The Multisensory Experience: A Case Study with Five Different Products

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ABSTRACT

The human perception arises from an inner sense intrinsically dependent on the sensitive channels. Vision is considered the dominating sense in humans, while hearing, touch, taste, smell, kinesthetic sense and balance are complementary in most cases, with numerous exceptions. Until now, most studies suggest that the greater the number of sensory modalities stimulated at the same time, the richer the experience will be. As a result, the increase in the number of sensory modalities presented in a virtual environment can help people feel immersed and also help to improve the memory of existing objects in the virtual environment (Schifferstein and Spenser, 2008). This study aimed to evaluate the influence of multisensory integration in the user experience with different categories of products. Participants were 60 volunteer subjects of both genders and all users of these products; they evaluated 25 different products in three levels of multisensory integration: vision, vision+touch and multisensory. Results indicated that intrinsic characteristics of each product were responsible for the emergence of differences between multisensory phases, and the relationship between usability and visual aesthetics were less evident in the process. More specific studies are necessary to recognize more accurately the relationship between product characteristics and user perception.

Keywords: Ergonomics, Design, User Experience, Multisensory Integration, Factor Analysis.

INTRODUCTION

The sensitive input has been traditionally studied separately due mainly to anatomic differences of the sensory organs and the way the sensory information is processed. However, these senses are highly integrated in the brain in order to provide a more complete perception of our surroundings, in a phenomenon called multisensory integration (Wallace, 2004; Schütte, 2005, Fenko, 2010, Vergara, 2011).

Vision is considered the primary sense in humans, while auditory, tactile, gustative, olfactory, balance and kinesthetic are complementary in most cases (Schütte, 2002 and 2005). In general, the first contact with a product is visually; depending on the interest of the user, he/she may intensify the experience with the product broadening his/her sensorial perception by touching, hearing, smelling, manipulating or even tasting the product (Picard, 1997; Schütte, 2008). Recent studies have investigated the importance of other sensory modalities in the use of products (Schifferstein and Cleiren, 2005; Schifferstein and Desmet, 2007), such as the tactile influence on consumption (Spence and Gallace, 2011; McCabe and Nowlis, 2003) decision and preferences (Peck and Childers, 2003), and the impact of the touch and kinesthetic sense on product usage (Fogtmann *et al*., 2008). Schifferstein and Spenser (2008) address the important role of the sensory senses in user experiences with products, stating that the experience will be based on the total perception of all the senses available, and it can happen conscious or unconsciously. Spence and Gallace (2011) alert to the fact that multisensory integration have a great impact on sales and one bigger challenge to companies is to manage online commerce of particular products such as clothes, for example, due to lack of interactions with other senses. McCable and Nowlis (2003) have shown that for some portable electronics such as mp3 players, smartphones, tables, etc. touching is also a very important sense in buying decisions. We reinforce this argument citing Syzbillo and Jacoby (1974) affirmation that the intrinsic qualities of the products such as color, shape, smell or texture can be more important in determining the quality of the product than extrinsic characteristics, such as price, brand, promotion or store image.

In many user experience studies products are usually evaluated using visual domain and then subjective records are obtained by means of the semantic differential (SD) test (Hsu et al., 2000; Chuang and Ma, 2001; Petiot and Yannou, 2004; Mondragón et al., 2005; Cheng and Chang, 2009). Some studies focus on certain elements of the visual stimuli like form (Chang and Wu, 2009), color (Hsiao et al., 2008), emotion (Schifferstein, 2006; Herz and Schooler, 2002) or fidelity of the prototype (Sauer and Sonderegger, 2009; Sauer et al., 2010), but they are exclusively based on visual domain to construct the semantic space with SD forms. Only in certain cases is the examination extended to other senses (Schütte and Eklund, 2005). Some studies compare different modalities of visual perception (Artacho-Ramírez et al., 2008; Sauer and Sonderegger, 2009), but few studies have included the sense of touch (Barnes et al., 2004; Choi and Jun, 2007; Wellings et al., 2008, 2010). Schifferstein and Cleiren (2005) and Schifferstein and Desmet (2007) investigated the isolation of senses in product usage and brought some light in comprehending the contribution of each sense to the total perception. Nagamachi (2002), in a article about implication of the Kansei Engineering (roughly described as an ergonomic method for manipulating emotional attributes of the products), points out that in studies regarding human perception is important to include all senses and the importance of each sense will depend on the context of use. Studies in this field indicate that the omission of sight is responsible for the greater degree of information loss in the interaction with the product, since it is the predominant channel (Schifferstein and Cleiren, 2005; Schifferstein and Desmet, 2007). It was also proven that touch and kinesthetic sense gain greater importance as interaction time increases and can be leveled in importance with vision (Fenko et al., 2010). It is presumed that this sensorial perception is dependent on the user experience with the product and its functional and aesthetic characteristics critically influence this relationship.

Recently, Vergara et al. (2011) investigated the influence of multisensory integration with hammers and proved that at least for this product the multisensory integration alters significantly some aspects of product perception. Campos et al. (2012) investigated the same aspect with pruning shears and concluded that the variables related to the usage were more affected by the lack of senses than other attributes of these products. The results of these two studies stress the influence of multisensory integration on the perception of products. However, both studies used hand tools as object and it is known that this category of product leads to determined type of interaction. Moreover, the characteristics and attributes of hand tools are task oriented and have specific design goals. Thus, this study had as a goal to analyze the influence of multisensory integration in products commonly used in daily activities.

MATERIAL AND METHODS

User sample

The participants were 60 volunteer subjects of both genders. Their age ranged from 18 to 54 years and they were all users of the products. The subjects were divided into groups of 12 individuals who assessed 5 products in one category.

Product sample

Twenty-five products commonly found in domestic or work places were evaluated, namely 5 coffeemakers, 5 screw-drivers, 5 vegetable peelers, 5 staplers and 5 paper punches. Images of these products can be seen in Table 1.

Table 1. Product sample.

Coffeemakers	
Screw-drivers	
Vegetable peelers	
Staplers	
Paper punches	

Procedure

Individual perception was collected using the Semantic Differential in an 11-point Likert scale, considering symbolic and usability aspects. The evaluation of the products was divided into three levels of multisensory integration. In the first level, the subjects evaluated the products through high resolution photographs (visual sense). In the second level users were asked to touch and manipulate the products, without really use them and then the evaluation was performed (visual and touch senses). For the third level the subjects were asked to perform predetermined tasks with each product and again their perception were recorded (multisensory). The trials were spaced in days to avoid remembering previous answers.

The results were analyzed with Factorial Analysis in order to extract the main factors that represent the semantic space of these products. The levels of multisensory integration were treated as dependent variables and analyzed with Wilcoxon's test. All analysis were performed with StatSoft Statistica R7.

RESULTS AND DISCUSSION

Factor Analysis (FA) with Varimax rotation was used to verify the semantic behavior of the variables in each product. The eigenvalue of 1.0 was used for all analysis. Tables 1 to 5 show the results of FA for the five products of the sample. The higher correlations values (above 0.7) were highlighted in bold and the medium correlation values (above 0.5) were underlined. The table shows the percentage of total variance and the percentage contribution of each factor for the total variance. In right side, is presented a box with a summary of the factors grouping.

Table 1 presents the results of the factor analysis for the coffeemakers. Three factors were encountered representing 69.69% of total variance. According to Laros (2005), variance above 60% is indicative of a good quality of the factors obtained. They were named 1) general quality; 2) easiness of use; and 3) heaviness and cleanliness.

Table 1. Factor analysis for coffeemakers.

Variables	Factor 1	Factor 2	Factor 3
Good appearance	**0.771081**	0.374233	0.105320
Efficient	**0.749538**	0.339227	0.005935
Good quality	**0.873843**	0.186789	0.137986
Heavy	0.022539	-0.024748	**0.859167**
Resistant	**0.843956**	-0.025854	0.205317
Safe	**0.869367**	0.105708	0.106333
Easy to clean the powder compartment	0.552337	0.234194	0.506234
Easy to clean the jar	0.315457	0.269232	0.666302
Easy to clean the body of the product	0.439286	0.618427	0.323370
Easy to dose water/powder	0.214442	0.677481	0.199230
Easy to remove the powder compartment	0.621050	0.270884	0.492480
Easy to remove the jar	0.558799	0.460107	0.111797
Easy to use	0.410698	**0.725425**	0.029413
Quick preparation of the coffee	-0.053580	**0.758359**	0.011704
% of total variance	*50.81567*	*11.44167*	*7.43262*
Total variance	**69.69%**		

Factor 1 – General quality
Good appearance; Efficient; Good quality; Resistant; Safe; Easy to remove the powder compartment; Easy to remove the jar

Factor 2 – Easiness of use
Easy to use; Quick preparation of the coffee; Easy to clean the body of the product; Easy to dose water/powder

Factor 3 – Heaviness and cleanliness
Heavy; Easy to clean the jar; Easy to clean the powder compartment;

Table 2 presents the results of the FA for the screwdrivers. Three factors were obtained representing 69.82% of total variance and they were denominated as: 1) Performance quality; 2) Handling aspects; and 3) Texture. Factor 1 grouped most of the variables which means that they were all correlated. The variable avoid electricity was not correlated with any factor.

Table 2. Factor analysis for screwdrivers.

Variables	Factor 1	Factor 2	Factor 3
Slippery	-0.083456	**0.716625**	0.195880
Good texture	0.101975	0.147067	**0.715924**
Good finishing	0.675110	0.249720	0.293075
Resistance of the tip	**0.880487**	0.210733	0.057598
Professional appearance	**0.874813**	0.181484	0.144000
Lightness	0.342647	**0.724955**	-0.063919
Good quality	**0.845411**	0.110035	0.246443
Resistance to break	**0.765881**	0.315760	0.144292
Good size	**0.810544**	0.176629	0.307647
Comfortable	**0.855840**	0.019468	0.232060
Modern	**0.897222**	0.066081	0.219449
Avoid electricity	0.429681	-0.161644	0.419178
Good appearance	**0.849971**	0.037902	0.209025
Good fitting with the screw	**0.820659**	-0.148279	0.126490
% of total variance	*53.27675*	*9.05964*	*7.47808*
Total variance	**69.82%**		

Factor 1 – Performance quality
Good finishing; Resistance of the tip; Professional appearance; Good quality; Resistance to break; Good size; Comfortable; Modern; Good appearance; Good fitting with the screw.

Factor 2 – Handling aspects
Slippery; Lightness;

Factor 3 – Texture
Good texture

Table 3 presents the FA results for vegetable peelers. Four factors were identified representing 65.75% of total variance. They were named as: 1) Comfort and easiness; 2) Visual quality; 3) Fragility and cleanliness; and 4) Performance. Some variables were not even moderately correlated to any factor and were not used in further analysis, as follows: durable; resistant; and safe.

Table 4 presents the FA results for staplers. Six factors were encountered representing 77.76% of the total variance. The factors were named as: 1) Safety; 2) Visual quality; 3) Easiness of use; 4) Performance; 5) Corrosion resistance; 6) Structure.

Table 3. Factor analysis for vegetable peelers.

Variables	Factor 1	Factor 2	Factor 3	Factor 4
Attractive	0.108842	**0.860698**	-0.092741	0.030366
Comfortable	0.591360	0.412564	0.105120	0.309277
Efficient	**0.912018**	0.096594	0.046905	-0.019954
Sharp	**0.883108**	0.083012	-0.029848	-0.156810
Durable	0.402196	0.479913	0.189683	0.382342
Heavy	-0.075989	0.301532	0.193583	0.509568
Resistant	0.243002	0.423510	0.098068	0.424742
Good handling	0.409220	0.259025	0.233004	0.683472
Effort demanding	-0.477303	-0.004024	-0.195582	0.538647
Safe	-0.122650	0.441334	0.441012	0.385933
Easy to use	**0.768289**	0.277137	0.155389	0.118672
Fragile	-0.188252	-0.020146	**-0.835082**	0.001384
Well-proportioned	0.203754	**0.846526**	0.001436	0.030439
Avoid accumulation of residuals	-0.125834	-0.075297	-0.131819	**0.820939**
Easy to clean	0.321661	0.422597	-0.604087	0.071441
Versatile	**0.791255**	0.070908	-0.107195	0.092845
% of total variance	*32.62361*	*16.50881*	*9.32969*	*7.29037*
Total variance	**65.75%**			

Factor 1 – Comfort and easiness
Comfortable; Efficient; Sharp; Easy to use; Versatile.

Factor 2 – Visual quality
Attractive; well-proportioned;

Factor 3 – Fragility and cleanliness
Fragile; Easy to clean

Factor 4 – Performance
Heavy; Good handling; Effort demanding; Avoid accumulation of residuals

Table 4. Factor analysis for staplers.

Variables	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6
Heavy	0.258274	0.136360	0.496307	0.019086	0.074905	0.659371
Robust	0.422709	0.282356	0.150792	0.130919	0.057254	0.667193
Good structure	-0.030059	-0.130030	**0.783908**	-0.066405	0.320127	0.116961
Durable	0.002358	0.416013	-0.190941	0.046548	-0.157739	-0.647860
Resistant to corrosion	-0.518338	0.230798	0.014296	0.024874	-0.600195	-0.404273
Avoid the staple to stick	0.438280	0.060702	0.403773	-0.008395	0.640901	-0.007008
Easy to switch the stapling type	0.374272	-0.134921	0.603266	0.307863	-0.290235	0.387127
Easy to use	0.139834	0.005117	**0.879838**	0.052874	-0.007465	0.098242
Easy to refill	**0.814493**	0.018118	-0.093946	0.248649	0.225910	0.047287
Safe to use	**0.900536**	-0.021242	0.132118	-0.031491	-0.041172	0.086791
Safe to refill	**0.925179**	-0.014506	0.134411	-0.128071	0.060653	0.103049
Safe to switch the stapling type	**0.725924**	0.122796	0.169229	0.148938	0.231208	0.242834
Stable	0.022263	-0.182327	-0.007494	**0.909504**	-0.053208	0.055993
Comfortable	-0.027348	**0.794823**	-0.154892	-0.172195	0.177579	0.075961
Modern	-0.048338	**0.860065**	-0.111479	0.049435	0.000262	0.017490
Finishing	0.105175	0.392282	0.041226	0.632375	0.510274	0.075862
Good appearance	0.132992	0.682484	0.347333	-0.203213	-0.339665	-0.054631
Efficient	-0.093792	-0.164712	0.301460	0.545188	-0.025563	-0.435524
% of total variance	*32.62361*	*16.50881*	*9.32969*	*7.29037*	*9.32969*	*7.29037*
Total variance	**77.76%**					

Factor 1 – Safety	**Factor 2 – Visual quality**	**Factor 3 – Easiness of use**	**Factor 4 - Performance**	**Factor 5 – Corrosion resistance**	**Factor 6 - Structure**
Easy to refill; Safe to use; Safe to refill; Safe to switch the stapling type	Comfortable; Modern; Good appearance	Good structure; Easy to switch the stapling type; Easy to use	Stable; Finishing; Efficient	Resistant to corrosion; Avoid the staple to stick.	Heavy; Robust; Durable;

Table 5 presents the FA results for paper punches. Six factors were identified representing 74.75% of the total variance. The factors were named as 1) handling quality; 2) resistance; 3) general quality; 4) easiness of use and efficiency; 5) safety and 6) performance attributes.

Table 5. Factor analysis for paper punches.

Variables	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6
Lightness	0.526469	-0.383686	0.463548	0.055825	0.159180	-0.086057
Efficiency	0.414318	0.059901	0.144677	0.687580	0.283450	0.138173
Efficacy	0.237075	0.081495	0.038619	**0.847627**	0.236626	0.120970
Effort demanding	-0.344172	0.048585	0.030646	0.054989	-0.023322	-0.733113
Precision of the perforation	0.176134	-0.097051	**0.742701**	0.057525	0.003565	-0.272625
Comfortable	**0.775413**	-0.018946	0.181002	0.258371	0.299770	0.126009
Sticks the paper during usage	-0.281318	0.397744	-0.050066	-0.359194	-0.151191	-0.556988
Attractive	0.054148	0.186395	**0.862438**	0.114390	0.150174	0.155693
Safe	-0.114090	0.067054	-0.147417	-0.086654	**-0.861715**	0.009311
Noisy	-0.106967	0.120337	-0.112663	-0.251074	-0.543723	-0.548619
Efficacy of the paper residuals compartment	-0.050950	0.429252	-0.184622	**0.704670**	0.128670	-0.131107
Modern	0.375037	0.054966	0.657211	0.274344	0.140358	0.169207
Resistant	0.056195	**0.896339**	0.060712	0.167452	0.090763	-0.111040
Durable	0.043364	**0.872447**	0.082036	0.165251	-0.202560	0.057930
Good handling	0.598151	-0.027813	0.205202	0.314734	-0.043612	0.462481
Slippery	0.183679	-0.189427	-0.031367	-0.271241	0.131129	-0.562744
Sharpness	0.256033	0.178956	0.001886	**0.794355**	0.033177	0.176531
Easy to empty the paper residuals compartment	0.048720	0.052334	0.328614	**0.787717**	-0.124912	0.058913
Easy to use	**0.844390**	0.149224	0.108902	0.253053	-0.031264	0.103708
Easy to clean	0.228772	0.049327	0.404586	**0.732013**	-0.092666	0.060143
% of total variance	*33.67908*	*14.18086*	*9.56836*	*6.44945*	*5.51368*	*5.18123*
Total variance	**74.57%**					

Factor 1 – handling quality	**Factor 2 – resistance**	**Factor 3 – general quality**	**Factor 4 – easiness of use and efficiency**	**Factor 5 – Safety**	**Factor 6 – performance attributes**
Lightness; Comfortable; Good handling; Easy to use	Resistant; Durable	Precision of the perforation; Attractive; Modern	Efficiency; Efficacy; Effort Demanding; Efficacy of the paper residuals compartment Sharpness; Easy to empty the paper residuals compartment	Safe	Sticks the paper during usage; Noisy; Slippery

The semantic profile identified varies considerably with the type o product. Some factor grouped variables with distinctive meanings. For example, variables related to appearance or aesthetics were correlated with performance aspects of the products, as for coffeemaker factor 1, screwdriver factor 1 and paper punches factor 3. For vegetable peelers, appearance attributes were isolated in one factor which indicates that the user noticed the aesthetic of the peeler as independent of performance or easiness attributes.

Another approach was to observe the influence of multisensory integration on the perception of the products. The Wilcoxon's test ($P \leq 0.05$) was applied in the comparison of the levels. In order to facilitate the presentation of the results due to the size of the sample, only the percentage of statistically significant differences found in the comparison of levels are shown.

On average, the multisensory integration causes changes in 35.4% of the scores of product evaluations. The results of this analysis are shown in Tables 6 to 10. In these tables, it is presented the percentage of significant changes that occurred by level comparison and in the right column (in grey) is presented the percentage of changes by product. For this latter measure was considered any change in the evaluation of the product independently on what level it was observed.

Table 6 presents the results for coffeemakers. Most of the changes occurred in the comparison of level 1 to level 3, that is, the visual evaluation in opposition to the post-use evaluation. The aspects of these products that have been more influenced by the multisensory integration were efficiency, easiness of use and easiness to open the jar. It is understandable that the users had to effectively use the product to have a more precise opinion about these mentioned aspects of the coffeemaker. However, other aspects that are also related to usage as 'resistant, safe and heavy' have not been influenced significantly by multisensory integration. The statistical tests due to sample size can only detect strong differences and then might have not been able to identify small changes (Cohen, 1992). Another possible answer is that users might have been able to predict these aspects only with the visual sense.

Table 6. Significant changes in variables scores due to multisensory integration on coffeemakers.

Semantic axes	Variables	Percentage of changes by level comparison 1 - 2	1 - 3	2 - 3	Percentage of changes by product
General quality	Good appearance	40%	40%	0	40%
	Efficient	0	60%	0	60%
	Good quality	0	20%	0	20%
	Resistant	0	0	0	-
	Safe	0	0	0	-
	Easy to remove the powder compartment	20%	40%	40%	40%
	Easy to remove the jar	40%	0	20%	60%
Easiness of use	Easy to use	20%	20%	0	40%
	Quick preparation of the coffee	0	80%	60%	80%
	Easy to clean the powder compartment	40%	20%	0	40%
	Easy to dose water/powder	0	20%	0	20%
Heaviness and cleanliness	Heavy	0	0	0	-
	Easy to clean the jar	0	60%	0	60%
	Easy to clean the body of the product	20%	20%	0	20%
	Total percentage of changes	**14%**	**29%**	**9%**	**34.3%**

In Table 7 are presented the results of multisensory integration for screwdrivers. Of all products, the screwdriver scores have presented the bigger percentage of changes. For this product, the majority of changes were obtained in the comparison of level 2 to level 3, that is, the manipulation in opposition to post use evaluation. Since it is essentially a hand tool, it is presumable that the users had to actually use or at least manipulate the screwdrivers to evaluate it properly.

Table 7. Significant changes in variables scores due to multisensory integration on screwdrivers.

Semantic axes	Variables	Percentage of changes by level comparison 1 - 2	1 - 3	2 - 3	Percentage of changes by product
Performance quality	Resistance of the tip	0	20%	80%	80%
	Professional appearance	20%	20%	80%	100%
	Good finishing	0	40%	100%	100%
	Good quality	20%	60%	40%	100%
	Resistance to break	0	0	20%	20%
	Good size	20%	100%	80%	100%
	Comfortable	0	60%	80%	80%
	Modern	0	60%	0	60%
	Good appearance	40	0	100%	100%
	Good fitting with the screw	0	100%	100%	100%
Handling aspects	Slippery	0	20%	0	20%
	Lightness	80%	100%	0	100%
Texture	Good texture	0	0	0	0
	Total percentage of changes	**16%**	**41%**	**57%**	**52,3%**

In Table 8 are presented the results of multisensory integration for vegetable peelers. These products showed the minor percentage of changes for all products. One possible explanation for this behavior is that all subjects recruited are users of this product and their previous experience might have lead to a better predictability of the variables. The semantic axe called Visual Quality, grouping the variables Attractive and well-proportioned, showed bigger changes with the multisensory integration than any other product attribute. It is an unexpected result since these aspects are traditionally related to the visual domain. One possible explanation is due to the contribution of other senses to compose the total perception of aesthetic, as stated by Grohmann *et al.* (2007). The authors studied the influence of tactile stimuli on consumer's perception of textile products and concluded that when touched, products can be better evaluated if they present good finishing or can be considered much worse if the tactile sense is not pleased.

Table 8. Significant changes in variables scores due to multisensory integration on vegetable peelers.

Semantic axes	Variables	Percentage of changes by level comparison 1 -2	1 -3	2 -3	Percentage of changes by product
Comfort and easiness	Comfortable	0	0	0	-
	Efficient	0	20%	20%	20%
	Sharp	0	20%	0	20%
	Easy to use	0	20%	0	20%
	Versatile	0	0	0	-
Visual quality	Attractive	40%	60%	0	60%
	Well-proportioned	40%	0	0	40%
Fragility and cleanliness	Fragile	0	0	0	-
	Easy to clean	20%	0	0	20%
Performance	Heavy	0	20%	0	20%
	Good handling	40%	0	0	20%
	Effort demanding	0	40%	20%	40%
	Avoid accumulation of residuals	20%	0	0	20%
	Total percentage of changes	**11%**	**11%**	**3%**	**21.5%**

Performance related aspects of the staplers have been greatly affected by the increase in sensitive senses (Table 9). The comparison of levels 1 to 3 and 2 to 3 were equal, resulting in 22% of changes. In all products, the easiness to switch the stapling type differed with the increase in sense modalities, indicating that the design of the product cannot give clues to the user to predict the usability of this particular function. The same result was found to the attribute finishing, which is closely related to the sense of touch and thus is more difficult to be assessed only with the visual domain. In opposition, attributes related to safety and visual quality were less affected by multisensory integration.

Table 9. Significant changes in variables scores due to multisensory integration on staplers.

Semantic axes	Variables	Percentage of changes by level comparison 1 - 2	1 - 3	2 - 3	Percentage of changes by product
Safety	Easy to refill	0	0	0	-
	Safe to use	20%	0	0	20%
	Safe to refill	40%	0	0	40%
	Safe to switch the stapling type	0	0	20%	20%
Visual quality	Comfortable	20%	0	20%	20%
	Modern	0	0	0	-
	Good appearance	0	0	0	-
Easiness of use	Good structure	0	0	0	-
	Easy to switch the stapling type	0	100%	100%	100%
	Easy to use	0	80%	20%	80%
Performance	Stable	0	0	0	-
	Finishing	80%	0	100%	100%
	Efficient	0	80%	80%	80%
Corrosion resistance	Resistant to corrosion	0	0	0	-
	Avoid the staple to stick	0	80%	20%	80%
Structure	Heavy	40%	60%	0	60%
	Robust	0	0	40%	40%
	Durable	20$	0	0	20%
	Total percentage of changes	**12%**	**22%**	**22%**	**36.7%**

Thirty-five percent of the paper punches attributes investigated was affected by the multisensory integration (Table 10). Most of the significant differences occurred in the comparison of level 1 and level 3(visual to multisensory).

The semantic axe denominated Resistance did not show statistical differences between trials. Again, one possible explanation is that users might have predicted these variables with the visual sense. The same result can be observed for the attractiveness of the paper punches. Other performance related attributes have changes for at least one product at one level.

Table 10. Significant changes in variables scores due to multisensory integration on paper punches.

Semantic axes	Variables	Percentage of changes by level comparison 1 - 2	1 - 3	2 - 3	Percentage of changes by product
Handling quality	Lightness	0	40%	0	40%
	Comfortable	20%	40%	20%	60%
	Good handling	0	0	20%	20%
	Easy to use	20%	20%	20%	40%
Resistance	Resistant	0	0	0	-
	Durable	0	0	0	-
General quality	Precision of the perforation	20%	40%	0	40%
	Attractive	0	0	0	-
	Modern	40%	40%	0	40%
Easiness of use and efficiency	Efficiency	20%	40%	20%	60%
	Efficacy	40%	20%	40%	60%
	Effort demanding	0	40%	20%	40%
	Efficacy of the paper residuals compartment	40%	40%	0	40%
	Sharpness	20%	40%	60%	60%
	Easy to empty the paper residuals compartment	20%	20%	20%	20%
	Easy to clean	20%	20%	0	20%
Safety	Safe	0	0	0	-
Performance attributes	Sticks the paper during usage	20%	20%	0	40%
	Noisy	20%	20%	20%	40%
	Slippery	0	40%	20%	60%
	Total percentage of changes	**14%**	**24%**	**15%**	**35.0%**

In general, the augment of sensory modalities changes the user's perception of 35.4% of the cases evaluated in this study. Most of the significant changes were obtained in the comparison of level 1 (visual) and level 3(multisensory), with one exception: the screwdriver. One possible explanation is that the cumulative changes were more significant in the comparison of level 1 to 3. Other comparison might have shown differences although this study was not able to identify.

It has been demonstrated that multisensory integration varies with the type of product. All products composing the sample of this studies presented high level of manual interaction with the user, demanding the use of at least the vision, touch and kinetics. Products with different levels of interaction such as television or table lamps can present different results.

CONCLUSIONS

Our results indicate that, in several ways, the multisensory integration affects the perception of the product and it counts for about one third misjudgment if only the visual channel is used. This is a very high percentage considering the amount of products sold every day in online stores or catalogues. Advances in augmented reality technology and interaction design are trying to create a more realistic shopping experience but still there is much to do in this field.

Another concern is the amount of studies in emotional design or user experience basing their results on online protocols to construct arguments concerning many aspects of user's perception. One example is the Kansei Engineering, with recent studies investing on the development of algorithms to better construct the assumption upon which the method is based. Further studies need to investigate the influence of multisensory integration on the construction of the semantic space of the Kansei Engineering.

Other aspects related to the user's perception were not considered in this study, such as user's characteristics or extrinsic aspects of the product, such as brand or user's preferences. However, it is not clear how these factors can be related to multisensory integration.

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