Quantitative Analysis of Cognitive Performance in Motion Graphic Design

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Abstract

Motion graphic design is a branch of information visual design.Based on questionnaires and the factor analysis of Statistics,this paper evaluated the hierarchy elements of motion graphic design through the cognitive performance of the three elected types of videos(from 9 selected sample).Furthermore, analysis of the design categories based on users' perspective; the weight ratio of each factor of design details in the cognitive process,and Set up visual data chart.The research is to provide a quantitative evaluation of motion graphic design methods and help to realize the value of cognitive analysis.
motion graphic design,quantitative analysis,cognitive performance,factor analysis

MG (motion graphic) is a comprehensive application of animation,graphic design,and information integration,a motion presentation of multiple senses which is a branch of information visual design (Krasner,2013).It could help people receive various active visual information in a short time and a limited physical space,and it is also increasing the power of memory about this MG video.The design methods of MG is a combination of several media,including graphics,photo,text,animation,video,audio interpretation,etc.Richard Wallman,the Father of information structure,once said:" The goal of information design is to empower its users"(Wurman,1989).The power comes from the quantity and quality of information.The designers can frame the means of broadcasting according to a specific target audience,make them obtain mass information from MG in a short time,and make the target audience interact with MG.

Analysis problems

MG design is a new type of information art design, though it has an animated expression form,it is a process of analysis and visual redesign of the whole information thinking,which needs to deeply understand the cognition and feeling of audiences when the designers start their designing.Therefore,it is essential to analyze the user's cognition performance.The "cognitive performance" here refers to the effect that the audiences receives objective information and subjective feeling from the design (Boff,Kaufman,& Thomas,1986).It covers that a few individuals receive information and ability when enjoying videos,such as vision,attention,memory,thinking,intellectual activities,etc.At present,in the earlier stage of MG design,few studied in quantitative analysis for the survey of the cognitive feelings.Most of design from a subjective decision of designers.

Research methods

A quantitative analysis method was used in this research,and the data are from the questionnaires.MG design elements are divided into four major categories according to information conveyed,visual design,motion effect,sound,specified into 31 detail

indexes,so that it is convenient for the tested crowd to choose and evaluate.The design and answering way will introduced in depth in the following part.Participating in the study were 30 adults,all of whom were college students.
When analyzing the data from questionnaires,factor analysis of Statistics was applied to complete the evaluation of cognitive performance.The factor analysis is to extract the primary or few influencing factors from several influencing factors to explain the effect on the results.Its main goal is to reduce variables and sum up them,and with this method,it is easier to figure out the characteristics of influencing factors.With this approach,MG design category based on users' perspective can be obtained,as well as the weight ratio of each element of design details in the cognitive process.

Research process

Video materials for the evaluation test

Influential MG design works were selected as video materials,and empirical studies carried on them.There was no stable model for MG design categories,so the video materials for evaluation was divided into three types:pure images,pictures & visual text,picture & Audio interpretation according to audiovisual elements.Such classification method based on element collocation and proportion,which might not result in ambiguity.

The first type:MG design in the expression of pure images.The central theme expressed by plane graphics,solid modeling,and physical images.There are few visual words or directive and illustrative statements and data drawing lists in the designs.They also have background music,while they do not have any oral narrations.Moreover,over 95% of the design is completed depending on images,graphic effects,and sound.

The second type:MG design in the combination of picture & visual words.The image content of this kind is mainly abstract images and solid modeling collocated with the key words.Visual words have motion effects,which play a significant role in the key guidance and inspiration for the readers.The Apple advertisement is a typical case in 2013,in which black-and-white abstract images collocated with the principal words were used to express the subject without any narrations.

The third type:MG design in the combination of picture & audio interpretation.This kind of design is expressed by visual animation collocated with audio description (narration).The scene is mainly expressed by vector graphic and data drawing list with narrative interpretation.This type of design is like expository writing which is concise,comprehensive,clear and easy to understand.
The description of the video material is shown in Figure 1:

type	number	Video information	Video screenshots
picture	1	Name=‘cosmo’ Style: black and white, engraving, concrete’ narrative Duration=2’40 keyword=Technology, space, spacecraft, time and space	
	2	Name=‘MUJI’ Style: black and white, simple strokes,concrete, narrative Duration=2’36 keyword=Home, christmas, combination, demolition	

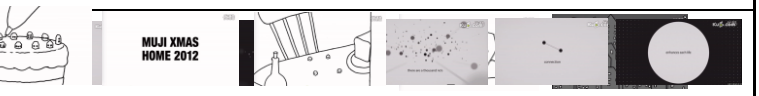
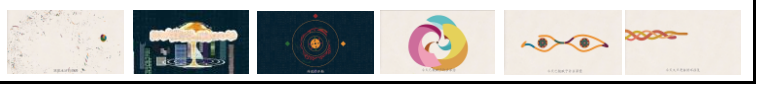
	3	Name="Apple 5c" Style: conceptualization, abstract, color Duration="9'37 keyword:Home, christmas, portfolio, demolition	
picture & visual words	4	Name="what is motion design" Style:Color, Mix and Match, abstract & concrete & image Duration="9'34 keyword:Space, 3d virtual space, origin, logo	
	5	Name="Apple ads" Style:Black and white, minimalist, flat Duration:1'30 keyword:Perfect, choice, feeling, love, contact, simplicity	
	6	Name="Video Surveillance" Style:color abstract & concrete flat Duration="1'17 keyword: time life Cherish	
picture & audio interpretation	7	Name="Haze" Style:Color cartoon concrete Duration:1'56 keyword:Haze, air pollution, hazards, disease, health	
	8	Name="N future" Style:Color abstract & concrete Duration:2'12 keyword:Zhejiang University, Faculty, Campus Life, Communication	
	9	Name="Every day is worth remembering" Style:color abstract & concrete Duration="1'17 keyword:time life everyday Cherish	

Figure 1:Video information in this research

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Subjects investigated were divided into two categories:one is with design basis (short for the grounded group below),juniors majored in industrial design and had learned something in graphic and animation design.The other is without design basis (short for the ungrounded group below),who had little knowledge in MG and seldom got in touch with the design.15 students were selected at random to answer the questionnaires.The tests were carried out for three times,and two of the tests were effective.45 samples collected,and 30 of them were effective.

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Weight questionnaires of MG design were used to investigate subjective perception and feelings of audiences on different design elements of vision,sound,motion effect when watching videos.Regarding vision,each element of MG was quantified in tables,and four one-class indexes,13 two-class indexes,and 31 three-class indexes listed as perceptual cues.Evaluated in the values from 1 to 10 points.Through data,trend analysis of users' experience feeling and weight order of each perceptual elements can obtained.Firstly,the analysis of the relative elements of GM design divided the evaluation indexes into information,vision,motion effect,sound.Then,according to these key words,conclude and extract users' evaluation indexes in this experiment.To avoid doubts arisen from subjects on the questionnaires,interpretative statements added to the third index in the survey.(Figure 2)

first-class index	second-class index	third-class indexes	interpretation
Information Communication	Problem representation	Information accuracy	Whether the theme is clear and logical
	Data collation	Integrity	Is the data complete and complete?
		effectiveness	The memory intensity of information
	Information understanding and resonance	Information easy to understand	Whether the message is easy to understand？
		duration	Is the duration of the animation satisfactory?
		Resonance	Is the message inspiring?
	Narration	speak speed	Is the speed of speech appropriate?
Visual design	element	abstract graphics	Geometric shapes,color blocks Visual effects feel?
		figurative graphics	How does the graphical visualization of a particular thing feel?
		picture	The actual photo shoot or picture,image visual effects
	color	overall effect	The overall color effect (color matching,color,etc.)
		color and light	Color and lighting effects
		the number of appropriate	Is the number of colors appropriate?
	graphic	aesthetic	The overall aesthetic of the graphic elements
		design method	Design style is good-looking,design approach is reasonable?
		constitute form	The combination of the various elements
	space	space effect	Elements in space before and after the relative position relationship
		base Ratio	Graphics and the proportion of the background
	word	color	color effect of word
		fonts	is beautiful?
		font size	The size of the word
		position	the position of the word
motion effect	motion graphic	frequency	Elements of the speed of movement
		special effects	The special effect of the picture
		sports mode	The trajectory and form of motion
	Transitions	lens movement	Push,pull,shake,shift……
		lens rhythm	The speed of the lens movement
		scene convergence	Whether the connection between scenes is reasonable?
music	Background music	compatibility	Is the music appropriate for the theme?
		rhythm	Is the rhythm of the music conforms to the graphic movement ？
	Sound effects	coordination	Special effects of sound and graphics movement coordination degree

Figure 2:Questionnaire information of MG design elements weight

Answering questionnaires

In the investigation,we extracted 30 students to carry out batch tests,15 persons each time,and each test lasted for two hours.In each test,questionnaires were first given to subjects,and they had about 3-5 minutes for scanning.Then nine videos were played in the order of clear images,pictures & visual words,picture & audio interpretation.Each type had three videos in different styles.Subjects were not told the video category when playing

them,which can reduce the interference of subjective information of designers to the subjects and make preparation for the research on design group in perspective of users.

The average length of videos is 2-3 minutes,and the longest one is about 9 minutes.Each video would play for three times.In the first time,subjects scanned it and made a preliminary impression in his mind; in the second time,the video would evaluate.Subjects could grade it depending on subjective impression; in the third time,unimpressive or uncertain information of the video would be implemented,and the grade would be perfected.During the test,subjects had finished grading basically in the second time.Through observation in the site,audiences were more interested in short videos,especially videos in 3 minutes.For those over 5 minutes,audiences might begin to show fatigue in various degrees,from which we can infer that the length of MG design is one of the factors influencing users' experience.Therefore,if a high expression is needed,segmented video or series design can be adopted.

Data analysis

The cognitive performance here refers to the effect of subjective information and objective feelings obtained by individuals in appreciating motion graphic design.It is divided into two parts; one is based on the comparison of MG design in users' perspective; the other one is the users' analysis of element thinking of design details in the cognition.

Analysis of MG design category based on users’ perspective

Design category from users' perspective can be obtained by factor analysis,which has an auxiliary effect on understanding users' visual feeling.Decide which quantity factor should be selected:according to the explanation of initial eigenvalue in the total variance table,estimate the factor quantity to be chosen,the number of those with >1 eigenvalue was the category quantity to be chosen.In the evaluation of grounded group,the number of those with >1 eigenvalue was 5.Therefore,five types should be chosen (Figure 3).In the evaluation of ungrounded group,the number of those with >1 eigenvalue was 6.Therefore,six types should be chosen (Figure 4).Also,the percentages accumulated by the first few factors in initial eigenvalue were 94.57% and 96.67%,which means these factors can be used to explain samples at 94.57% and 96.67%.In general,the larger the value is,the more representative and critical the chosen factors are.

Confirm the variables of each factor:according to the component matrix above,confirm variables of each factor and choose variables with large coefficient in each type.In this statistic,0.5 was set as a standard to choose variables (often choose variables over 0.4,but sometimes a larger variable can be chosen according to the actual situation).In the evaluation of grounded group,design elements larger than 0.5 among the five factors were 21,13,14,3,2.The fourth and fifth factor were eliminated for there were few design elements in them,so there were three results of the elements orders of all the effective factors.In the evaluation table of the ungrounded group,design elements larger than 0.5 among the six factors were 29,9,2,2,2,0.Therefore,the same as the grounded group,for there were few design elements in three to six elements,which did not match the induction conditions,three to six elements were eliminated.

According to effective factor variables,the statistic result showed:the cognition

category of the ungrounded group was divided into two:pure images and picture & visual words were combined into one type,which can be regarded as MG design in images and in audio interpretation.The cognition of the grounded group was the same as the three types pre-installed.Pictures collocated with visual words and pure images were regarded as images by the ungrounded group,while the grounded group have a better understanding and show more interests in images than the ungrounded group.The ungrounded group were more accustomed to learning through narrative interpretation.(Figure 5,6)

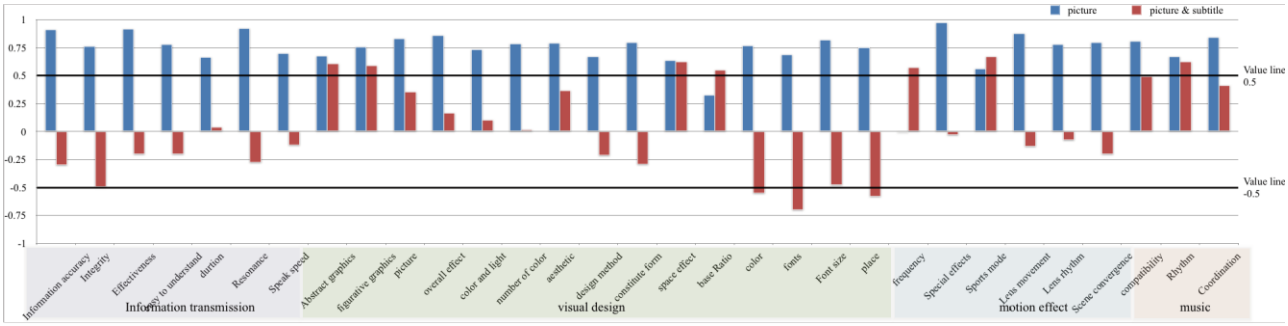

Figure 5:The evaluation values of each element from ungrounded group

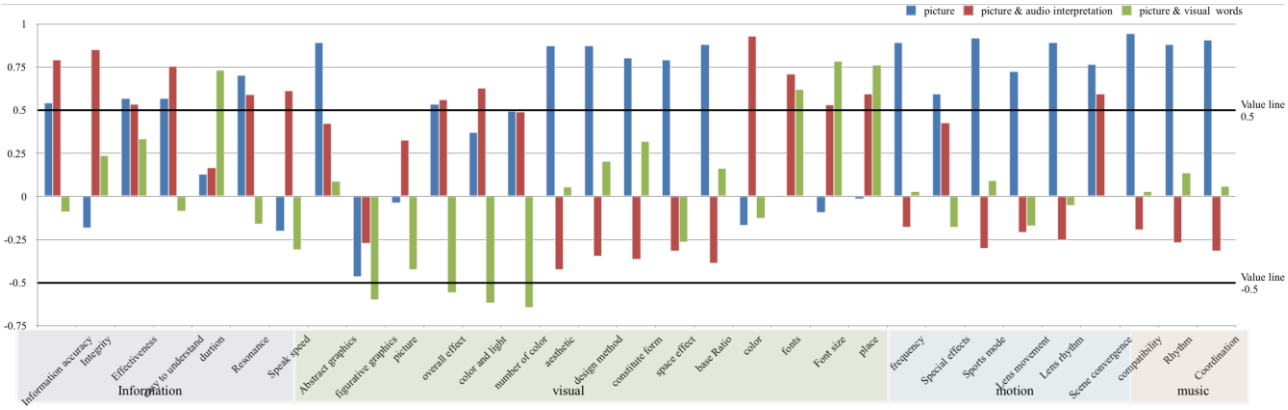

Figure 6:The evaluation values of each element from grounded group

Weight analysis of design elements in cognition

Through factor analysis,results can be found the grounded group and the ungrounded group had different ideas on MG design cognition category.Further,obtain the weight value of the three-class index in 3.1 and weight sum of one-class in 4 for the research on the element order of influencing users' experience.The larger the value and the higher the ranking of elements are,the more attractive they are to users,and users are satisfied with the design details.There is no definite ranking of elements,and statistics also showed that many elements were at a similar value.Sequencing them was only used for marking element level and assisting designers to consider the design.

	classification	element	Component matrix A	type 1 : picture	Absolute value	Sort	Weighted sum of square	type 2 : picture & audio interpretation	Absolute value	Sort	Weighted sum of square	type 3 : picture & visual words	Absolute value	Sort	Weighted sum of square
	Problem representation	Information accuracy	A1	0.543	0.543	19		0.793	0.793	3		-0.091	0.091	22	

Information	Data collation	Integrity	A2a	-0.184	0.184	24	2.694	0.851	0.851	2	4.303	0.236	0.236	13	1.644
		Effectiveness	A2b	0.569	0.569	17		0.534	0.534	12		0.336	0.336	10	
	Information understanding and resonance	Information easy to understand	A3a	0.568	0.568	18		0.753	0.753	4		-0.087	0.087	24	
		duration	A3b	0.129	0.129	26		0.166	0.166	31		0.733	0.733	3	
		Resonance	A3C	0.701	0.701	15		0.592	0.592	10		-0.161	0.161	18	
	Narration	Speak speed	A4		0	31		0.614	0.614	7			0	31	
visual design	element	overall effect	B1a	0.891	0.891	6	12.089	0.423	0.423	17	7.31	0.088	0.088	23	6.766
		Color and light	B1b	-0.464	0.464	22		-0.272	0.272	25		-0.600	0.600	7	
		The number of appropriate	B1c	-0.036	0.036	28		0.328	0.328	21		-0.424	0.424	9	
	color	Aesthetic	B2a	0.535	0.535	20		0.563	0.563	11		-0.558	0.558	8	
		design method	B2b	0.372	0.372	23		0.627	0.627	6		-0.618	0.618	6	
		Constitute form	B2c	0.496	0.496	21		0.489	0.489	14		-0.645	0.645	4	
	graphic	Space effect	B3a	0.874	0.874	9		-0.425	0.425	16		0.055	0.055	26	
		Base Ratio	B3b	0.874	0.874	9		-0.347	0.347	20		0.203	0.203	14	
		overall effect	B3c	0.805	0.805	11		-0.365	0.365	19		0.320	0.320	11	
	space	Color and light	B4a	0.791	0.791	12		-0.317	0.317	22		-0.264	0.264	12	
		The number of appropriate	B4b	0.880	0.880	8		-0.386	0.386	18		0.162	0.162	17	
	word	Aesthetic	B5a	-0.167	0.167	25		0.931	0.931	1		-0.128	0.128	20	
		design method	B5b	-0.003	0.003	30		0.711	0.711	5		0.622	0.622	5	
		Constitute form	B5c	-0.094	0.094	27		0.532	0.532	13		0.783	0.783	1	
		Space effect	B5d	-0.016	0.016	29		0.594	0.594	8		0.761	0.761	2	
motion effect	motion graphic	frequency	C1a	0.894	0.894	4	4.791	-0.179	0.179	30	1.965	0.030	0.030	29	0.535
		Special effects	C1b	0.595	0.595	16		0.428	0.428	15		-0.180	0.180	15	
		Sports mode	C1c	0.918	0.918	2		-0.302	0.302	24		0.093	0.093	21	
	Transitions	Lens movement	C2a	0.724	0.724	14		-0.208	0.208	28		-0.173	0.173	16	
		Lens rhythm	C2b	0.893	0.893	5		-0.255	0.255	27		-0.054	0.054	27	
		Scene convergence	C2c	0.767	0.767	13		0.593	0.593	9		-0.005	0.005	30	
music	Background music	compatibility	D1a	0.944	0.944	1	2.732	-0.193	0.193	29	0.777	0.031	0.031	28	0.228
		Rhythm	D1b	0.881	0.881	7		-0.267	0.267	26		0.139	0.139	19	
	Sound effects	Coordination	D2	0.907	0.907	3		-0.317	0.317	22		0.058	0.058	25	

Figure 7:Weight analysis on MG design element from grounded group

Result analysis:the first type:pure images.Elements of this kind with design value over 0.5 ranking in top 10 were:the fitness of music and subject,mode of exercise,harmony between music and graphic motion,frequency,lens rhythm,abstract images,music rhythm,figure base proportion,aesthetic and design techniques.The vision weight sum was 12.089,followed by the motion weight amount 4.791.Because camera movement and transitions of graphics are important design factors of matching images.Then the sound weight sum was 2.732,and the information conveys weight amount was 2.694.Users need to have a good understanding of figures and pictures towards this kind of design,but many users did not understand the intention of these design works,so the value of information convey ranked the fourth.

The second type:picture & audio interpretation.Elements of this type with design value over 0.5 ranking in top 10 were:the colors of words,completeness,information accuracy,the easiness to understand information,font,color and,light,speaking speed,position,scene cohesion,resonance.Vision convey weight sum was 7.31; information conveys weight amount was 4.303; motion effect weight sum was 1.965; sound design weight sum was 0.777.This type mainly focuses on audio interpretation,so there was a small proportion of vision.There were narrative descriptions,and information can be accepted quickly,so there were four elements about information understanding among the top ten elements,which means it was easy for users to understand the information,and there were little doubts.Therefore,narrative

interpretations played a major role in promoting the users' recognition and resonance,but regarding statistics,the attention of the users on figure design and motion effect transition design would be reduced for a little.

The third type:pictures & visual words.Vision convey weight sum was 6.766; information conveys weight amount was 1.644; motion effect weight sum was 1.555; sound design weight sum was 0.228.In this type,there were only eight design elements whose value was over 0.5:size of words,position,length,color number,fonts,concrete figures,overall effect.Among them,there were three elements about words and four about figures and images,which means when words are added as visual elements into design,creative design of words should be focused on.Therefore,it is the key to this type of design to collocate images and words with visual effects.

	classification	element	Component matrix A	type 1 : picture & audio interpretation	Absolute value	Sort	Weighted sum of square	type 2: picture、 picture & visual words	Absolute value	Sort	Weighted sum of square
Information Communication	Problem representat	Information accuracy	A1	0.909	0.909	4	5.656	-0.301	0.301	17	1.509
	Data collation	Integrity	A2	0.762	0.762	18		-0.494	0.494	12	
		Effectiveness	A3	0.917	0.917	3		-0.203	0.203	21	
	Information understanding and resonance	Information easy to understand	A4	0.782	0.782	15		-0.200	0.200	22	
		duration	A5	0.665	0.665	27		0.037	0.037	28	
		Resonance	A6	0.924	0.924	2		-0.274	0.274	19	
	Narration	Speak speed	A7	0.697	0.697	22			0	31	
visual design	element	overall effect	A8	0.676	0.676	24	10.89	0.605	0.605	5	6.182
		Color and light	A9	0.757	0.757	19		0.592	0.592	6	
		The number of appropriate	A10	0.833	0.833	8		0.352	0.352	16	
	color	Aesthetic	A11	0.859	0.859	6		0.164	0.164	24	
		design method	A12	0.734	0.734	21		0.100	0.100	26	
		Constitute form	A13	0.784	0.784	14		0.014	0.014	30	
	graphic	Space effect	A14	0.792	0.792	13		0.364	0.364	15	
		Base Ratio	A15	0.673	0.673	25		-0.212	0.212	20	
		overall effect	A16	0.799	0.799	11		-0.295	0.295	18	
	space	Color and light	A17	0.633	0.633	28		0.625	0.625	4	
		The number of appropriate	A18	0.326	0.326	30		0.550	0.550	10	
	word	Aesthetic	A19	0.767	0.767	17		-0.551	0.551	9	
		design method	A20	0.688	0.688	23		-0.702	0.702	1	
		Constitute form	A21	0.820	0.820	9		-0.475	0.475	13	
		Space effect	A22	0.749	0.749	20		-0.581	0.581	7	
motion effect	motion graphic	frequency	A23	-0.005	0.005	31	3.994	0.572	0.572	8	1.682
		Special effects	A24	0.975	0.975	1		-0.032	0.032	29	
		Sports mode	A25	0.560	0.560	29		0.670	0.670	2	
	Transitions	Lens movement	A26	0.879	0.879	5		-0.134	0.134	25	
		Lens rhythm	A27	0.778	0.778	16		-0.074	0.074	27	
		Scene convergence	A28	0.797	0.797	12		-0.200	0.200	22	
music	Background music	compatibility	A29	0.810	0.810	10	2.319	0.495	0.495	11	1.536
		Rhythm	A30	0.669	0.669	26		0.626	0.626	3	
	Sound effects	Coordination	A31	0.840	0.840	7		0.415	0.415	14	

Figure 8:Weight value analysis of each MG design elements from ungrounded group

Results:the first type:picture & audio interpretation.Design elements with over 0.5 value ranking in top ten were:special effects,resonance,effectiveness,information accuracy,lens movement,the overall effect,the coordination of music and graphics

movement,pictures,word size,fitness between music and theme.Visual convey weight sum was 10.89; information convey amount was 5.656; motion effect weight sum was 3.994; sound weight sum was 2.319.

The second type:pure images and picture & visual words.Design elements with over 0.5 value ranking in top ten were:font,mode of exercise,sound rhythm,space effect,abstract figure,concrete figure,font position,frequency,the proportion of image base,font color.The convey weight sum was 6.182; motion effect weight amount was 1.682; information conveys weight sum was 1.509; sound weight sum was 1.536.

The results showed that the values of resonance,effectiveness,and data accuracy were high in MG design with narrations,which means users accepted this type very much; there were few doubts in answering questionnaires; users made an excellent oral evaluation of it.Therefore,if narrations are adopted in the design,figure creation can be simplified.The second type designs and design & visual words were analyzed through users' perspective.From the top ten elements,a conclusion can be drawn that sound,motion effect and,color collocation are needed for picture and image design.Only when a complete visual system is formed can the design intention be expressed.Therefore,this kind of music and graphics transitions are also the key to design.

According to the weighted sum obtained above,adopt a pie chart to express the four one-class index proportion of the two groups of users,which can present the ratio of different kinds of MG design elements more clearly.(Figure 9,10,11,12,13)

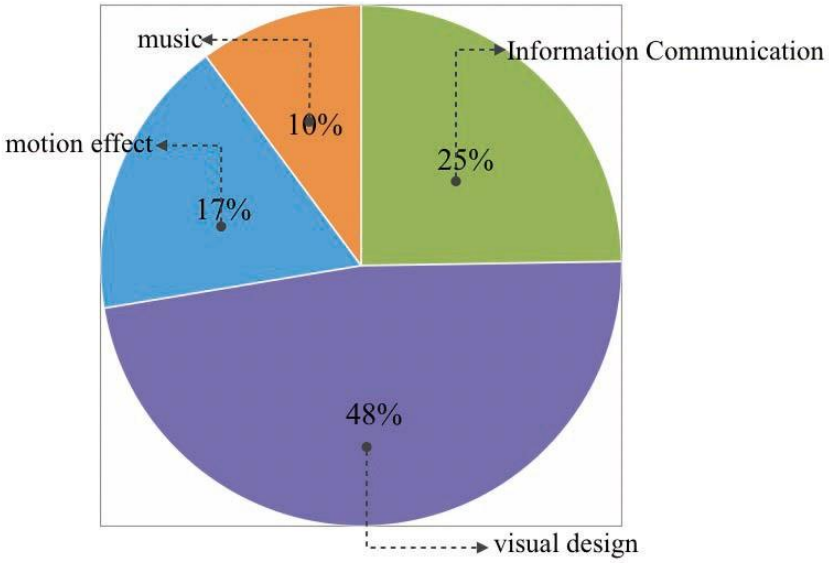

Figure 9：weight analysis of each element experience from ungrounded group：picture & audio interpretation

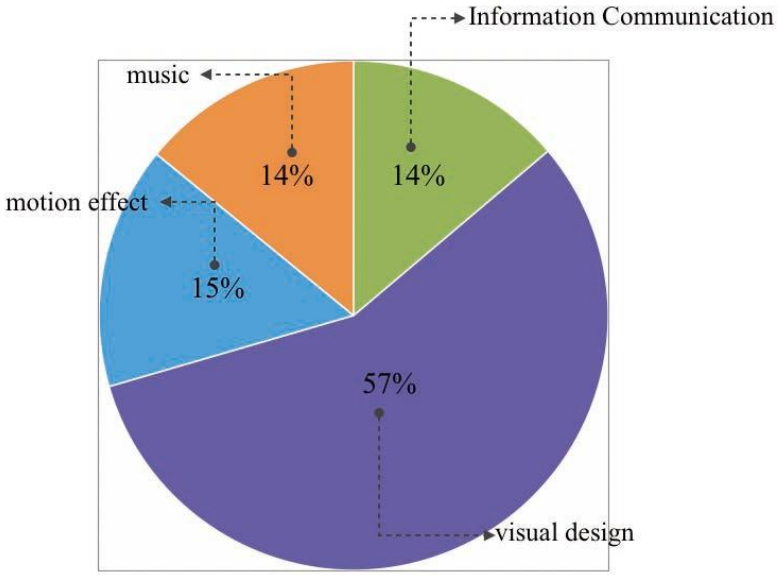

Figure 10 ⊏ weight analysis of each element experience from ungrounded group ⊏ picture ◢ picture & visual words

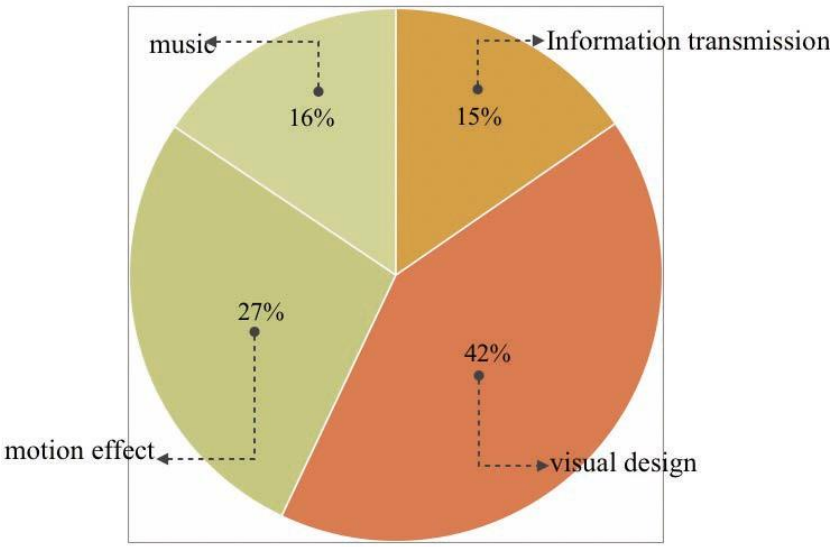

Figure 11：weight analysis of each element experience from grounded group：picture

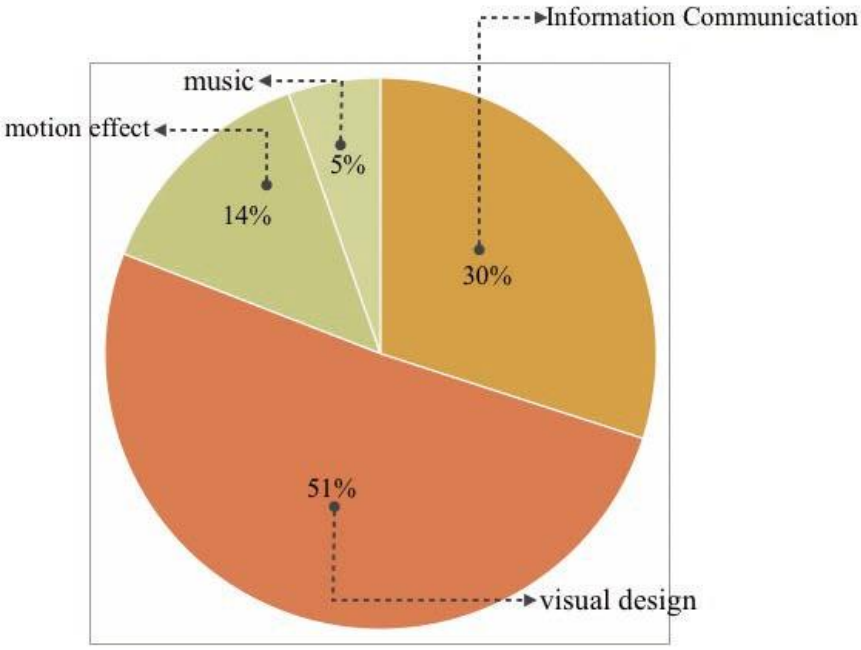

Figure 12 ⊏ weight analysis of each element experience from grounded group ⊏ picture & audio interpretation

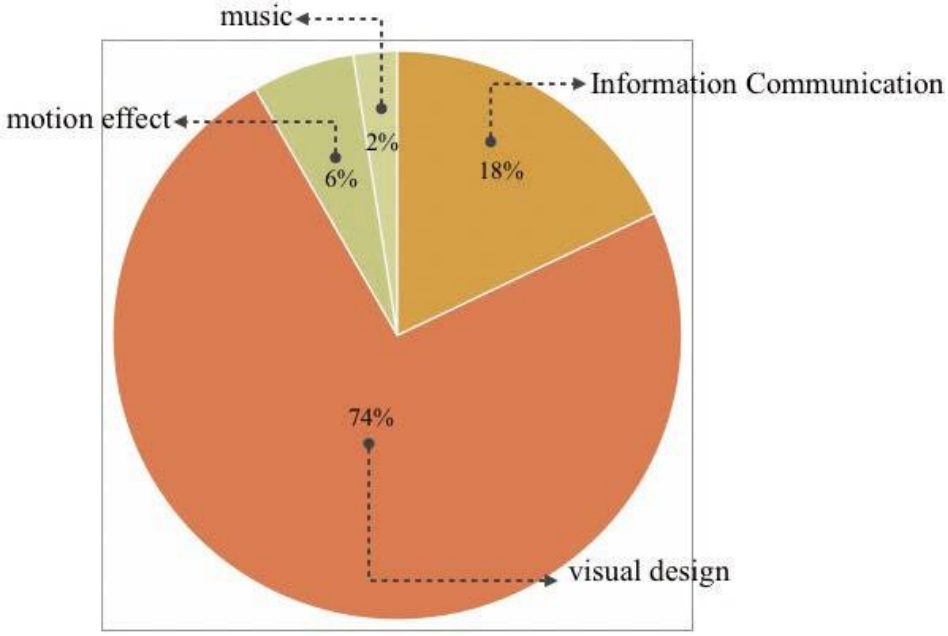

Figure 13 ⊏ weight analysis of each element experience from grounded group ⊏ picture & visual words

Result and discussion

MG design is one of information visual design.Visual design elements have many detail elements in the 31 three-indexes,which takes the largest proportion in the experienced weight of the two groups.Therefore,figures and images always play an important role in the expression of design intention.The information conveys effectiveness of the picture & visual words type of grounded group increased to 18%,and sound and motion effect took a total account of 6%,which means the creative design of keywords had an evident effect on the scene understanding and attention of

users.The information conveys ratios of the two groups in picture & audio interpretation were 30% and 25%,which means both of the two groups had excellent information accuracy and resonance and could easily understand the problems explained in the video.This type of design is simple and easy to be understood,but the visual feeling will be reduced.Therefore,it would be the best to adopt concrete modeling to express the subject.If the design is intended to apply abstract figures to make users produce associations or be attractive by the visual impact of the scene,it would be the best to design with pure images and few visual words collocated with images.The type with the highest sound ratio of the two groups was pure images with 16% of the grounded group and 14% of the ungrounded group,which means the type of pure images has the highest requirements on sound design,and users will apprehend problems in a combination of watching and listening.

Conclusion

The main limitation of this study there were not so many subjects,and these subjects share a similar background.In the later tests,the number of subjects with different background can be increased.MG design is not only a single visual convey or animated design anymore,but is user-centered and focuses on information visual design of users' experience.In the early stage of design,motion graphic designer needs quantitative analysis to reorganize information,explore its value and comprehend the real intention of users.Constantly further researches on quantification analyies and test methods are needed in this field.Statistics analysis of this project was based on the data from questionnaires,and the data also provided significant information for design.

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