective becomes apparent when examining aesthetic experiences in the setting of interactive art installations. The concept of aesthetic experience has always been linked to perceptual, emotional, and cognitive mechanisms. Modern theories highlight the significance of the interaction between bottom-up processing of sensory information and higher cognitive processing (Pelowski et al., 2019). In particular, claimed that aesthetic experiences can be characterized by the interaction of attention, memory, and emotion. Vessel et al. (2021) opined that it is possible to measure aesthetic experiences quantitatively using psychometric instruments when constructs are operationalized. Traditional approaches to measuring the constructs related to aesthetics have included the use of self-report scales focusing on the evaluation of such factors as beauty, liking, and emotions. Nevertheless, such unidimensional measures of constructs usually lack construct validity and do not describe an aesthetic experience thoroughly. Therefore, multidimensional scales have recently started to appear more frequently in scientific literature (Chatterjee & Vartanian, 2020). Interactive art brings about a new paradigm when it comes to the way aesthetic experience is created. Contrary to static artworks, interaction art requires the involvement of the audience, hence turning them into an important component of the whole artwork. It has been pointed out by Candy and Ferguson (2022) that the act of engaging with the installation plays an important role in shaping the experience itself. In the realm of digital art, interactivity is considered to increase user engagement through a feeling of being in control. The concept of agency has been understood as a person's perception of their capacity to have a certain degree of influence on what happens within the system. It has been linked to increased user satisfaction and presence (Edmonds & Muller, 2021). Furthermore, feedback systems, which could be of different types like visual, auditory, or tactile feedback, are vital for maintaining the interaction process. The presence of these feedback systems generates an engaging interaction process and is what sets apart interactive art from non-interactive art.

Immersive experience is also a crucial concept used in assessing interactive artworks. Immersion describes the extent to which people feel immersed or surrounded by the environment they are in. According to Radianti et al. (2020), in immersive art installations, especially those using VR or AR technologies, participants typically describe greater sensations and less consciousness of the surrounding world. Presence, another essential concept linked to immersion, relates to the feeling of being in a mediated environment (Slater & Sanchez-Vives, 2019). Presence has been widely researched in the field of virtual reality studies and is believed to be one of the most critical factors affecting the quality of users' experiences. In an artistic context, high levels of presence may lead to heightened emotional reactions and increased perceptions of the experience's authenticity. In spite of the significance of both concepts, immersion and presence are frequently confused or inadequately assessed.

Emotional resonance is still an essential aspect of the aesthetic experience. Pelowski et al. (2019) demonstrated that there is evidence that pieces of art that can create strong emotional reactions are also considered more meaningful and memorable. When it comes to interactive pieces, emotions might not only be triggered by the work itself but also by the behavior of the user and the feedback of the system. Interpretation is another essential aspect of interactive art appreciation. Meaning-making and reflection allow the audience to create their understanding of the work, thus engaging in the process of learning and perception through constructive means. Candy and Ferguson (2022) in recent studies noted that the phenomenon of interactivity entails new levels of experience, such as agency, feedback processes, and co-creation between the participant and the artwork. This complicates existing models of aesthetic judgment, where the role of the viewer moves from passive observer to active co-participant in the creative process. Therefore, there is currently a dearth of validated tools for measuring these multi-dimensional experiences. Moreover, the emergence of immersive technology, particularly augmented reality (AR), virtual reality (VR), and sensor-based settings, has led to the rapid expansion of interactive exhibits within museum and gallery settings, as well as in public spaces (Radianti et al., 2020; Slater & Sanchez-Vives, 2019). This creates a greater need for precise assessment strategies to differentiate overlapping concepts, including immersion, engagement, and emotional response.

One of the main problems of developing new fields of knowledge is creating reliable and valid tools for measuring constructs in these fields. According to Boateng et al. (2018) modern recommendations, scale development involves several stages such as generating items, testing content validity, conducting exploratory factor analysis (EFA), and confirming obtained results by means of confirmatory factor analysis (CFA). It is essential for obtaining reliable results that are generalizable. From a measurement point of view, the task here is to devise a scale that meets the requirements of various psychometric standards, such as reliability, construct validity, and dimensional stability, while at the same time being responsive to the specific characteristics of interactive art settings. Modern methodological discourse places great emphasis on the use of both exploratory and confirmatory factor analysis as well as cross-validation in independent samples during scale development (Boateng et al., 2018; Kyriazos, 2018). In response to these issues, this research seeks to contribute to the development and validation of the Aesthetic Response Scale for Interactive Art (ARSIA), a multidimensional scale tailored to the interactive setting. In response to the aforementioned limitations, this research seeks to create a new scale called the Aesthetic Response Scale for Interactive Art (ARSIA). This multidimensional measure is designed specifically for use in the context of interactive experiences and is based on relevant theoretical approaches. The key research objectives include:

1. Defining and operationalizing measurable dimensions of the aesthetic experience in an interactive environment;
2. Creating a reliable measuring instrument according to psychometric principles;
3. Assessing the psychometric properties of the created scale; and

4. Developing normative ranges for the ARSIA to aid in the interpretation and categorization of aesthetic reactions to interactive artworks.

Research Questions

With these objectives in mind, the study will be framed through the following research questions:

1. What are the inherent dimensions of aesthetic experience in interactive art exhibitions?
2. How can these dimensions be conceptualized into a testable measurement instrument?
3. How well is the generated instrument able to prove reliable and valid as a measure of aesthetic reaction to interactive art?
4. What is the process of creating normative score ranges for the ARSIA that would allow for the interpretation and categorization of aesthetic reactions to interactive art installations?

RESEARCH METHODOLOGY

A comprehensive scale development and validation process was conducted for this study, aligned with current practices in psychometric and behavioral sciences. The study employed a mixed-methods approach that combined both qualitative and quantitative techniques. The qualitative stage was used to define constructs and create items, while the subsequent quantitative phase involved statistical validation, including content validation, pilot studies, factor analysis methods such as EFA and CFA, and evaluations of reliability and validity. To ensure ecological validity, all project tools such as questionnaires and survey instruments were used in real art-interaction environments. In Southwestern Nigeria, the sample primarily included gallery attendees, art students, artists, and the broader community. The study concluded with a multistage sampling approach that deliberately targeted Lagos, Oyo, and Osun States because of their interactive art exhibits. The pilot study includes 120 participants (40 to each state), while the CFA stage involved a sample consisting of 250 participants, drawn proportionally from the same three states. Individuals taking part in the real-art websites had to be a minimum of 18 years old, possess experience with interactive installations, and give their informed consent. Age, gender, educational level, and familiarity with art were considerations in sampling.

A set of 60 original items was assembled to identify five aesthetic phenomena, including Sensory Engagement, Emotional Resonance, Cognitive Interpretation, Interactivity and Agency, and Immersion. Three procedures guided item creation: literature review, expert consultation, and field observation. Relevant concepts were derived from literature on aesthetics and human-computer interaction, supplemented by insights from interviews with 12 specialists such as artists, curators, and UX researchers, to enhance the theoretical framework and ensure content relevance. The study involved observing how users engaged with three different interactive art installations to capture their real-world contextual experiences. The items were designed as statements of first-person perspective and evaluated using a four-point Likert scale, which ranged from 'strongly disagree' to 'strongly agree.' Content validity was measured using content validity indices (CVI). Items falling under such circumstances were then revised or deleted from the instrument, leading to an eventual total-item count of 45 out of the original 60 items.

A pilot study was conducted with 120 participants across three interactive art installations incorporating gesture-based, projection-based, and virtual reality systems. Before proceeding with the analysis, the data was carefully examined and thoroughly investigated to ensure it was suitable for factor or PCA analysis. Data loss was quite low, averaging 1.8%, and only a small number of cases with more than 5% missing responses were excluded. Outliers identified through Mahalanobis distance ($p < .001$) were removed; this concerned four cases. Normality was verified by acceptable skewness and kurtosis metrics within the ranges of ±3 and ±7, respectively. Multicollinearity assessments confirmed VIF values below 5.0, indicating no issues. The sample's suitability was supported by a KMO value of 0.86, and Bartlett's Test of Sphericity was significant with $\chi^2 = 2145.32$, df = 990, $p < .001$), implying that the data from this study were appropriate for exploratory factor analysis, so all assumptions could be agreed upon for the reliable step of multivariate analysis and extraction of these factors.

RESULTS

Research Question 1: What are the inherent dimensions of aesthetic experience in interactive art exhibitions?

To answer this question, an Exploratory Factor Analysis (EFA) was done to determine the underlying factor structure and dimensionality of the revised set of items and scale. With the assumption that the latent variables are correlated, the use of the Principal Axis Factoring (PAF) model was deemed appropriate, with oblique rotation (Promax) for extracting the correlation between factors. Previously, the fitness of the data set for conducting the EFA was assessed using acceptable Kaiser-Meyer-Olkin (KMO) values, along with a significant Bartlett's Test of Sphericity, indicating that the correlation matrix was indeed fit for performing factor analysis. The adequacy of the data set for factor analysis was already confirmed before by satisfactory Kaiser-Meyer-Olkin (KMO) values and a statistically significant result of the Bartlett's test of sphericity, indicating that the correlation matrix was suitable for factor extraction. Several measures were taken into consideration in deciding upon how many factors to retain in order to increase reliability and prevent both over- and under-extraction. First, all factors with eigenvalues greater than 1.0 were selected, after which a scree plot was reviewed to determine inflection points. Parallel analysis was performed to compare the observed eigenvalues to eigenvalues obtained from random data sets, ensuring that only factors that have more variance than what is attributable to chance alone would be retained. The outcomes of the eigenvalue extraction and variance explained are summarized in Table 2, which demonstrates that the first five factors explain a substantial amount of total variance and were therefore retained.

Table 2: Total Variance Explained (EFA for 45 Items)

Factor	Eigenvalue	% of Variance	Cumulative %	Extraction SS Loadings	% of Variance	Cumulative %
1 (Sensory Engagement)	6.42	14.27	14.27	5.98	13.29	13.29
2 (Emotional Resonance)	4.18	9.29	23.56	3.87	8.60	21.89
3 (Cognitive Interpretation)	3.21	7.13	30.69	2.94	6.53	28.42
4 (Interactivity & Agency)	2.64	5.87	36.56	2.41	5.36	33.78
5 (Immersion)	2.11	4.69	41.25	1.96	4.36	38.14
6	1.85	4.11	45.36			
7	1.62	3.60	48.96			
8	1.48	3.29	52.25			
9	1.31	2.91	55.16			
10	1.22	2.71	57.87			

It is important to note that Extracted Sums of Squared Loadings are only provided for the retained factors. These numbers depict the variance accounted for by the factor solution after rotation. The first five factors were retained because of eigenvalues greater than 1.0, the scree test, and their interpretability.

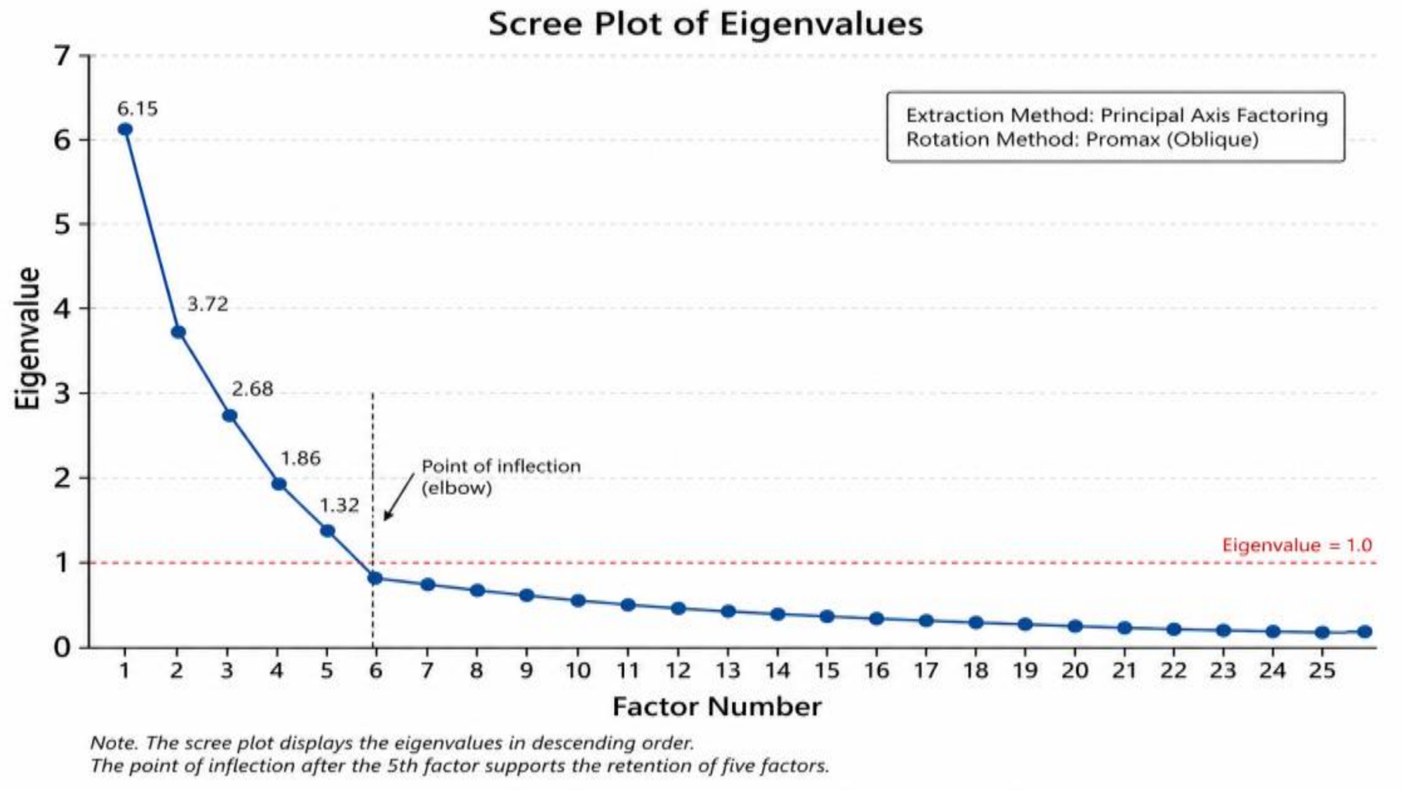

Figure 1: Scree Plot of Eigenvalues

As seen in the scree plot, there is a drastic drop-off in the eigenvalues after which the graph becomes almost flat, suggesting that the first five factors account for all the variance in the data. A short interpretation of the scree plot shows that there is a drastic fall in the value of the eigenvalues from the first five factors after which there is an almost horizontal pattern. The point at which the graph stops falling sharply and becomes horizontal is known as the "elbow," and beyond this point, the variance explained is very little. Hence, it can be concluded that the first five factors explain all the variance in the data. The item retention criteria considered both statistical and substantive elements. The items had to load strongly (minimum loading of 0.50) on one of the extracted factors, meaning a high degree of correspondence to the theoretical construct. Items whose secondary loadings exceeded 0.30 on several factors were deemed unreliable and therefore discarded to maintain the factorial purity. Additionally, items were checked conceptually in relation to the factors they belonged to, and those that did not align well were discarded. As a result of this sequential procedure of item elimination, five reliable factors emerged from the data. The interpretation of the factors revealed a structure that mapped onto the predicted five constructs—Sensory Engagement, Emotional Resonance, Cognitive Interpretation, Interactivity and Agency, and Immersion. Consequently, the EFA solution resulted in 25 selected items, each factor representing a unique construct for further confirmatory analysis.

The matrix of rotated factor loadings generated using the Promax rotation technique can be seen in Table 3. It is from this matrix that it is possible to obtain information about the strength and nature of the relationship between each item and its associated factor. From the pattern of loadings, one can easily determine how much each individual item influences the particular construct it is associated with.

Table 4: Rotated Factor Loading Matrix (Promax Rotation, 25 Retained Items)

Item	Item Statement	F1 (SE)	F2 (ER)	F3 (CI)	F4 (IA)	F5 (IM)
SE1	I felt visually stimulated by the installation.	.78				
SE2	The artwork strongly engaged my senses.	.74				
SE3	The colors, sounds, or visuals captured my attention.	.72				
SE4	I found the sensory elements of the artwork	.69				

	compelling.					
SE5	The installation created a rich sensory experience.	.71				
ER1	I felt emotionally moved by the artwork.		.81			
ER2	The experience evoked strong feelings in me.		.77			
ER3	I felt a personal emotional connection to the piece.		.75			
ER4	The artwork affected my mood.		.73			
ER5	I experienced emotional engagement throughout.		.70			
CI1	I reflected on the meaning of the artwork.			.72		
CI2	The installation made me think deeply.			.69		
CI3	I interpreted the artwork in my own way.			.71		
CI4	The experience stimulated my imagination.			.68		
CI5	I tried to understand the concept behind the work.			.66		
IA1	I felt I could influence the artwork.				.76	
IA2	My actions affected what happened in the installation.				.71	
IA3	I actively participated in shaping the experience.				.73	
IA4	The artwork responded to my inputs.				.69	
IA5	I felt a sense of control during interaction.				.67	
IM1	I felt fully immersed in the environment.					.80
IM2	I lost track of time during the experience.					.75
IM3	I felt absorbed in the artwork.					.77
IM4	The installation made me feel “inside” the experience.					.72
IM5	I was deeply engaged throughout the interaction.					

The findings presented in Table 4 show a very distinct and understandable five-factor structure. All sets of items have strong relationships with their intended factors, with standardized loadings between .66 and .81, which surpass the cutoff value of .50 and signify strong item-factor relationships. The items for Sensory Engagement (SE1-SE5) have exclusive relationships with Factor 1, whereas items for Emotional Resonance (ER1-ER5), Cognitive Interpretation (CI1-CI5), Interactivity and Agency (IA1-IA5), and Immersion (IM1-IM5) have exclusive relationships with Factors 2-5, respectively. There is no presence of any significant cross-loading (≥ .30). This pattern provides strong evidence of construct validity at the exploratory stage, confirming that the items cluster in accordance with the theorized dimensions. Furthermore, the relatively high and consistent loadings within each factor suggest internal coherence and homogeneity of the item sets. Taken together, the rotated solution supports the multidimensional structure of the ARSIA and justifies the retention of the 25-item, five-factor model for subsequent confirmatory analysis.

The EFA analysis suggests that there exist five underlying dimensions associated with the aesthetic experience in interactive art exhibits. The EFA showed that there is a stable five-factor structure characterized by Sensory Engagement, Emotional Resonance, Cognitive Interpretation, Interactivity/Agency, and Immersion. These factors were established using a cut-off value of >1.0 for eigenvalues, scree plot method, and parallel analysis, and in all cases, a five-factor solution was supported. The total variance explained by the retained factors was quite high, while the rotation of the factors resulted in good factor loadings (≥ .50). Furthermore, communalities were also above the desirable levels, indicating that the questions were adequately covered in the factor pattern. On balance, the results indicate that an aesthetic experience in interactive art exhibitions is intrinsically multidimensional and involves the sensory, affective, cognitive, participant, and immersive dimensions.

Research Question 2: How can these dimensions be conceptualized into a testable measurement instrument?

To answer this question, translation of the extracted factors into a measurement scale was done through a systematic process of psychometric testing. The scale was first put to confirmatory factor analysis (CFA) to determine the validity of the proposed structure of measurement. The process assessed how well the data fitted the proposed five-factor framework and offered statistical proof of construct validity. Reliability and validity testing (internal consistency [Cronbach's alpha], composite reliability [CR], convergent and discriminant validity [AVE, HTMT]) were performed to ascertain that the scale generates reliable and consistent measures.

Confirmatory Factor Analysis (CFA) was employed to confirm the factor structure determined from the EFA and evaluate the validity of the proposed five-factor model. CFA was done using structural equation modeling (SEM) with the Maximum Likelihood estimator based on an independent sample of 250 subjects. The hypothetical model comprised five latent variables: Sensory Engagement, Emotional Resonance, Cognitive Interpretation, Interactivity and Agency, and Immersion that were represented by five manifest variables each. All latent variables were modeled as reflective, and error terms were assumed to be uncorrelated. Several measures of goodness-of-fit were used to assess the model's adequacy. The outcomes of the CFA are shown in Table 5.

Table 5: Model Fit Indices for CFA

Fit Index	Obtained Value	Recommended Threshold	Interpretation
Chi-square (χ^2)	512.34 (df = 265, $p < .001$)	$p > .05$ (sensitive to sample size)	Acceptable
CFI	0.94	≥ 0.90 (acceptable), ≥ 0.95 (good)	Good
TLI	0.93	≥ 0.90	Good
RMSEA	0.05	≤ 0.08 (acceptable), ≤ 0.05 (good)	Good
SRMR	0.04	≤ 0.08	Good

All fit indices indicated that there was an acceptable to excellent fit to the data, meaning that the model proposed by the researchers can accurately represent the structure of the data. The results from Table 5 can be interpreted as follows: First, the chi-square value is statistically significant ($\chi^2 = 512.34$, $p < .001$); this result is expected since the chi-square value is highly sensitive to sample sizes, and it is often not used to determine whether the model fits the data. Second, the results show that the Comparative Fit Index is relatively high (CFI = 0.94) and exceeds the cutoff point of 0.90. Moreover, the Tucker-Lewis Index is 0.93, meaning that the model has a good comparative fit to the data compared to a null model. Third, the RMSEA value equals 0.05; it means that the discrepancy between the estimated and observed covariance matrix is very small. Finally, the SRMR value is equal to 0.04, which means that it is below the threshold of 0.08. Together, these indexes indicate that the proposed five-factor measurement model is an excellent fit for the data and provides support for the structural validity of the ARSIA tool.

Factor loadings were analyzed to measure the degree of relationship between the observed variables and the latent constructs that underlie them. Table 6 presents the analysis results.

Table 6: Standardized Factor Loadings (CFA)

Construct	Loading Range	Interpretation
Sensory Engagement	0.68 – 0.82	Strong
Emotional Resonance	0.70 – 0.85	Strong
Cognitive Interpretation	0.66 – 0.80	Strong
Interactivity & Agency	0.69 – 0.83	Strong
Immersion	0.71 – 0.86	Strong

The values for all factor loadings were more than the value suggested of 0.50, hence, signifying that the observed variables are good indicators of the constructs involved. However, a further look at Table 6 shows that all constructs demonstrate good standardized loading values, ranging from 0.66 to 0.86. The above values imply that the variance shared between the observed variable and the construct was significant, thus establishing strong indicator reliability. For Sensory Engagement, the values for loadings range from 0.68 to 0.82; therefore, the indicator reliability is soundly measured in sensory experiences. On the other hand, Emotional Resonance exhibits stronger loadings ranging from 0.70 to 0.85. In the same vein, Cognitive Interpretation (0.66-0.80) indicates that the cognition of engaging with the art is consistent, whereas Interactivity and Agency (0.69-0.83) shows that the measures of involvement and agency are reliable. It is noteworthy that the Immersion scale displays the largest upper-bound loading (0.86). Furthermore, the fact that there are no low loadings (lower than 0.50) indicates that no items need to be excluded during the confirmatory stage, thus providing more confirmation regarding the correctness of the previous selection of items based on the EFA. Narrow loadings for each construct further show that items are internally consistent and homogeneous. Overall, all findings strongly support the presence of convergent validity and prove that the measured variables have been reliable indicators of latent constructs within the ARSIA framework.

In order to examine construct validity, the study evaluated both convergent and discriminant validity. Results are provided in Table 7 below.

Table 7: Convergent and Discriminant Validity

Construct	AVE	CR	√AVE	Max Inter-Construct Correlation	Interpretation
Sensory Engagement	0.56	0.87	0.75	0.45	Valid
Emotional Resonance	0.59	0.89	0.77	0.47	Valid
Cognitive Interpretation	0.54	0.86	0.73	0.44	Valid
Interactivity & Agency	0.57	0.88	0.75	0.48	Valid
Immersion	0.60	0.90	0.77	0.48	Valid

In-depth analysis of Table 7 reveals that all constructs exhibit convergent validity due to AVE scores ranging from 0.54 to 0.60, which is higher than the required minimum value of 0.50. This implies that there exists a reasonable degree of variance accounted for by each construct within its corresponding indicators. Besides, the CR scores range between 0.86 and 0.90, which exceeds the threshold of 0.70, implying that the measures have high reliability levels. Concerning the aspect of discriminant validity, the square root of the Average Variance Extracted (AVE) of each factor is higher than the maximum correlation between any two factors. As an example, the square root of AVE for the variable sensory engagement is 0.75, a value that is higher than the correlation with any other construct at 0.45, and the same trend continues for all the constructs. On the whole, the findings suggest strong support for convergent and discriminant validity of the measurement model used, which is further validation of the five-factor structure of the ARSIA scale. In conclusion, the CFA was able to verify that the dimensions can be reliably used to construct a testable instrument since they exhibit excellent model fit, high factor loadings, and good validity. Hence, this confirms that ARSIA is indeed a reliable multi-dimensional instrument for assessing aesthetic experience.

Research Question 3: How well is the generated instrument able to prove reliable and valid as a measure of aesthetic reaction to interactive art?

To answer this question, the reliability of the ARSIA questionnaire was determined based on several measures to provide consistency, stability, and accuracy of measuring each construct. Cronbach's alpha coefficients were calculated to estimate internal consistency of each construct. Table 8 presents the values ranging between 0.82 and 0.91, which surpass the acceptable level of 0.70. Therefore, the internal consistency is deemed high, meaning that questions under each scale are similar and assess the same concept. The composite reliability (CR) of each construct was also determined for reliability purposes. All constructs yielded CR values greater than 0.80, which validated the strength of the construct's reliability within the structural equation modeling technique. Item-total correlations of the constructs were also tested in order to determine how each item relates to the total construct. All items yielded values higher than the minimum acceptable value of 0.40, which

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signifies that each item is significant in measuring the construct. Moreover, test-retest reliability was also evaluated using a subset of 60 participants at a two-week time period. ICC values were computed, and all constructs proved to be above the minimum standard ICC value of 0.75.

Table 8: ARSIA Construct Reliability Indices

Construct	Cronbach's Alpha (α)	Composite Reliability (CR)	Item-Total Correlation Range	ICC (Test–Retest)
Sensory Engagement	0.85	0.87	0.52 – 0.71	0.81
Emotional Resonance	0.89	0.89	0.56 – 0.75	0.84
Cognitive Interpretation	0.84	0.86	0.50 – 0.69	0.79
Interactivity & Agency	0.86	0.88	0.53 – 0.72	0.82
Immersion	0.91	0.90	0.58 – 0.78	0.85

The results reported in Table 3.13 show very convincing evidence about the high reliability of the ARSIA across all dimensions. In this regard, the high levels of Cronbach's alpha and composite reliability reflect internal consistency, and the high item-total correlation shows effectiveness in terms of measuring constructs by each single item in the questionnaire. Moreover, the high ICC levels show that the reliability of results produced by this instrument is high. In regard to Research Question 3, the above results suggest that the instrument designed generates very convincing evidence regarding its reliability and can form a basis for its validity. Together with the strong fit model, the high factor loading level and convergent as well as discriminant validity shown in CFA analysis, the above mentioned evidence suggests that ARSIA may be regarded as a psychometrically sound instrument.

The ARSIA measurement instrument also underwent comprehensive validation analysis to gauge its validity and the level of accuracy of measuring aesthetic responses in interactive art settings. Validity assessment focused on various aspects such as convergent validity, discriminant validity, and criterion-related validity. To measure the level of convergent validity, AVE values were calculated for all the constructs, which were all found to be above the minimum value of 0.50 (refer to Table 7). This is an indication that there is a large amount of variance in the indicators that can be attributed to the underlying constructs. Besides this, the high standardized factor loadings between 0.66 and 0.86 also point to the convergent validity of all the constructs. Discriminant validity was examined through the Fornell-Larcker approach and heterotrait-monotrait ratio (HTMT). Fornell-Larcker findings (Table 7) reveal that the square root of AVE of all constructs is greater than inter-construct correlation, proving that each dimension has an empirical distinction. In addition to the Fornell-Larcker analysis, HTMT ratios were calculated, which are shown in Table 9.

Table 9 heterotrait–Honotrait Ratio (HTMT) Ratio of Correlations

Construct Pair	**HTMT Value**	**Threshold**	**Interpretation**
SE – ER	0.62	< 0.85	Acceptable
SE – CI	0.58	< 0.85	Acceptable
SE – IA	0.64	< 0.85	Acceptable
SE – IM	0.60	< 0.85	Acceptable
ER – CI	0.66	< 0.85	Acceptable
ER – IA	0.59	< 0.85	Acceptable
ER – IM	0.65	< 0.85	Acceptable
CI – IA	0.61	< 0.85	Acceptable
CI – IM	0.57	< 0.85	Acceptable
IA – IM	0.68	< 0.85	Acceptable

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All HTMT values are below 0.85, further supporting the hypothesis that constructs are unique and do not share common factors. Criterion-related validity was analyzed via correlations between the scores in the ARSIA scale and the external variables, such as user engagement and satisfaction, which have been assessed throughout the course of research. Moderate-strong correlation was found for all variables (r = 0.52 – 0.71), which indicates the relationship between high scores in the ARSIA scale and engagement/satisfaction of users. The results obtained show that the ARSIA instrument is highly reliable and valid since it has high construct validity and criterion validity. In combination with reliability and confirmatory factor analysis results, which were already shown earlier, the ARSIA instrument can be said to be reliable and valid in terms of measuring aesthetic reactions to interactive art.

Research Question 4: What is the process of creating normative score ranges for the ARSIA that would allow for the interpretation and categorization of aesthetic reactions to interactive art installations?

To ensure meaningful interpretation of the participants' responses, normative values were generated for the 25-item ARSIA questionnaire based on a four-point Likert response scale. The modified response scale ranged from 1 (Strongly Disagree) to 4 (Strongly Agree). Since the revised questionnaire comprised 25 questions, the highest obtainable scores would be 25 and 100 respectively, and higher scores would reflect more pronounced aesthetic response to the interactive art exhibits. Based on the percentile distribution and interval procedures, four categories of normative values were identified by means of combining both the pilot and validation sample responses (n = 366). The average total score for the participants obtained for ARSIA was 71.84 (SD = 11.26) and represented generally a moderately high degree of participants' engagement with the aesthetic experience. As per the above score ranges, the respondents were grouped into four categories of interpretation: Low, Moderate, High, and Very High aesthetic response.

Table 10: Normative Interpretation of ARSIA Total Scores (4-Point Likert Scale)

Score Range	Percentile Range	Interpretation
25 – 49	Below 25th percentile	Low Aesthetic Response
50 – 69	25th – 49th percentile	Moderate Aesthetic Response
70 – 84	50th – 74th percentile	High Aesthetic Response
85 – 100	75th percentile and above	Very High Aesthetic Response

Table 10 displays the normative interpretation matrix for the total ARSIA score with regard to the modified four-point Likert scale. Based on their score range and percentile rank in the validation sample, respondents have been divided into four different levels of aesthetic response namely: Low, Moderate, High, and Very High. Respondents who scored from 25 to 49 were considered as exhibiting a Low Aesthetic Response, meaning that there was only very little sensory, affective, cognitive, participation, and immersion in the interactive art installation. Scores from 50 to 69 fall under the category of Moderate Aesthetic Response and indicate average participation levels, implying some aesthetic involvement and experience. This group consists of scores between the 25th and 49th percentiles. The final category is High Aesthetic Response, which denotes a participant with high levels of experience across multiple dimensions, such as emotional connection, immersion, and interactive qualities. Scores in this group include those falling between the 50th and 74th percentiles. Lastly, scores from 85 to 100 indicate a Very High Aesthetic Response, denoting a highly involved interaction with the interactive installation. Individuals who fell into this category exhibited very high sensory arousal, emotional connection, meaning interpretation, participation, and absorption. Such scores are at or above the 75th percentile.

Subscale norms were also derived to help interpret results at the construct level. Given that each subscale is comprised of five items rated using a four-point scale, subscale scores could range between 5 and 20.

Table 10: ARSIA Subscale Norms (4-Point Likert Scale)

Subscale	Low	Moderate	High	Very High
Sensory Engagement	5 – 9	10 – 13	14 – 16	17 – 20

Emotional Resonance	5 – 8	9 – 13	14 – 16	17 – 20
Cognitive Interpretation	5 – 9	10 – 13	14 – 16	17 – 20
Interactivity & Agency	5 – 8	9 – 13	14 – 16	17 – 20
Immersion	5 – 8	9 – 13	14 – 16	17 – 20

These normative categories offer a practical approach in the analysis of the results of the ARSIA measure for research purposes, exhibition assessments, and user-experience evaluation. Those ARSIA scores that fall into the moderate category reveal the presence of moderate aesthetic experience, whereas those that fall into the high and very high categories demonstrate significant sensorial, affective, cognitive, participatory, and immersive engagement when dealing with an art installation. The new four-point ARSIA scale makes it easier to analyze the responses of the participants.

DISCUSSION

As a highly reliable psychometric tool, ARSIA has the potential to question established ideas in neuroaesthetic research and traditional HCI paradigms. The dominant neuroaesthetic models Pelowski et al. (2019) mainly describe the experience of beauty through attributes like smooth perception, emotional payoff, affective cues, and neural mechanisms that encode the concept of beauty. Nonetheless, the current study implies that aesthetic engagement in interactive art is not sufficiently explained with passive perceptual models alone. The elements of Interactivity and Agency add an independent layer, implying that users engage with interactive artworks in a way that allows them to influence and define the aesthetic experience through their involvement and collaborative creation. The result undermines classical theories of aesthetic response that view audiences as detached observers instead of active, invested individuals.

The acknowledgment of various dimensions like Sensory Engagement, Emotional Resonance, Cognitive Interpretation, Interactivity and Agency, and Immersion emphasizes the complex, multidimensional aspect of aesthetic experience and reveals an underlying tension in the prevailing theoretical models that the study was based on. In what respect is Sensory Engagement most relevant to the study of art and cognition? One could point out that it resonates with perspectives from neuroscience stressing multisensory "making" and a well-adapted complex attention behavior as the foundations of aesthetic experiences (Pelowski et al., 2019). Another implication of Emotional Resonance according to Vessel et al. (2021) is the evidence that emotional responses play a very significant role in aesthetic judgments and memorization. Moreover, the system will respond to these processes by activating itself, especially during interactive work, where interpretive and participatory activities become so intertwined that they overshadow any experiences based solely on physical and sensory enjoyment. Neuroaesthetic reductive explanations that focus on neural reward systems face a significant challenge when it comes to accounting for the Cognitive Interpretation dimension of artistic experience. The interpretation presented in this study underscores a primarily theoretical approach, favoring a constructivist view that meaning is developed through social and contextual negotiation rather than being biologically fixed. In interactive artworks, participants play a proactive role in constructing meaning by exploring, making decisions, and interpreting the work. Therefore, instead of a passive response, the aesthetic experience evolves into an active mental process shaped by social engagement and situational factors.

The Interactivity and Agency dimension also makes a substantial impact of the debates in HCI, and whereas conventional HCI researchers had almost never accounted for entertainment, efficacy, or measure of performance as the main avenues for a successful interaction. On the contrary, argumentation-art context emphasizes more on playfulness, expression; and relational depth than the end-state aesthetics of row functionality than most interactive situations. The current study demonstrates how aesthetic engagement could perhaps augment via unpredictability and exploratory interaction, not necessarily usable interactivity alone. Therefore, it is paved the way for a deliberately human-centered interactive design research. The findings set up HCI-driven idea that pleads for more experiential and emotional frameworks beyond utilitarian understanding of interaction. The research proves that user input may be seen as a main aesthetic mechanism for understanding art in the interface. The same way, the Immersion dimension raises the question of the experience-through-difference in the digital assertion. Studies on VR and immersive experiences typically indicate a connection between a sense of presence and absorption, which are related to emotional intensity and user engagement (Radianti et al., 2020; Slater & Sanchez-Vives, 2019). Contrary to some views, findings indicate that within interactive art, immersion functions as a mental experience, with technological involvement blending perception, emotion, and personal agency in a tightly linked manner. Therefore, an immersive experience should rather be viewed as the psychological and aesthetic transformation such a process represents, not remaining merely the technical hallmark of digital systems.

From a methodological standpoint, in expanding on criticisms of extant measurement of the aesthetic experience, ARSIA examined a scale that limited itself to emotional and perceptual aspects and paid least regard to participation and immersion. Engagement in social and participatory interactive art has not been operationalized. The reduced form of the items from the initial 60 to the final 25-item scale resulting from EFA and CFA confirmed that it followed all well-established psychometric procedures (Boateng et al., 2018; Kyriazos, 2018) while introducing an extended measurement approach to HCI and digital aesthetics. The reliability and validity calibration tied further to ARSIA only strengthens it as a robust composite measurement device. That is corroborated by a high level of internal consistency (α = 0.82–0.91), satisfactory AVE values, strong factor loadings, and generally good fit index in the CFA in defining distinctive dimensions vis-a-vis tective conceptualizations. The older scales were more impotent in spelling out interactivity, immersive aesthetic experiences because ARSIA offers a broader canvas to look about aesthetic engagement as it occurs in technology-mediated environments. Hence, having embodied participation rather than passive appreciation of aesthetic experience, the interactive art converts this experience significantly. Consequently, it is possible that both neuroaesthetic and HCI theories may need to shift paradigms from the static perceptual perspective and the usability-centered model towards embodiments that integrate a dynamic system of understanding of such phenomena as its reception in interpretation, immersion, and interaction.

CONCLUSION

In conclusion, the research reveals a comprehensive five-dimensional model of aesthetic experiences in interactive art forms and confirms that the model can be effectively translated into a psychometrically sound measurement instrument. The ARSIA displays excellent psychometric properties in both EFA and CFA, with high internal consistency, convergent, discriminant, and criterion validity. Overall, this study proves the existence of multiple dimensions of aesthetic responses in interactive art and suggests ARSIA as an effective measurement instrument to use in empirical studies.

Implications include:

1. Standardized assessment devices for artists and curators: The ARSIA offers a rigorous method based on empirical evidence that helps artists, curators, and exhibit designers evaluate audience reactions in a systematic manner that goes beyond mere subjective impressions.
2. Interactive design user experience study: The measure serves as a strong tool for researchers studying experiential aspects of interactive systems. Being a multidimensional construct, it provides an opportunity to explore intricate links between sensory, emotional, and cognitive reactions in relation to user autonomy and involvement.
3. Applications of the ARSIA across disciplines in HCI and digital media: The ARSIA is not limited to the realm of art alone; it also finds relevance in HCI, VR, game development, and digital media studies.

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Appendix

Item	Item Statement	Strongly Agree	Agree	Disagree	Strongly Disagree
1	I felt visually stimulated by the installation.				
2	The artwork strongly engaged my senses.				
3	The colors, sounds, or visuals captured my attention.				
4	I found the sensory elements of the artwork compelling.				
5	The installation created a rich sensory experience.				
6	I felt emotionally moved by the artwork.				
7	The experience evoked strong feelings in me.				
8	I felt a personal emotional connection to the piece.				
9	The artwork affected my mood.				
10	I experienced emotional engagement throughout.				
11	I reflected on the meaning of the artwork.				
12	The installation made me think deeply.				
13	I interpreted the artwork in my own way.				
14	The experience stimulated my imagination.				
15	I tried to understand the concept behind the work.				
16	I felt I could influence the artwork.				
17	My actions affected what happened in the installation.				
18	I actively participated in shaping the experience.				
19	The artwork responded to my inputs.				
20	I felt a sense of control during interaction.				
21	I felt fully immersed in the environment.				
22	I lost track of time during the experience.				

23	I felt absorbed in the artwork.				
24	The installation made me feel “inside” the experience.				
25	I was deeply engaged throughout the interaction.				