Understanding Furniture Design Choices Using a 3D Virtual Showroom

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ABSTRACT

This study is a Web-based investigation that utilizes virtual reality technology to understand the factors considered for residential furniture purchase and furniture style preference. In residential interior design, furniture has significant financial and symbolic meaning. From a broader perspective, residential furniture is important to the domestic furniture industry as well as to woodworking and textile markets.

Despite this importance, little is known about how consumers make residential furniture choices and what designs or styles are preferred. The purpose of this study is to understand the most important factors involved in choosing living room furniture and to identify preferences for furniture style using an online virtual showroom application. In this survey, 301 college participants responded to questions regarding priorities and style preferences when purchasing living room furniture. The participants evaluated 117 living room furniture items representing three style categories: traditional, modern, and casual. The survey results demonstrated significant differences between males and females in their priority considerations, style preferences for furniture, and the number of possibilities they try before making final choices. This empirical study is an effort to provide important information on consumer characteristics and their furniture choices for interior practitioners and furniture industry personnel in a three-dimensional virtual furniture showroom constructed for the study.

Introduction

Furniture plays a significant role in residential interior design, as both a major personal expenditure (Lihra & Graf, 2007) and as an expression of the self (Altman & Chemers, 1984; Cooper, 1974). The prospect of finding furniture that meets one's needs and expectations can often be both exciting and challenging, given the consideration of multiple factors, including cost, style, color, material, construction quality, durability, current stage of the family lifecycle, and so forth.

To date, little is known about the factoring influencing furniture selection which adversely impacts both consumers and the industry. For example, furniture shoppers may end up with less than satisfying solutions while the furniture industry faces a growing challenge of surviving without a good understanding of target consumers and their different tastes and priority considerations. Despite the importance of research on this topic, conducting furniture studies can be difficult, especially when studying such large-scale furniture items in context and adequately accounting for customization and combination possibilities.

This study proposes an innovative research strategy that allows consumers to simulate the experience of furniture shopping without going to a furniture store. A Web-based Virtual Reality Integrated System (VRIS), based on advanced Web-based, three-dimensional (3D) graphics technology, was developed. While tactile experience and physical comfort are also important to fully simulate a furniture shopping experience, an experimental survey was designed to explore furniture design choices based on the enhanced visual experience with controlled pricing via the VRIS. The VRIS enables viewers to examine furniture items with dynamic features such as zooming, rotating, navigation, real-time customization, and mix-and-match capability with other items in a 3D virtual showroom.

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In the VRIS furniture survey system, there are two interface components: a virtual showroom representing a living room on one panel, and a survey on another panel. A total of 301 college students with mixed disciplinary majors (139 males and 162 females) participated in the survey. Participants responded to an e-mail invitation to www.vr-solution.com. The VRIS presents a collection of furniture consisting of 51 sofas, 38 chairs, and 28 tables from three different style groups—traditional, casual, and modern.

A primary purpose of this study was to introduce a new approach to exploring various factors that influence furniture design choices. Using an empirical approach, the study demonstrates a research framework and useful information for those who are interested in furniture design, marketing (furniture manufacturers, market retailers, and designers), and other researchers in related disciplines. The results of the VRIS survey lead to good understandings of potential findings in future studies on furniture choices, including the factors taken into consideration during decision making about furniture.

Background

Furniture as a Mode of Self-Expression

Furniture occupies a significant part of every residential environment. Psychological theorist Carl Jung (1967) stated that the Self archetype can be displayed through a self-expression in built form. Jung described the house as a "symbol-of-self" (Jung, 1967, p. 151). Cooper agreed with Jung in saying "The house reflects how man sees himself" (Cooper, 1974, p. 130). Furniture further personalizes our houses with "expressions of our image of ourselves" and "message about ourselves" (Cooper, 1974, p. 132). Despres (1991) studied the meaning of home using a psychological, social, and phenomenological approach and defined home as a reflection of one's ideas and values, an indicator of personal status, and as a societal entity. While it is often difficult for everyone to own a house that fully reflects their own desires and hopes, furniture provides a better chance for people to project their self-image with more options and affordability. Lihra and Graf (2007) reported that next to the purchase of the house itself, the purchase of furniture is generally the second largest household personal consumption expenditure in the United States, outstripping even new car purchases. In addition to the significant symbolic and financial meaning of residential furniture, the difficulty of whether new furniture will fit in well with the rest of one's furniture in terms of size and design often makes choosing a piece of residential furniture a great challenge.

Furniture Design Choices

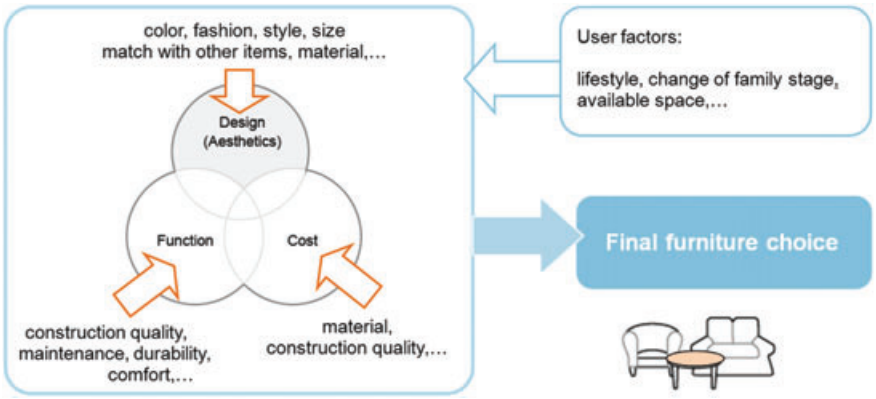
Despite the importance of furniture purchase to consumers and suppliers, little is known about how people make furniture choices and what design or styles they like. Critical issues that hinder research on this topic includes the logistics of creating experimental settings to evaluate full-scale furniture (Oh, Yoon, & Shyu, 2008). Finding an ideal piece of furniture can be an exciting activity for a family; it can also be complex and quite stressful because it is a significant financial commitment with a long-lasting consequence.

Furniture is one of those products that are often purchased for appeal as well as function. For example, consumers typically want a sofa that provides comfortable seating and is esthetically acceptable. When looking for furniture, people consider its dual role—function and design esthetics—within their budget. Among the three primary criteria for choosing furniture—function, esthetics, and cost—esthetic merit is the most difficult one to gauge. Individual tastes widely vary and, most of all, consumers often do not know what they like or they are unable to articulate preferences (Roy, 2002).

Visual characteristics of furniture therefore carry very personal esthetic and symbolic values associated with the individual's emotional responses. When furniture alternatives are similar regarding functionality and price, people tend to choose the one more

Most people do not have clear images of what kind of furniture they want regarding designs or styles before they see them in the showroom (Roy, 2002).

Figure 1. Factors affecting furniture design choices.



esthetically pleasing. Several studies have identified different properties that contribute to the individual's judgment of esthetics. Surveying 146 consumers in the age range 18 to 65 in Europe, Creusen and Schoormans (2004) found that shape, color, size, or style have significant impacts on product choice. Telephone answering machines were used in their study. Further, color preferences depend on the object to which it is applied (e.g., furniture or clothing) and the style of the object (e.g., "traditional' or 'modern") (Whitfield & Wiltshire, 1983). Even the same color and style associations sometimes vary from culture to culture. In America, white symbolizes purity, whereas in Korea this color is associated with mourning. Cultural and social influences have an effect on perception and thus on preferences for appearances. Esthetic judgment on furniture preference can also be moderated by the perceived esthetic fit of the new furniture into the home interior (Bloch, 1995).

Furniture styles, the general categorization for different designs, are identified by a particular period in history or region in the world. However, decorative details can be borrowed from different style groups. Additional features contributing to furniture's role for design appeal include color, material, and coordination with other items. Materials and construction techniques have a major impact on durability and design appeal; at the same time, durable materials tend to be more expensive (Figure 1). In addition to these factors, individuals have unique needs that must be taken into account: available space, time, current items, harmony with current items, and lifestyle (Applied Research & Consulting LLC, 1999).

For designers, the selection of furniture requires a considerable amount of knowledge because each furniture type comes in a virtually infinite variety of designs, styles, sizes, materials, and price points. In addition, a satisfactory interior design solution requires an extra-sensitive selection of furniture that meets consumers' criteria. Most people do not have clear images of what kind of furniture they want regarding designs or styles before they see them in the showroom (Roy, 2002). Therefore, in order to understand furniture preferences, it is necessary to showcase a number of furniture pieces that can be coordinated in one place. As a major reason behind the lack of information and knowledge available regarding priority considerations and preferences in design and style by different consumer groups, setting up a showroom of large furniture pieces with virtually unlimited customizability is a big challenge.

Gender Roles in Design Choices

While esthetic judgments are primarily based on very personal and emotional responses, studies in consumer marketing and advertisements have focused

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on understanding subgroups of consumers and their relatively homogeneous responses to products and brands (Brennan, 1995). Gender is a widely investigated segmentation variable.

Previous studies in design preference demonstrate distinct esthetic preferences by gender. Xue and Yen's (2007) study on design choices shows that, for nonfunctional products such as fragrance bottles, males are more interested in regular-geometric forms, whereas females are more drawn to organic forms; for functional products such as cellular phones, males are more concerned with interface controls than are females. The study concludes that women focus on form, whereas men emphasize functionality. Similar findings were reported in Moss and Colman's (2001) experiments, which utilized a wide range of ages (children and adults), varying nationalities, and occupations. From two experiments, one with business cards (227 subjects) and the other with Christmas cards (65 subjects), they reported that women are more interested in color than men and that people tend to prefer designs by designers of their own gender (Moss & Colman, 2001). Earlier studies found the importance of the product's perceived masculinity and femininity in form and/or color to be a significant predictor of different choice intentions by female and male shoppers (Coughlin & O'Connor, 1985; Fischer & Arnold, 1990).

Research in gender differences—found across disciplines including education, psychology, sociology, anthropology, marketing, and design—are rooted in different biological and sociocultural characteristics between males and females. Biological differences are mainly accounted for by brain lateralization related to differences in the left hemisphere's specialization for verbal skills, and of the right hemisphere's specialization for spatial skills. Brain lateralization begins earlier in females than males; with girls demonstrating superior verbal skills in early developmental stages than boys. Delayed male lateralization appears to result in superior spatial skills (Knox & Kimura, 1970). The brain hemispheres of females tend to be more symmetrically organized, whereas the hemispheres of males appear specialized to a greater degree (Saucier & Elias, 2001).

Further physical gender differences are augmented by the socialization of gendered roles. Men who have dominant achievement-oriented and agnatic goals tend to be ego-centrist (Bakan, 1966). In contrast, judgments of females who have affiliation-oriented and communal goals tend to be field dependent and more responsive to cues and contexts. Whether gender differences originate from biological and/or sociocultural perspectives to some extent, the differences between males and females empirically observed in many studies help understand different design choices.

Compared to males, females are known to be more susceptible to nonverbal, situation-specific information (Lenney, Gold, & Browning, 1983) and to exert a greater stimulus elaboration on message cues and engage in comprehensive information processing (Meyers-Levy & Sternthal, 1991). Specially, females are more visually oriented (Holbrook, 1986) and engage in more associative, imagery-laced interpretations (Haas, 1979), and relational processing (Putrevu, 2001). In contrast, male information processing tends to use only subsets of available cues (Benyamini, Blumstein, Lusky, & Modan, 2003; Darley & Smith, 1995; Gilligan, 1982; Lenney, Gold, & Browning, 1983). These differences suggest that males and females are predisposed to different types of processing and select different cues from the environment or the object.

Challenges for the Furniture Industry

Residential furniture consumption has increased over the past two decades in the United States and is expected to grow over the next decade (Aktrin Research Institute, 2008). Despite the optimistic outlook, the U.S. furniture industry is facing a crisis as many domestic manufacturers and showrooms have downsized or closed, owing to significant business failures. Both furniture manufacturers

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and retailers are struggling with maintaining huge inventories. Manufacturers produce new designs while maintaining existing product lines (Schuler & Buehlmann, 2003); retailers focused on meeting consumers' diverse tastes tend to carry a wide collection of furniture in their limited showroom spaces.

Ever-increasing demands for low-priced imports from China and so-called democratic design products by foreign mega-retailers like IKEA somewhat explain the growth in furniture consumption despite a failing domestic furniture industry. While the sustainability of the U.S. residential furniture industry is vital to textile and woodworking industries, consumers will not be loyal to domestic goods simply because of where they are manufactured. It is a challenge to survive in today's furniture marketplace (Oh, Yoon, & Shyu, 2008).

There are still advantages for the domestic retailers, including shorter delivery time and customization ability. However, in order to compete with foreign imports, furniture suppliers and designers should meet consumer needs within their niche based on a better understanding of their target populations' tastes and buying behaviors or preference. To date, it is apparent that the U.S. furniture industry has not been very successful in grasping consumers' taste and personal needs. Only a few manufacturers with the capacity of managing both production and retail have channels to research target markets to any degree. These manufacturers are the largest suppliers in the U.S. household furniture industry and include Ethan Allen, La-Z-Boy, Thomasville, and Basset. Even these companies have seen considerable declines in production during the last few years and have increased imports (Murillo, 2007).

Previous Furniture Studies

Research on furniture design is quite limited. Most furniture studies focus on consumer market information reported by market research groups such as NFO WorldGroup, Worldfurnitureonline, HighBeam Research, and so forth. Thompson and Davis's (1988) research attempted to identify factors influencing furniture design preference using drawings of furniture. Participants identified their preferences for three furniture styles (traditional, contemporary, and country) with a semantic differential scale. Three factors they found significant were the perceived currency of the style, the perceived esthetic/utility of the style, and the perceived prestige of the style. They concluded that people tend to consider ''currency of the style'' and ''perceived esthetics/utility of the style'' to be more important than style groups.

NFO WorldGroup, a provider of research-based marketing information, conducted a national study in 2001 with 750 consumers who had spent at least $100 on furniture within the last 6 months to better understand purchasing decisions (Roy, 2002). This study found that most furniture purchases are planned (91%) and based on some form of information gathering. The top motivations for buying furniture are ''to replace worn items'' (37%), followed by ''moved to a new home'' (18%) and ''wanted a new model or style''(12%). Living/family room furniture was found to be the most expensive and frequently purchased furniture (56%). Another finding is that the majority of furniture shoppers do not consider brands and models for selection, and final selections are made in the store. This reinforces the importance of carrying a large variety of styles for retailers.

Lihra and Graf (2007) studied different communication channels that affect consumers' furniture buying behaviors. The communication channels include retail stores, the Internet, and advertisements. They found that females tend to pay more attention to communication channels than males for their furniture purchase decisions. Their findings indicated that women are generally more interested in furniture and furniture purchases than males. Roy and Tai (2003) examined the effect of the visual imagery of furniture at stores on shopping behaviors. They reported that presented visual imagery reduced shoppers' abilities to delay gratification and thus enhanced their desire for the furniture and led to a purchase. Recently, Oh, Yoon, and Shyu (2008) proposed an innovative method to perform furniture market research utilizing

a Web-based virtual reality (VR) system. In this study, they suggested that furniture purchase experience simulated in a virtual environment can effectively map consumers' decision-making processes with its benefits of enhanced learning in a somewhat realistic experience.

Virtual Experience

Today's computer and network technologies enable consumers to search, examine, and purchase goods via the Internet. About 65–70% of shoppers use the Internet for shopping (Verhoef, Neslin, & Vroomen, 2007; Weinberg, Parise, & Guinan, 2007). For furniture, the Internet becomes an important communication channel before shoppers make an in-store purchase. According to an industry survey conducted on 1101 shoppers in 2004, 14% of shoppers purchased furniture at stores after researching first on the Internet, and they spent a longer time for browsing and researching furniture compared to other products (Anderson, 2005). To help shoppers better examine and experience products, company Web sites offer VR technology. VR technology elevates the degree of interactivity; viewers can rotate, zoom, customize, 3D, and more closely scrutinize furniture pieces.

VR refers to real-time, interactive, 3D computer visualization technology. VR provides individuals with a more engaging experience than 2D images. Advanced technology has made high-quality 3D graphics for VR available on home computers; as a result, Web-based VR for e-commerce sites has been increasingly popular for its capability to provide online shoppers with more realistic experience (''virtual experience'') (Yoon, Laffey, & Oh, 2008). Li, Biocca, and Daugherty (2001) have established experimentally that virtual experience is vivid and engages active affective psychological states occurring in an individual interacting with 3D computer simulations. They analyzed the verbal reports of 30 undergraduate student participants who described what they ''think and/or feel'' while examining four products—bedding materials, a watch, a ring, and a laptop computer (Li et al., 2001). In a follow-up study, they concluded that in comparison to the indirect experience offered by media such as catalogs, these virtual experiences offer better consumer learning that is closer to direct experience with the product (Daugherty, Li, & Biocca, 2008).

Methods

This study aims to propose a research framework that explores how furniture design choices are made and the factors affecting that decision making. A new Web-based survey system integrating a 3D virtual showroom representing a living room was developed to empirically demonstrate the application.

Participants

A total of 301 graduate and undergraduate students, of which 162 were females (53.8%), from two public universities in the United States participated in the VRIS online survey (www.vr-solution.com). The 301 participants were from business (53%), engineering/science (14%), interior design or other allied design field (15%), and other diverse nondesign majors including journalism, agriculture, tourism, and medicine (9%). One campus is in the Midwest and the other is in the Southeast. The sample consisted of a diverse number of academic majors, with the ages ranging from 18 to 58. The median age was 20. Student participants were considered appropriate for this experiment because they are likely to represent potential adopters of 3D visualization with more experience in online product search and shopping.

Stimuli

Living room furniture consisted of a sofa, chair, and table. Living room furniture accounts for the largest sector of the market in terms of sales value (Household Furniture Market Report, 2008) because it is relatively expensive and more frequently purchased (Roy, 2002). Survey participants can view different furniture to mix and match furniture pieces

Figure 2. Furniture samples.

within the virtual showroom while providing their responses to survey questions.

Among the considerations for furniture choice, eight features of furniture were identified by the female consumer focus group. Those factors include "style," "color," "price," "construction quality," "ease of maintenance," "comfort," "material," and "match with other items." The focus group consisted of eight women with furniture shopping experiences, because women are the primary furniture consumers (Cutler, 2003). Another focus group—the expert focus group with five professionals in interior design and furniture marketing—was formed to gather opinions regarding distinct furniture styles and to determine furniture models, colors, and materials to be used in the study.

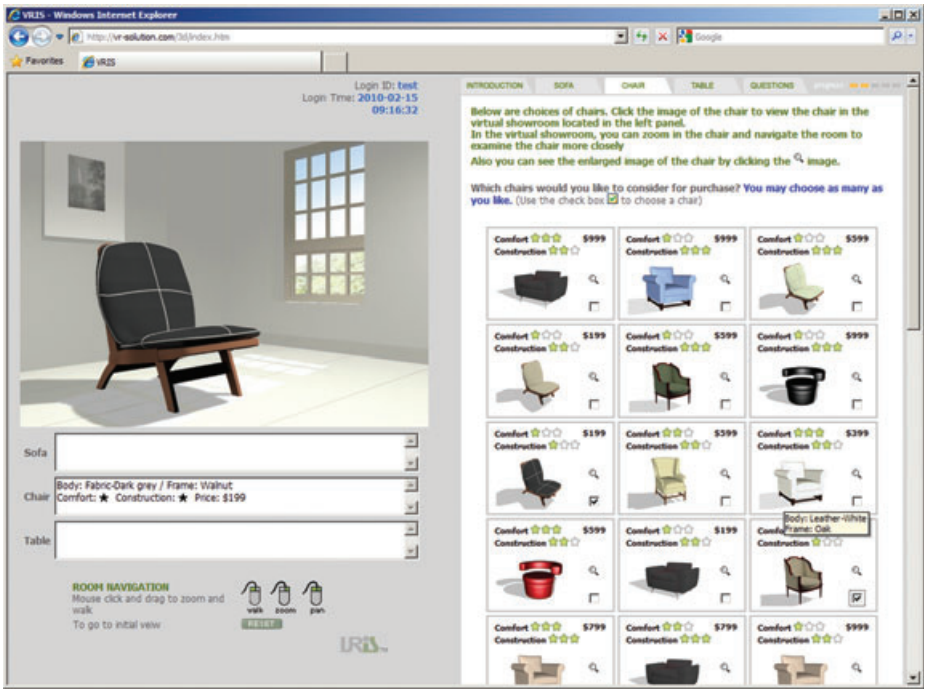
The expert focus group referred to furniture dealers' Web sites, advertising brochures, and magazines to identify commonly recognizable terms that categorize furniture styles. Three style categories of "traditional," "modern," and "casual" were selected as frequently used and relatively easier for a layperson to distinguish from each other. Traditional furniture was characterized by classical details influenced by designs from different historical periods or regions. In contrast to traditional furniture, modern furniture was characterized by simplistic and contemporary design. Casual style was identified as another category for comforting, informal, and utilitarian design that was characterized by overstuffed sofas and country or arts-and-craft-style wood construction.

Furniture items, which were correctly identified with above 90% of the agreement, were selected, and then a computer-generated, 3D furniture collection was developed using 3D modeling software. The furniture pieces were combined with product information (price, construction quality, comfort rating for sofa and chair, and size for table), resulting in 51 sofas, 38 chairs, and 28 tables (Figure 2). Prices were controlled to be comparable.

Procedure

Initial e-mail invitations were sent to students enrolled in large classes open to all academic majors at all levels. Volunteer students logged on to the link to www.vr-solution.com from the e-mail to start the survey. After a greeting and participant registration, they were asked to review furniture in the 3D virtual showroom and complete a series of survey questionnaires. The questions included items asking participants to rank along a 7-point Likert scale the importance of eight features in the consideration of furniture purchases. The data set consisted of a collection of furniture types in the order of sofas, chairs, and tables. In each section, a furniture thumbnail list allows participants to view and record individual

Figure 3. Screenshot of VRIS single item view.



furniture models in the virtual room. Selected furniture models are saved for review together with other models in a combination view before making the final selection. On average, participants spent 5–10 minutes completing the survey.

The survey procedures are shown in Figure 5. Using the VRIS Web-accessible program, participants responded to the following query: "Suppose you are about to buy a sofa (or a chair or a table) for your living room. How important is each of the following features for your purchase?" The participants used a Likert-type scale ranging from 1 ("not important") to 7 ("very critical") to gauge their responses. The VRIS survey system allows participants to freely examine a furniture item alone and together with other furniture. Participants could select as many pieces as they wanted for review later before final selection. Finally, participants were asked to evaluate the saved furniture groupings by reviewing them in a sofa–chair–table combination view in the virtual showroom. In the virtual showroom, participants could zoom in and out, navigate, and look up and down. Out of 117 total furniture models, 51 sofas, 38 chairs, and 28 tables were included (Figures 3 and 4).

VRIS Development

For this study, VRIS, an online accessible VR integrated system was developed with a virtual showroom representing a living room embedded in the interface. VRIS offers individuals a virtual furniture shopping experience via interactive mix-and-match combinations, working seamlessly with a 3D model database. VR technology provides an enhanced learning experience via real-time interactivity that includes the ability to zoom in, to walk about the room, and to pan or look around. A previous study demonstrated that user satisfaction and decision confidence with a VR system was

Figure 4. Screenshot of VRIS combination view.

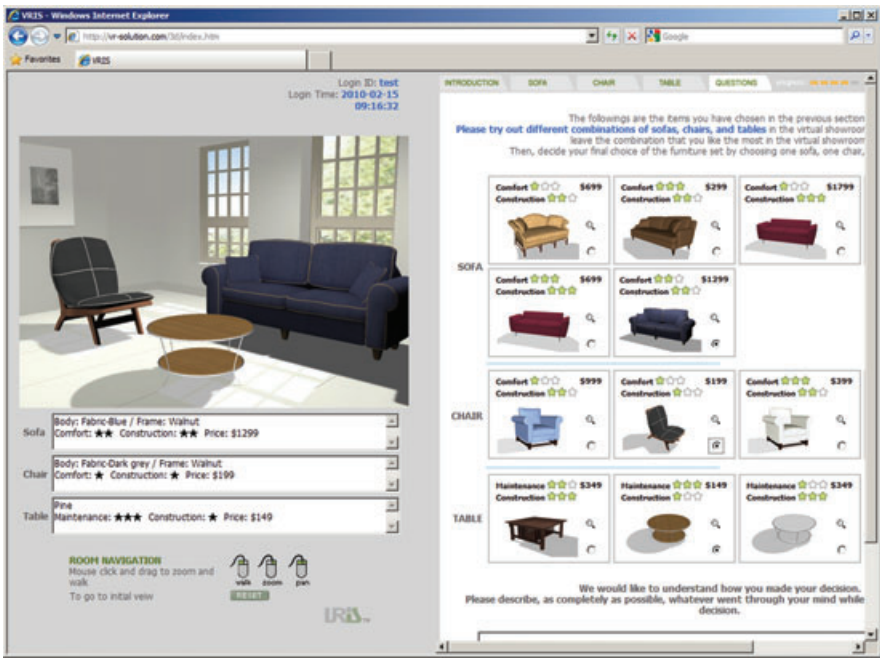
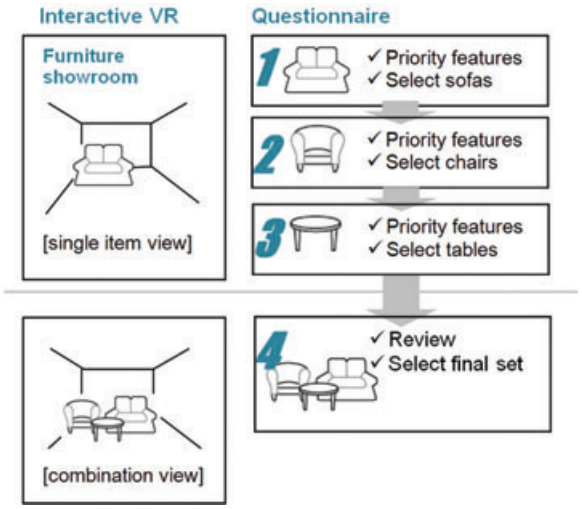


Figure 5. VRIS Procedure.



significantly higher than when using 2D catalog type interfaces (Yoon, Oh, & Laffey, 2008).

Figure 6 shows the overview of the furniture modeling process. Given an image and scale dimensions such as depth, width, and height of the furniture from a reference (a), a wire-frame model is created (b), and wrapped with a JPEG (*.JPG) texture map (c), to get the final product in (d). 3D furniture models and a living room were created in AutoDesk 3D Studio Max and then converted into EON Reality VR objects. With the open source database MySQL, the VRIS provides an interactive 3D furniture showroom and a consumer survey on the Web at www.vr-solution.com.

Analyses and Results

Survey data from 301 participants were collected through the VRIS system. Data were analyzed by the SPSS statistical package using multiple methods, including descriptive statistics, *t*-test, ANOVA, and cross-tabulation. A summary of demographic information is shown in Table 1.

Both males and females agreed on "comfort" as the most important feature to be considered for sofas and chairs. Interestingly, a noticeable difference between males and females was discovered in their ratings for "color" and "style."

Figure 6. Furniture modeling process.

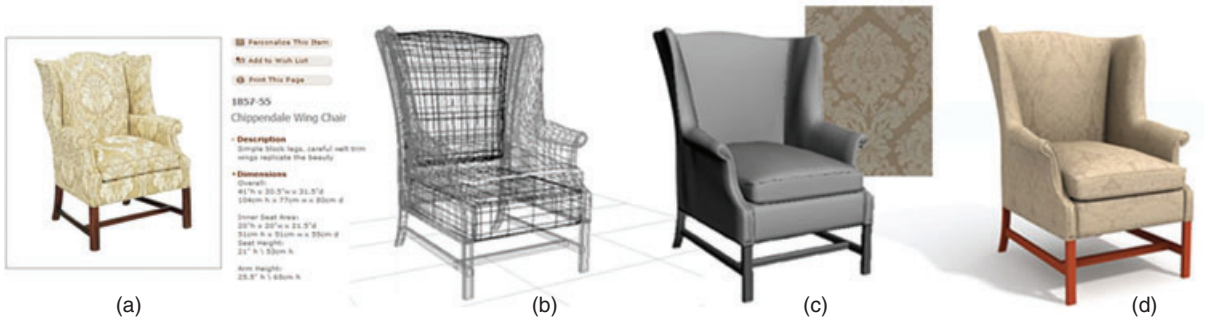


Table 1. Participant characteristics

Demographic variables		*Total: 301*
Gender	Females (average age: 21.96)	162
	Males (average age: 20.8)	139
Age ($M_{age} = 21.96$)	<25	282
	26–50	17
	51>	2
Ethnicity	White	219
	African American	13
	Asian or Pacific Islander	30
	Hispanic	30
	Other	9

Priority Considerations for Furniture

Gender Difference

In order to understand differences regarding the perceived importance of the eight furniture features, independent sample *t*-tests were performed. As shown in Table 2, females reported consistently higher mean scores across all eight features characterizing the sofas, chairs, and tables. The only features where females and males somewhat agreed on the importance were "price" for all three items, "comfort and size" for sofas and chairs, and "material" for tables. It was observed that female participants gave higher ratings for overall criteria, displaying that in general and compared to males, females tend to be more sensitive to specific furniture features. Further, strong and consistent gender differences appeared for ratings of "style" and "color" across sofa, chair, and table selections ($p < .05$). Importance of "match with other items" was also considered differently between males and females ($p < .05$). Females considered "style," "color," and "match with other items" significantly more important than males. These are features contributing to the esthetic appeal of furniture.

Gender difference in the priority rankings among the eight features was also examined. Both males and females agreed on "comfort" as the most important feature to be considered for sofas and chairs. Interestingly, a noticeable difference between males and females was discovered in their ratings for "color" and "style." While males considered "price" and "construction quality" more important than "color" and "style," females value "color" and "style" more than "price" and "construction quality." Among the eight features, "match with other items" followed by "ease of maintenance" and "material" were found to be relatively less important considerations by both males and females (Table 3).

Furniture Style Preferences

Further analysis examined furniture design choices by focusing on selected styles. We first looked at the selections made by candidates before the final decision. Table 4 shows how many furniture models

Table 2. Gender difference by furniture attribute

		Gender: M(SD)			
		Males	*Females*	*T*	*df*
Style	Sofa	5.58(1.08)	6.23(1.04)	5.39***	299
	Chair	5.55(1.21)	6.13(1.07)	4.38***	299
	Table	5.53(1.20)	6.05(1.14)	3.88***	299
Color	Sofa	5.59(1.16)	6.25(1.00)	5.32***	299
	Chair	5.38(1.21)	6.08(1.11)	5.24***	299
	Table	5.14(1.34)	5.76(1.31)	4.03***	299
Price	Sofa	5.74(1.18)	5.96(1.19)	1.58	299
	Chair	5.72(1.04)	5.84(1.30)	.88	299
	Table	5.70(1.16)	5.83(1.31)	.90	299
Construction Quality	Sofa	5.60(1.02)	5.88(1.15)	2.22*	299
	Chair	5.60(1.11)	5.79(1.23)	1.42	299
	Table	5.71(1.06)	6.04(1.11)	2.63**	299
Ease of maintenance	Sofa	5.09(1.21)	5.58(1.20)	3.55***	299
	Chair	5.15(1.28)	5.41(1.41)	1.68	299
	Table	5.10(1.35)	5.58(1.36)	3.07**	299
Comfort & size	Sofa	6.33(.90)	6.45(.85)	1.19	299
	Chair	6.29(.83)	6.26(1.07)	.32	299
	Table	5.69(1.09)	6.01(1.08)	2.52*	299
Material	Sofa	5.35(1.18)	5.69(1.19)	2.48*	299
	Chair	5.38(1.17)	5.54(1.29)	1.13	299
	Table	5.22(1.35)	5.49(1.37)	1.81	299
Match with other items	Sofa	2.14(2.86)	2.99(3.12)	2.45*	299
	Chair	2.06(2.80)	2.91(3.04)	2.48*	299
	Table	2.10(2.83)	2.88(3.03)	2.28*	299

*$p < .05$, **$p < .01$, ***$p < .001$.

Table 3. Rankings of priority consideration

Sofa	Males	Comfort > Price > C.Q > **Color > Style** > Material > Maintenance > Match
	Females	Comfort > **Color > Style** > Price > C.Q > Material > Maintenance > Match
Chair	Males	Comfort > Price > C.Q > **Style > Color** = Material > Maintenance > Match
	Females	Comfort > **Style > Color** > Price > C.Q > Material > Maintenance > Match
Table	Males	C.Q > Price > Size > **Style** > Material > Color > Maintenance > Match
	Females	**Style** > C.Q > Size > Price > Color > Maintenance > Material > Match

C.Q = Construction quality, Maintenance = Ease of maintenance, Match = Match with other items.

were presented to participants from furniture style categories.

As seen in Table 4, the number of sofa, chair, and table options presented to participants was unequal in three styles—traditional, casual, and modern. Thus, we analyzed the percentages between selected numbers versus provided numbers in order to test which style has the highest percentage in selection. In the *t*-test result, overall casual style (sofa, chair,

Table 4. Number of furniture models presented to participants

Item	*Total*	*Traditional style*	*Casual style*	*Modern style*
Sofa	51	17	24	10
Chair	38	11	6	21
Table	28	4	9	15

and table) which suggests casual style furniture will be selected is much higher than other styles for this type of sample segments.

The average number of furniture models selected varied by gender: sofa ($M_{male} = 4.90$, $M_{female} = 5.59$), chair ($M_{male} = 3.37$, $M_{female} = 4.12$), and table ($M_{male} = 3.37$, $M_{female} = 3.87$). Overall, females tended to choose more models than males. An independent sample *t*-test result (Table 5) shows a clear gender difference in selection counts, especially for casual chairs. Females selected significantly more casual style chairs than males (t [299] = 2.21, $p < .05$).

Final Purchase Decisions

Final Selection from Multiple Candidates

In the last stage of this study, the participants were asked to make the final choice of a furniture set—a sofa, a chair, and a table—after reviewing the multiple sofa, chair, and table options previously chosen. Pie charts in Figure 7 show the percentages of each style group provided, in comparison to the percentages of actual selection counts. Compared to the presented percentage, a preference for modern style sofas was detected. Also, a strong preference for the casual style was observed for the final chair selection.

A significant decrease in selected counts for the traditional style of all three furniture items was found. The lower percentages of final selections for the traditional style in comparison to what were presented demonstrate a general preference for casual and modern style furniture over traditional style furniture. While there was no previous evidence known to the authors, the assumption can be made that this finding may reflect the cohort effect given the overall age of the college student sample.

Gender Difference in Style Preference

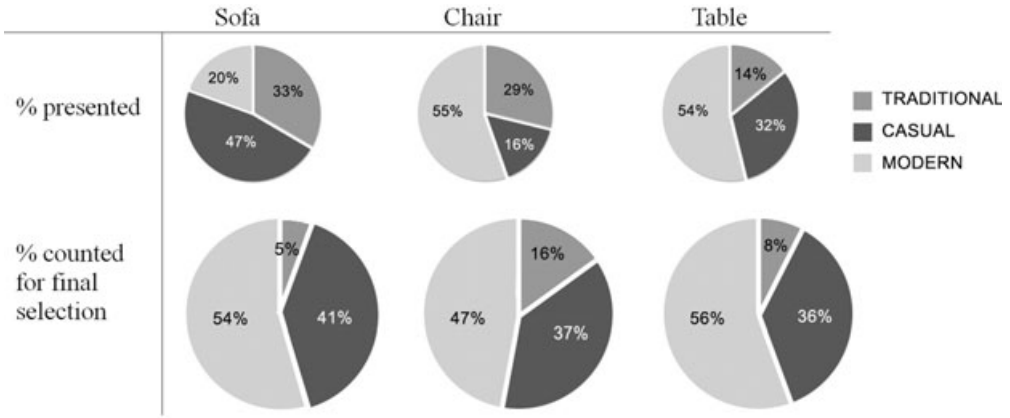
To further examine the style preferences found in the final selection, gender difference was analyzed using Chi-square tests. Figure 8 pie charts provide the visual comparison of the finally selected furniture styles between gender. Overall, it was found that females selected more casual style sofas and tables

Table 5. Gender difference for furniture style selected as candidates

		Gender: M(SD)			
		Males	*Females*	*T*	*df*
Traditional	Sofa	4.57(7.76)	5.41(9.11)	.853	299
	Chair	5.56(8.65)	6.29(9.57)	.685	299
	Table	9.53(17.39)	11.72(17.66)	1.083	299
Casual	Sofa	12.74(11.90)	14.51(11.33)	1.317	299
	Chair	12.83(15.84)	22.74(18.65)	4.923*	299
	Table	12.94(14.99)	15.84(16.23)	1.597	299
Modern	Sofa	10.65(15.94)	11.85(16.43)	.643	299
	Chair	9.49(10.17)	9.85(10.87)	.293	299
	Table	14.15(13.32)	12.59(14.01)	.983	299

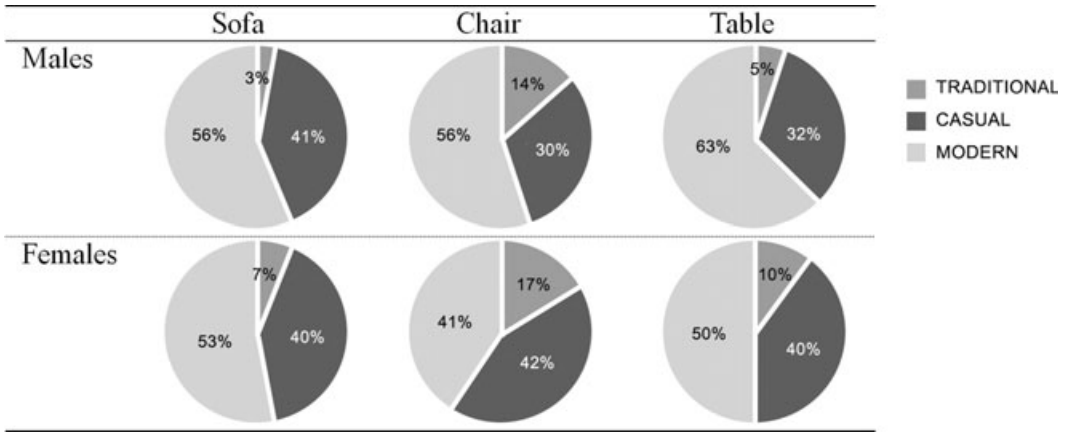
*$p < .05$.

Figure 7. Percentage of each style presented versus percentage of style counts for final selection.



	Sofa	Chair	Table
Traditional	15 (5%)	47 (16%)	24 (8%)
Casual	122 (41%)	111 (37%)	109 (36%)
Modern	164 (54%)	143 (47%)	168 (56%)
Total	301 (100%)	301 (100%)	301 (100%)

Figure 8. Styles chosen for final selections: males versus females.



than males, whereas males selected more modern style sofas, chairs, and tables than females.

Chi-square tests were performed to examine potential associations between gender and furniture style preference. A significant gender difference was found for chair style preference as shown in Table 6. The result indicates that males significantly preferred modern style chairs ($\chi^2(2) = 6.74$, $p < .05$), whereas females preferred casual style chairs.

Table 6. Final furniture style choices by gender

		Traditional	*Casual*	*Modern*	*Total*
Sofa	Males	4 (6.9)	57 (56.3)	78 (75.7)	139
	Females	11 (8.1)	65 (65.7)	86 (88.3)	162
	Totals	15	122	164	301
	$\chi^2 = 2.44$, $df = 2$, $p = .295$				
Chair	Males	20 (21.7)	42 (51.3)	77 (66.0)	139
	Females	27 (25.3)	69 (59.7)	66 (77.0)	162
	Total	47	111	143	301
	$\chi^2 = 6.74$, $df = 2$, $p = .034$*				
Table	Males	7 (11.1)	45 (50.3)	87 (77.6)	139
	Females	17 (12.9)	64 (58.7)	81 (90.4)	162
	Total	24	109	168	301
	$\chi^2 = 5.97$, $df = 2$, $p = .051$				

Chi-square significance test results: *$p < .05$.
The values given in parentheses are the expected counts.

Table 7. Final chair–table style choices by gender

Chair–table Combination	*Chair Table*	*Traditional Traditional.*	*Traditional Casual*	*Traditional Modern*	*Casual Traditional*	*Casual Casual*	*Casual Modern*	*Modern Traditional*	*Modern Casual*	*Modern Modern*
Males		5 (7.9)	5 (6.9)	10 (6.9)	2 (2.3)	15 (24.9)	25 (24.0)	0 (.9)	25 (18.5)	52 (46.6)
Females		12 (9.1)	10 (8.1)	5 (8.1)	3 (2.7)	39 (29.1)	27 (28.0)	2 (1.1)	15 (21.5)	49 (54.4)
Totals		17	15	15	5	54	52	2	40	101
$\chi^2 = 20.108$, $df = 8$, $p = .01$										

Chi-square significance test results: *$p < .05$
The values given in parentheses are the expected counts.

Style Choices of Furniture Groupings

In order to understand how people make furniture choices in combination such as chair–sofa, sofa–table, and table–sofa, Chi-square tests were performed. Any significant association between gender and the style of combination was examined. Sofa–chair, chair–table, and table–sofa combinations were analyzed, and a significant gender difference was found in chair–table combinations, as shown in Table 7 ($\chi^2(2) = 20.108$, $p < .05$). The result indicates that males tended to select modern style chairs and modern style tables together, while females preferred casual chairs with casual tables.

Chi-square tests also revealed a significant gender difference in the final choices of the sofa, chair, and table combination ($\chi^2(3) = 14.4$, $p < .05$). Male participants selected modern style combinations for all three items significantly more frequently than the expected count, and female participants selected casual style combinations more often than the expected count (Table 8). This result supports the coherent preference for modern style furniture by males and casual style by females.

The most frequently selected models for both males and females were a casual chair and table, and a

As age and stage of family lifecycle are likely to influence furniture choices, it is considered that different age groups may lead to more interesting findings.

Table 8. Final sofa–chair–table style choices by gender

	All traditional	*All casual*	*All modern*	*other*	*Total*
Males	0 (2.3)	10 (18.9)	40 (38.3)	89 (79.4)	139
Females	5 (2.7)	31 (22.1)	43 (44.7)	83 (92.6)	162
Totals	5	41	83	172	301
$\chi^2 = 14.400$, $df = 3$, $p = .002$*					

Chi-square significance test results: *$p < .05$.
The values given in parentheses are the expected counts.

Figure 9. Most frequently selected furniture across gender.

modern sofa (Figure 9). However, the design of the selected casual chair does appear quite similar to that of the modern style.

Discussion

Limitations and Contributions of the Study

Despite the rigor exercised in this study, it is important to carefully examine limitations that need to be taken into consideration when interpreting the survey results and their generalizability. The recognition of limitations also can inform future studies in order to produce more reliable and applied knowledge for the related fields.

One limitation in this study was that the subjects were college students. College students can be considered homogeneous in terms of furniture purchasing experience and purchasing power. They are potential furniture shoppers; yet they have typically limited purchasing power compared to the older cohorts. As age and stage of family lifecycle are likely to influence furniture choices, it is considered that different age groups may lead to more interesting findings. Only about half of the sample had any experiences with purchasing furniture (42.5% for sofas, 51.1% for chairs, and 51.9% for tables). Tapping into the younger cohorts' patterns at the beginning of their future-buying lifetime can be meaningful, especially considering they are the generation of Internet users and shoppers. However, the generalizability of results to other populations is limited because their responses may display trends in the younger generation and reflect the group's unique characteristics involving their financial limitations and possibly lower sensitivity to furniture.

The second limitation is that participants were from two mid-size college towns: in Missouri and in Florida. The regions of data collection may have influenced the findings reported. People from different geographical areas may have different lifestyles, cultures, or design preferences, that are likely to influence experiences and thus to form certain preferences.

The third limitation is on the furniture style classification and models adopted. They were carefully reviewed by the expert focus group based on common understandings in theory for traditional, casual, and modern styles in furniture. However, there often exist possible overlaps and confusion in identifying designs for a specific style. How well the models and their colors and materials represent the style might not be fully agreeable by different reviewers. Assessing the dimensionality, actual surface texture and finish of furniture is also limited by technology.

This is one of the first studies that empirically explores furniture choices by simulating the furniture purchase scenario through the creation of a virtual experience using a 3D virtual showroom.

The fourth limitation of this study involves the unbalanced numbers of furniture models for each style category. Therefore, appropriate statistical procedures were adopted based on this inequality. However, more power could have been given to the results by balancing the different furniture and style group sizes. This limitation was mainly due to difficulties in developing and optimizing the traditional style models within the parameter of this study time and resources. Traditional style models generally require more time to develop, and file sizes are larger and with more complex geometries. For future studies, ready-made computer models can be considered to reduce the time and effort required for system development since more and more companies including Hickory chair and Office Depot are developing 3D computer models.

The fifth limitation is that the possible gender effect on the furniture models selected by the focus group, consisting of only females, was not considered yet the survey responses of both genders were evaluated.

Finally, another limitation relates to the data collected. The quantitative data reveals patterns in preferences, but qualitative data is needed to delve into the reasoning behind the furniture selection.

In spite of the limitations discussed above, the findings reported in this study offer significant contributions to researchers, designers, and industry affiliates interested in understanding furniture design choices and the decision-making process of a consumer regarding the residential furniture market. This is one of the first studies that empirically explores furniture choices by simulating the furniture purchase scenario through the creation of a virtual experience using a 3D virtual showroom. Virtual experience via 3D product visualization has been receiving increasing attention in the field of interactive marketing and advertising today. The findings have broader implication for 3D design products.

Conclusion

The purpose of this study was to develop a research framework using technology for understanding furniture design choices and to prove the potentialof 3D VR. Studies on furniture design choices and consumer profiling are surprisingly rare despite its significance to the industry and consumers. The approach proposed in this study allows researchers to gain knowledge of how people make furniture choices and their style preferences using a new Web-based application based on an interactive 3D virtual showroom. It is an empirical attempt to overcome current issues with furniture studies, largely attributed to challenges in presenting large-sized furniture pieces with nearly unlimited possibilities of customization. While there was no precedent study in focusing on different furniture design preferences and priority considerations, this study found that people have different priority considerations among eight features—style, color, price, construction quality, ease of maintenance, comfort, material, and matching with other items—as well as different furniture style preferences between different gender groups. Previous studies in consumer marketing and design have reported gender differences in design preferences and design choices. The men tend to rate construction quality and price more importantly than visual characteristics of furniture represented by color and style, whereas to women, color and style take priority over construction quality and price. From the virtual shopping simulation, we also found that women are apt to look at significantly more possibilities before making their final choices. These findings are somewhat consistent with previous studies reporting that men make judgments based on selective and key objective attributes such as construction quality and price, whereas women base their judgments on more integrated, subjective, and visual information (Benyamini et al., 2003; Darley & Smith, 1995; Gilligan, 1982; Holbrook, 1986; Lenney, Gold, & Browning, 1983). In addition, this study found that men are more inclined to choose furniture with a modern style, whereas females prefer furniture with a casual style. Previous studies on gender effects on esthetic judgments for product design have

From the virtual shopping simulation, we . . . found that women are apt to look at significantly more possibilities before making their final choices.

reported males to be more interested in regular-geometric forms and the product's masculinity (Moss & Colman, 2001; Xue & Yen, 2007). It is possible to assume that perhaps modern style furniture delivers more design appeal to men with more simple, regular, masculine forms and less decorative details.

This study provides resources for furniture industry and design professionals by exploring priority considerations and design preferences when buying furniture. The U.S. residential furniture industry has declined dramatically as foreign competitors have gained an increasing share in the market (Schuler & Lawser, 2007), and the U.S. furniture industry is facing the challenge to become more adept at responding to the needs and tastes of target consumers. The current study uncovered different priorities and preferences in furniture selections between men and women within a relatively young sample of participants. The findings provide new knowledge to researchers, design professionals, and decision makers in the furniture industry, and the results, if confirmed by additional studies, may have important implications. Future studies involving a diverse group of participants, especially with a wider range of age levels, and from a broader geographic region, will help provide more definitive results toward gaining practically useful knowledge that can be translated into successful residential furniture design, marketing, and manufacturing.

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