**Master Thesis**

# 'Multisensory Shopping Experience'

Applied Cognitive Psychology II

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**Abstract** When thinking of a shopping environment, products are presented in the most attractive way. This is often accomplished by presenting stimulation to a multitude of our sensory modalities. According to the literature, rhythmical synchronization of sound and vision results in an increase of attention (Van der Burg, Olivers, Bronkhorst, Theeuwes, 2008). We were interested in finding an effect for multisensory stimulation. We tested if participants had a preference for a location where multisensory stimulation took place. We hypothesize that the conditions with multisensory stimulation will result in increased subjective attention for that location. We also hypothesize congruent multisensory stimulation will score higher on likeability compared to incongruent multisensory stimulation.

We created a 3x2 factorial design. Light and sound were our independent variables. We manipulated the intensity and the frequency of light. Factor light contained three levels, 3 seconds (0.33 Hz), 5 seconds (0.2 Hz) and static light. We also manipulated the intensity and the frequency of our sound. Factor sound contained two levels, 3 seconds (0.33 Hz) and 5 seconds (0.2 Hz). Congruency was obtained by presenting the frequency of the light and the sound in the same phase. For incongruency light and sound were presented in a different frequency.

From our main experiment we cannot conclude or disapprove if participants have a preference for a location where (congruent) multisensory stimulation took place. From our questions regarding attention we can conclude that our dynamic light conditions result in increased subjective attention, independent of sound. If a shop wants to use a dynamic light to attract attention it is advisable to use a light with a high frequency, making it highly noticeable compared to static light. Congruent multisensory conditions scored higher on likeability. If a shop were to make use of multisensory stimulation (sound combined with light) to attract attention to their products it is advisable to make these multisensory patterns congruent compared to incongruent.


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## Introduction

The context of this project is situated around the shopping experience of customers. When thinking of a shopping environment, products are presented in the most attractive way. This is often accomplished by presenting stimulation to a multitude of our sensory modalities. Product brands try to stand out from the crowd by using uniquely shaped packaging, the use of different colors and even the music and sounds being played in a store. Our brains are continuously bombarded with all these different stimuli in the shopping environment, this is problematic because our brain is unable to simultaneously detect and identify all targets of interest in our visual field. Instead of shutting down, our brain is able to deal with this excess of input through the use of attentional mechanisms. These mechanisms enable us to make a selection of the stimuli in a cluttered environment that seem relevant to us. These stimuli are visually salient, and will be processed further. Seen from an evolutionary perspective this means we are able to rapidly detect certain prey, mates or threats in our visual environment (Itti and Koch, 2001).

Attention takes the role as a gatekeeper selecting stimulations from the outside world which then enter our visual information processing system, resulting in consciousness of these stimuli and conversely a suppression of other stimuli (Treue, 2003). Is it possible to influence this selection, attending people to certain products that they will conversely consider buying?

From the literature (van Ee et al., 2009), it is known that multisensory rhythm can act as a mechanism for attentional control over perceptual selection. In a situation with perceptual ambiguity (e.g. competing auditory and competing visual stimuli), attentional control is enhanced for those percepts that have cross-modal congruency. When for example auditory and visual stimuli behave in rhythmical synchronization, there is more “proof” for this perceptual interpretation due to the cross-modal congruency, compared to the situation when those stimuli are temporally desynchronized. We expect it to be possible to attract attention through the use of congruent multisensory signals as a form of stimulus-driven capture (Yantis, 1993).

Multisensory signals are integrated by multisensory neurons we possess. These neurons have the ability to react to more than one of our senses. Vision and audition is such an integration. If we direct our attention to a stimulus that matches a cell's preferences an increased firing rate was measured (True, 2001). This also holds true for the multisensory stimulation. A lot of research has been done on animals by Meredith and Stein (1986; 1993; 1996). When forms of multisensory stimulation were presented to cats, there was a higher response detected in the superior colliculus compared to the response from both unimodal stimuli (Meredith and Stein, 1993). Attention to multisensory stimulation leads to increased fire rates of cells that prefer multisensory stimulation. In their animal research Meredith and Stein (1993) further identified several key principles for multisensory integration to occur, most importantly, for integration to occur stimuli should match temporally and spatially.

Frassinetti, Pavani and Làdavas (2002) ran numerous tests and discovered that humans possess a similar integrated visuoauditory system and that the key principles Meredith and Stein discovered also apply to us.

From previous research we know multisensory bottom-up processes have the ability to capture our attention (Van der Burg, Olivers, Bronkhorst, Theeuwes, 2008). For this research we are interested in drawing attention bottom-up through the use of salience. There are a lot of studies that describe the efficiency with which salience helps in visual search tasks (Egeth and Yantis, 1997). In this experiment we are not interested in visual search per se, but rather in involuntary attention capture that is not seen as too intrusive. If a stimulus is salient enough, differing enough from its background and context, it has the ability to pop out and automatically attract attention (Itti and Koch, 2001). Visual salience starts with certain low-level visual features, for instance colour, orientation, motion, size, abrupt onset and offset (itti and Koch, 2001; Yantis, 1993; Wolfe and Horowitz, 2004). With these low-level features we can think of numerous ways to achieve visual salience, from sirens to alarm bells, flashing lights to neon colored lights, fast moving objects, just to name a few. One thing these stimuli have in common is that they have the tendency to be perceived as annoying, stressful, and intrusive.

Our aim is to control attentional selection of products in a subtle way. The challenge lies in attracting attention in a way that is not perceived as annoying. We will investigate this by recreating a shopping experience in a lab. In this lab we will be using multisensory stimulation. Light will be combined with sound to try and catch the attention of participants. Based on multisensory research findings, we will test if we are able to attract attention of customers to a product or placement option of a product when sound and light are synchronously presented as opposed to when these are not synchronized.

**Purpose/Hypothesis**

According to the literature, rhythmical synchronization of sound and vision results in an increase of attention (Van der Burg, Olivers, Bronkhorst, Theeuwes, 2008). We hypothesize that the condition with sound and light in synchronization will result in increased attention (engagement) for that product and potentially also a higher attractiveness to buy the product.

Is it possible to subtly increase attention through the use of multisensory stimulation? When asked where participants think products will sell better, will people prefer product placement on locations that have congruent multisensory stimulation? We started with a pilot-test to test the light and sound stimuli we created.

### Pilot-test 1

## Method

### Participants

Five subjects participated in the second pilot-test, one female and four males. Age ranged from 18 to 26, with a mean age of 24. Four out of five participants were right handed. Participants were recruited from the Philips Research intern population. For this test we used a within-subjects design.

### Materials

To investigate our hypothesis we built and decorated a laboratory room to look like a shop (Shop Lab). We did this to provide an experience that resembles a real shopping experience. The room measured 4.03m x 3.34m x 2.80m.

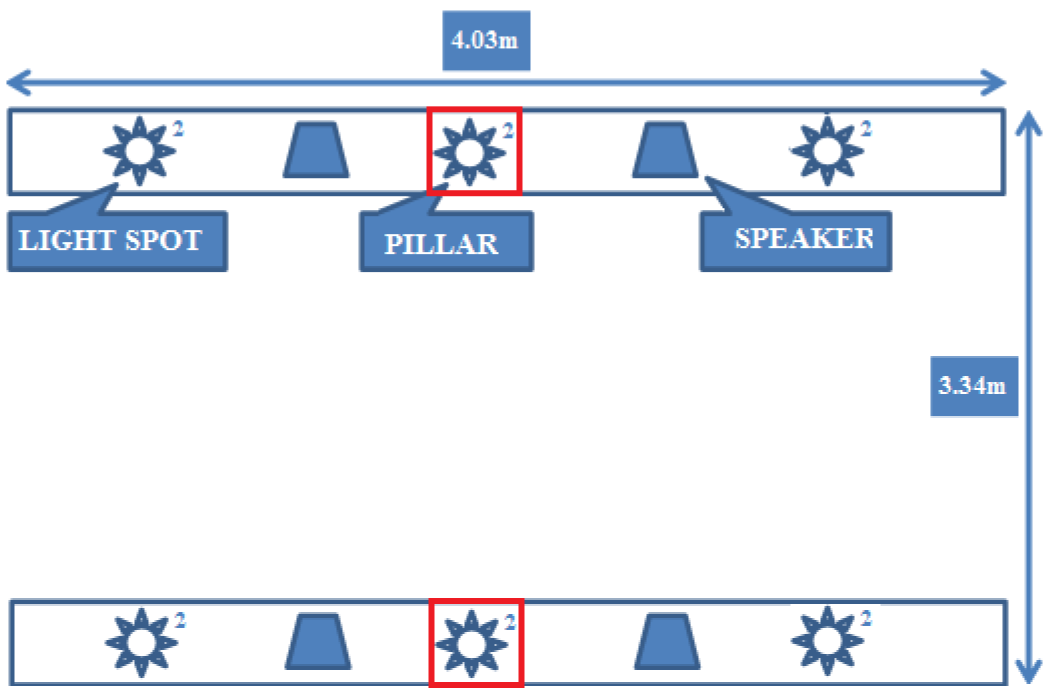


*figure 1. Schematic top view of the room.*

Black drapes hung on each side of the room effectively sealing the room and preventing external light from coming into the room. The two overhead length beams in the setup measured 2.84m in length, each beam contained 6 light spots and 2 speakers. The orientation of the spots could be adjusted, the speakers were fixed in place. On each side, under the middle spots, a pillar was placed to put a product on.

Props were placed in the room to make the room look less like an experimental room. Two small bird statues, two fake plants, two white chairs and one white table placed in the middle of the room. The props were mirrored on the left and right side of the room, to create an identical layout.

To control the speakers and the light spots we created software in LabView. The six spots could be controlled in pairs (intensity, rhythm, on/off). Three different conditions were tested: congruent, incongruent and a control condition. For all conditions the two outer light spots on each side had a fixed brightness level, 375 lm, to illuminate the room. A typical ringtone from a mobile phone was used as a sound. For the congruent condition, the middle light spots were varied in brightness at the same frequency as the sound (5 seconds, 0.2 Hz). For the incongruent condition, the middle light spots were varied in brightness at a higher frequency than the sound (3 seconds, 0.33 Hz). For the control condition, the middle spots were static in brightness level.

In the congruent and the incongruent condition the middle two spots would flash abruptly. The minimum value of the light was 375 lm, when the spot flashed the intensity rose to 500 lm. For the control condition all six spots would shine at 375 lm intensity. Sound was measured and had a minimum value of 45 dB and went up to a maximum value of 60 dB. Sound came from both sides of the room. We decided to do this because participants noted in previous pilot-test that no matter on what side of the room they were, they were able to hear the sound.

**Design**

We measured on which side of the room participants placed a product, left or right. Light was our independent variable, we manipulated the frequency of the lamps at the left and right side. We created three conditions. The frequency of the light and sound were identical (congruent), the frequency of the light and sound would not match each other (incongruent) and light would be continuous in intensity (control). Sound was not varied, it had the same frequency in all of the conditions. For each trial, two of the three conditions would be presented simultaneously to the participant, one on the left side and one on the right side of the Shop Lab.

In this pilot-test we conducted three trials for each participant. We compared congruent versus control and incongruent versus control and congruent versus incongruent. The dependent variables were the selection of the participant for one of two audiovisual conditions, and a questionnaire about the participant's preferences. Participants indicated their preferences on a 7-point scale with 1 corresponding to low and 7 corresponding to high. The questionnaire also had open-ended questions about what people liked and disliked about the light and sound settings, to get an indication for preferences of each condition opposed to just the selection of a condition. To see the questionnaire refer to Appendix p.35.

### Procedure

After entering the Shop Lab and taking a seat the experimenter explained the task to the participant. After this the participant was asked to read and sign the informed consent. The participant was given the task of shopkeeper and handed a product he had to sell. The participant had to place an object on either the left or right side of the room. He had to choose the side in which he thought the product looked the most appealing. The participant was informed he could place the object on each of the pedestals for as long and often as he wished, so he could see what it looked like. After he had made a choice the participant had to leave the product on the chosen pedestal and exit the Shop Lab to fill in the questionnaire about their preferences. In the meantime, the experimenter changed the light settings in the Shop Lab. When the questionnaire was completed, the participant repeated the same task, this time under different conditions. This was repeated three times for each participant. When the third questionnaire was completed the test was over.

### Results

In our test, we found that when participants were faced with the choice between the congruent and control condition, 40% of the choices participants placed the products on the side of the shop that had congruent audiovisual stimuli, 60% of the choices participants chose the control (static light) condition. The incongruent condition was never chosen, this led to a 100% choice rate for the congruent and control condition when they competed with the incongruent condition.

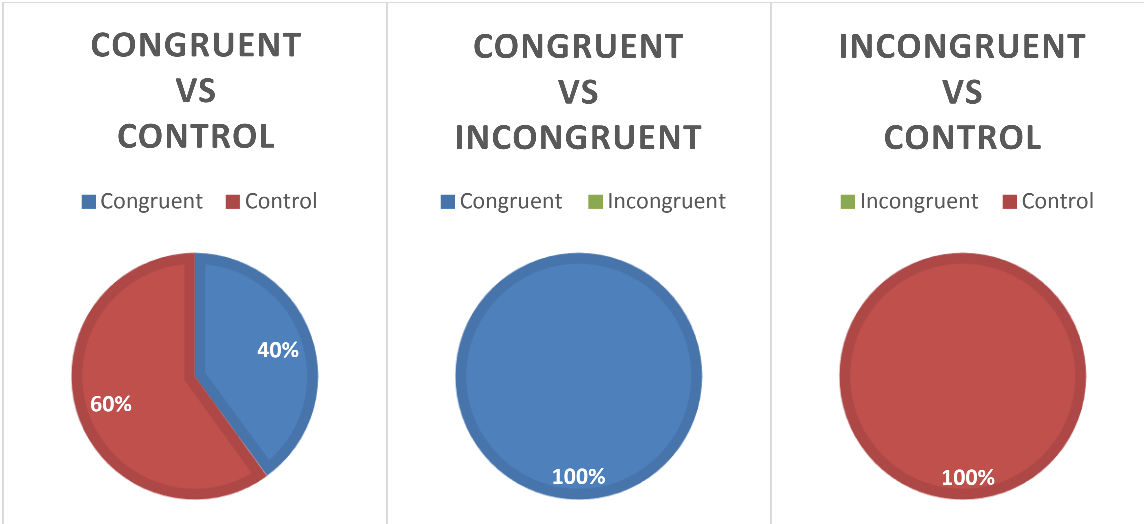


*figure 2. Participants preferred conditions as a percentage.*

After making a choice for a preferred condition, the participants filled in a questionnaire (see Appendix p.35). The scale for the questionnaire goes from 1-7 with 1 indicating low and 7 indicating high. Participant's ratings for the congruent versus the incongruent versus the control condition were taken together according to the choice of the participant, and then the median was taken (see figure 3). There is no score for the incongruent condition because this condition was not chosen by the participants (see figure 2, pie chart 2 and 3, 0% chose incongruent).

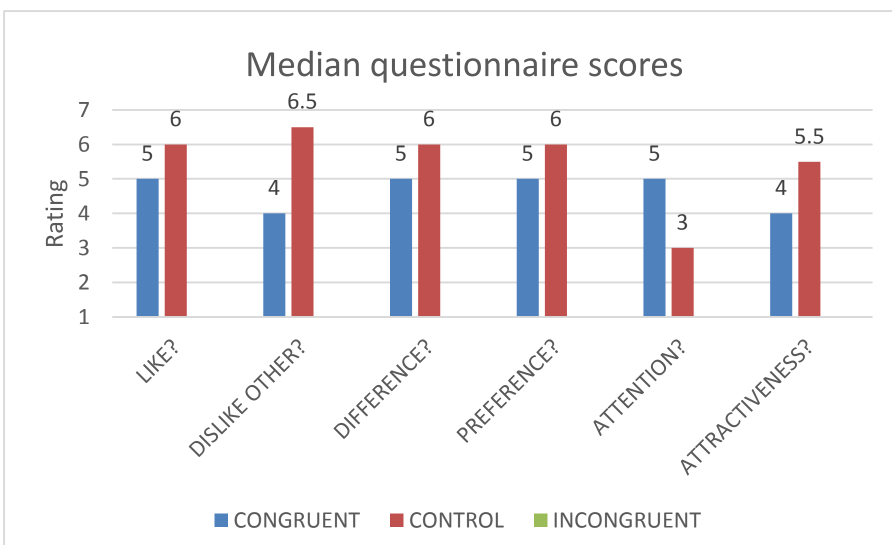


*figure 3. Median value for each separate question from our questionnaire.*

### Conclusions

These results indicate that participants prefer congruent condition of audiovisual stimuli above our incongruent condition of audiovisual stimuli.  However, participants did not always prefer dynamics above non-dynamic, our continuously stable condition was chosen in 60% of the trials congruent versus control.  Attractiveness and likeability scored higher for the control condition compared to the congruent condition.  However, when participants were asked which audiovisual setting would trigger the most attention towards the product, participants would answer that the dynamic stimuli had the biggest effect.

## Discussion

From the open-ended questions we noticed the light flash was seen as distracting, broken, or 'simply too much'. Given that participants preferred the non-dynamic control condition in at least half of the trials we conclude we have to make our congruent condition more appealing than our control condition. For our next experiment we changed the light flash to a sine-shaped light pattern, making the transition less abrupt. We thought this would be perceived as less annoying and still have the ability to attract attention. From the open ended questions we gathered the sound stimulus was seen as annoying, stressful, or deemed too loud. For the experiment we will change our sound to a more relaxing sound, a waterfall. This sound will also follow a sine-shaped pattern.

It is important to note that attention should not be drawn to the source of the light but to the product that appears in the light source. This is why we decided the dynamic stimulation should come from the location of the product instead of the overhead spots. We noticed some participants looking upwards when the overhead light spots were flashing. Because of this we plan to create light spots that display the dynamic light coming from the inside of the columns.

### Experiment 1

We were interested in finding an effect for multisensory stimulation. We tested if participants had a preference for a location where (congruent) multisensory stimulation took place. We hypothesize that the conditions with multisensory stimulation will result in increased subjective attention (engagement) for that location. We also hypothesize congruent multisensory stimulation will score higher on likeability compared to incongruent multisensory stimulation.

## Method

### Participants

We tested two groups in this experiment. Participants were recruited from the Philips Research intern population. We used a mixed design. Our light conditions were tested within-subjects, our sound conditions were tested between subjects.

Group one contained twelve subjects, seven females and five males. Two participants were removed from this group, one because the participant failed to understand the instructions and only chose the right most column and evaluated it the same independent of the light condition. The other participant was removed because he was not consistent throughout the trials, halfway the experiment he started answering all the questions regarding likeability and attention with 1. Age ranged from 22 to 35, with a mean age of 25. Seven out of ten participants were right handed.

Group two contained thirteen subjects, four females and nine males. Three participants had to be removed from analysis. One because the participant failed to understand the instructions and only chose the right most column and evaluated it the same independent of the light condition.

Another participant was not consistent on his likeability and attention answers and for the final participant we learned from the open ended questions he based all his questionnaire responses on the overhead lights that were identical across conditions. Age ranged from 22 to 29, with a mean age of 25. Two out of eight participants were left-handed. Participants were recruited from the Philips Research intern population.

### Materials

To investigate our hypothesis we changed the layout of our Shop Lab. On the right side of the room beneath the right length beam we positioned three columns at equal distance next to each other. Each column was placed beneath an overhead light spot. We integrated light spots inside each of the columns, these light spots would point upwards. The columns measured 50cm x 50cm x 100cm and were labeled A, B and C. The top of the column was made out of identical plastic diffuse layers that would distribute the light coming from the inside spots.

With this setup we were able to display three different light streams at the same time. On the right side of the Shop Lab three of the six overhead light spots were turned on at a fixed level, one spot to illuminate each column plus the room. On the left side of the room beneath the overhead beam we placed a table with a chair for the participant to fill out the questionnaires in between the trials. On this side the middle overhead spots were turned on to illuminate the desk, the rest of the spots were turned off.

We also changed our questionnaire. We selected the questions, from pilot-test 1, we deemed most important. These were the questions regarding likeability and attention. We decided to repeat these questions for each individual column, to get a better understanding of what participants found of each individual light condition (see Appendix p.35).

*figure 4. From left to right, the three columns; top of a column; table plus chairs where the participant filled out the questionnaire.*

We recreated the three different conditions we used in pilot-test 1: congruent, incongruent and control.  At first we wanted to use phase differences for our different conditions but participants had difficulty noticing the phase difference in a previous pilot-test (see Appendix p.27).  This is why we decided to use different frequencies for our conditions.

Light spots would follow a sine-shaped light pattern of either 5 seconds (0.2 Hz), 3 seconds (0.33 Hz) or would remain static.  The sine-shaped lights minimum value was 50 lm, the maximum value was 500 lm, the pattern was set to repeat.  For the control condition the light inside of the column would remain static and was set to 500 lm.

Sound would follow an identical sine-shaped pattern of either 5 seconds (0.2 Hz) or 3 seconds (0.33 Hz) and was also set to repeat. Sound was measured and had a minimum value of 45 dB and went up to a maximum value of 60 dB. Sound came from one side of the room, the right side, where the columns were positioned.

The software we used to setup and interact with the different speakers and light spots was programmed in LabView.

### Design

We conducted more pilot-tests that can be viewed in the Appendix p.30. From these pilot-tests we decided to setup a 3x2 factorial design. Light and sound were our independent variables. We manipulated the intensity and the frequency of each lamp in our different columns. Factor light contained three levels, 3 seconds (0.33 Hz), 5 seconds (0.2 Hz) and static light. We chose these light frequencies because the difference between these conditions were very noticeable (see Appendix p.33). Light was measured within-subjects.

We also manipulated the intensity and the frequency of our sound speakers. Factor sound contained two levels, 3 seconds (0.33 Hz) and 5 seconds (0.2 Hz). We chose these sound frequencies to match our light frequencies. Sound was measured between-subjects.

In our ‘congruent column condition’, synchronization was obtained by presenting the frequency of the light and the sound in the same phase. For our ‘incongruent column condition light and sound were presented in a different frequency. On the ‘control column condition’, light was presented continuously at a fixed value (500 lm), the maximum value the light would reach in the dynamic conditions.

For group 1 the frequency of the light and sound were identical (congruent) for the 5 second (0.2 Hz) pattern, the frequency of the light and sound would not match each other (incongruent) for the 3 second (0.33 Hz) pattern. For group 2 the frequency of the light and sound were identical (congruent) for the 3 second (0.33 Hz) pattern, the frequency of the light and sound would not match each other (incongruent) for the 5 second (0.2 Hz) pattern.

In each trial of our experiment one column would be congruent, one would be incongruent and hence the third would be control.

**Procedure**

Participants were seated in front of a table, on the left side of the room, inside of the Shop Lab. The experimenter explained what the experiment consisted of and handed the participant the informed consent to read and sign. The participant had to decide on which of the three columns the object looked more attractive, would sell better or faster. The three columns were identical in appearance, the only thing that differed was the frequency of the light coming from inside of them when compared to the frequency of the audio coming from the overhead speakers. Every trial the participants had to select a column they preferred, plus rate each column on likeability and attention.

In this experiment there was an apple on top of every column. Participants were informed they were allowed to envision any product they wanted instead of an apple. In front of the columns we placed a line that the participants had to stand behind at all times. Each session started with the participant standing in front of column A while the experimenter started the program. The participant then had to observe the first column for 15 seconds, the experimenter would time this. When 15 seconds had passed the experimenter signaled the participant to move towards the next column and also observe this for 15 seconds followed by the final column for another 15 seconds. After observing each column separately the participant was given another 15 seconds to revisit the conditions or be able to observe all three columns in unison. The experimenter stopped the program and asked the participant to fill in the questionnaire. We collected data on which column the participant preferred for product placement, plus the likeability of each column and the attention it generated, this was measured on a 7 point scale. While the participant filled out the questionnaire the experimenter reprogrammed the lights inside of the columns. The three light conditions remained the same, only their order of appearance changed. We repeated this until we tested all six possible orders for each participant. For each participant the order of appearance was randomised. With the counterbalancing of which column displayed what condition we hoped to eliminate any order effects and with repeating the questionnaire we make it possible to measure the consistency of each participant across the trials. After the sixth, final, trial the participant was handed an extra questionnaire containing open-ended questions regarding the motivation behind their choices on the different trials (See Appendix p.38).

**Results**

First we had to check if the two groups of ten people we tested did not differ significantly from each other. We had to do this to be able to compare the results between these participants. All participants were interns at Philips chosen at random, so we expected no big differences between the two groups. In addition to likeability and attention we collected data on age, handedness and sex of each participant. We ran a paired sample t-tests, analysing age and found no significant result. Age: (M=25, SD= 2.9) (M= 24.8, SD= 3.0) $t(9) = .145$, $p = .888$. We also ran chi-square tests, analysing handedness and sex which also led to no significant results. Handedness: $\chi^2(1, N = 20) = 0.80$, $p = .37$ and Sex: $\chi^2(1, N = 20) = 0.267$, $p = .61$. This means we are allowed to compare these two groups with each other plus if we find an effect the differences on these traits between the two groups are not the cause.

We calculated the percentages for each column choice per individual participant. With these percentages we ran a Repeated Measures for our different light conditions, (congruent, incongruent and control), these were defined as our within subjects factor. Sound was defined as our between subjects factor. Column Choice $F(2,36) = .895$, $p = .418$ (within subjects). Sound $F(1,18) = 1$, $p = .331$ (between subjects). Interaction between Column Choice and Sound $F(2,36) = 1.823$, $p = .176$. This did not lead to any significant results.

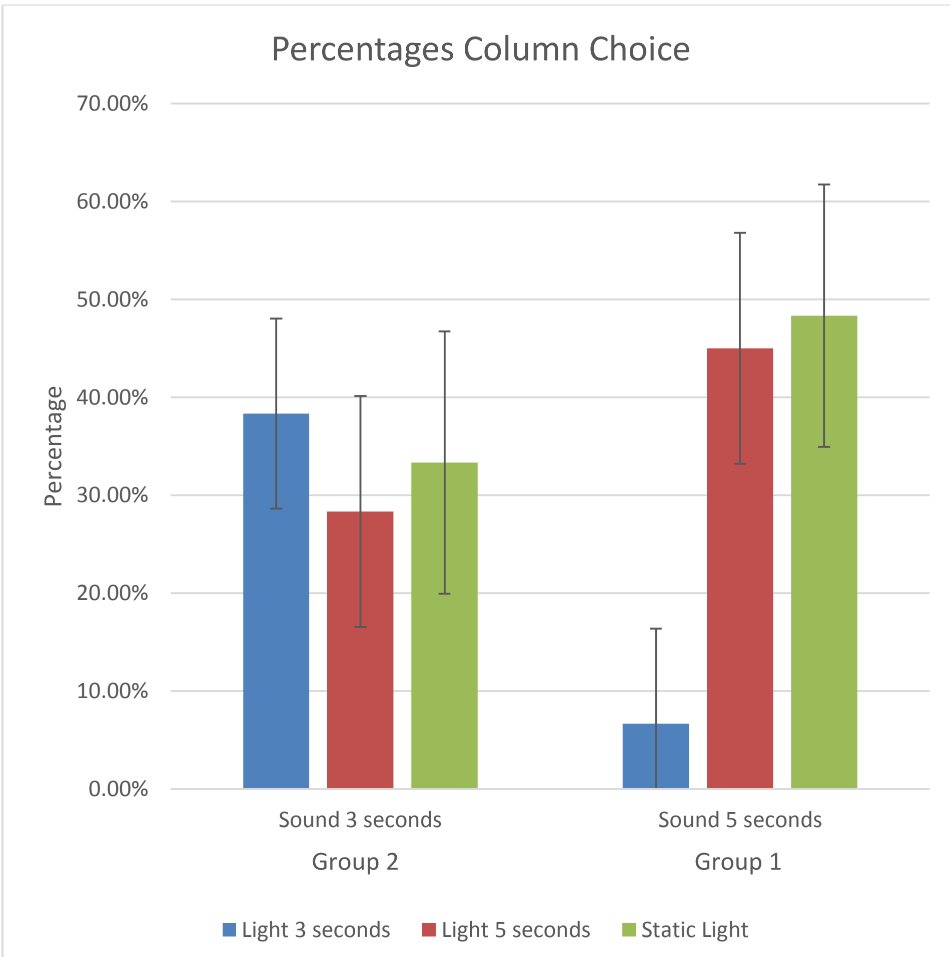


*Figure 5. For each group we calculated the percentage of choices for that column condition. The three conditions combined per group equals 100%.*

We used a Repeated Measures with likeability ratings of our different light conditions within subjects, defining the three levels we used in our experiments (congruent, incongruent and control) and we defined sound as the between subjects factor. Light $F(2, 36) = 2.103$, $p = .137$ (within subjects). Sound $F(1,18) = 1.933$, $p = .181$ (between subjects). Interaction between Light and Sound $F(2,36) = 5.705$, $p = .007$. We found a significant interaction effect between our light and sound conditions.

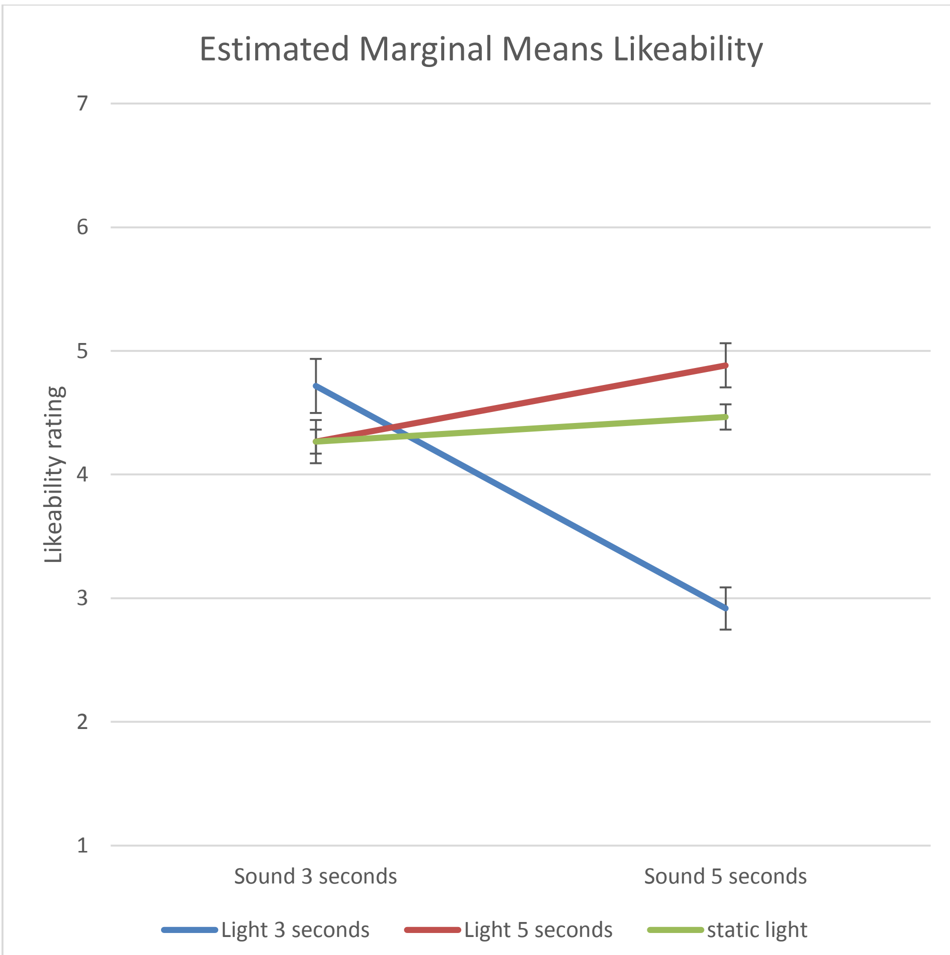


*figure 6. Graph Estimated Marginal Means Likeability. The combination light 3 seconds, sound 3 seconds and light 5 seconds, sound 5 seconds are our congruent conditions. The combination light 3 seconds, sound 5 seconds and light 5 seconds, sound 3 seconds are our incongruent conditions.*

We also ran a Repeated Measures for our data on attention ratings of our different light conditions within subjects, defining the three levels we used in our experiments (congruent, incongruent and control) and we defined sound as the between subjects factor. Light $F(2, 36) = 72.791$, $p = .000$ (within subjects). Sound $F(1,18) = .025$, $p = .877$ (between subjects). No interaction between Light and Sound $F(2,36) = .936$ $p = .402$. We found a significant main effect for light.

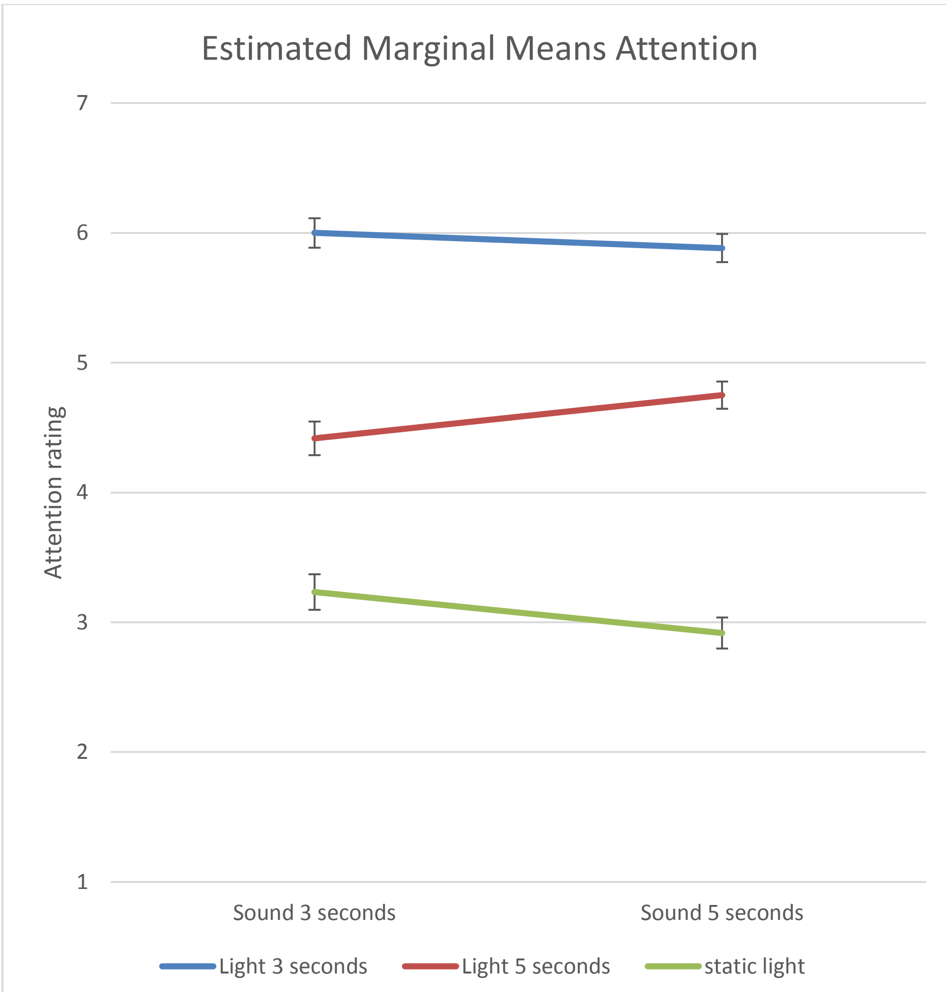


*figure 7. Estimated Marginal Means for Attention. The combination light 3 seconds, sound 3 seconds and light 5 seconds, sound 5 seconds are our congruent conditions. The combination light 3 seconds, sound 5 seconds and light 5 seconds, sound 3 seconds are our incongruent conditions.*

## Discussion

The interaction between the Column Choice and Sound is not significant but we think the result is small enough to not reject our null hypothesis nor accept our alternative hypothesis. Retesting could be an option to see if the interaction between column choice and sound remains this small.

For likeability we found an interaction effect. The lines in figure 6 show a classic interaction effect. The effect of a sound pattern combined with an identical light pattern leads to a higher likeability. If the sound pattern and the light pattern do not match it leads to a decrease in likeability. This leads us to rejecting the null hypothesis and accepting our alternative hypothesis, congruent multisensory stimulation scores higher on likeability compared to incongruent multisensory stimulation.

For attention we found a main effect of light. The faster the movement of the dynamic light condition the more attention it attracts. We expected to find this effect for our multisensory conditions but this was not the case. This does not come as a total surprise to us, the ability to attract attention was measured subjectively through the use of our questionnaire. The static light scored lowest on the ability to attract attention, the light frequency of 5 seconds scored higher followed by the frequency of 3 seconds. It seems that the faster the dynamics of our light stimuli were, the higher they were rated on attention independent of an accompanying sound.

## Conclusion

From the pilot-test we concluded people necessarily do not always prefer dynamic stimulation over non-dynamic stimulation. In our first pilot-test we ran tests with an abrupt light flash accompanied with an abrupt sound stimuli. This dynamic stimulation was seen as annoying and intrusive. We were able to reduce the complaints, by changing the abrupt sound and light flash to sine-shaped patterns.

From our main experiment we cannot conclude or disapprove if participants have a preference for a location where (congruent) multisensory stimulation took place. We suggest retesting and possibly expanding upon our factorial design. We have the possibility to add a static condition for sound, this results in another congruent condition if paired with our static light. We are also able to increase the number of frequencies we are able to test for our light and sound stimuli. From our questions regarding attention we can conclude that our dynamic light conditions result in increased subjective attention, independent of sound. If a shop wants to use a dynamic light to attract attention it is advisable to use a light with a high frequency, making it highly noticeable compared to static light. We can also conclude that our congruent multisensory conditions scored higher on likeability. If a shop were to make use of multisensory stimulation (sound combined with light) to attract attention to their products it is advisable to make these multisensory patterns congruent compared to incongruent.

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## Appendix

### Pilot-test 2 - Phase difference

We wanted to see if we could use a phase difference to differentiate between our incongruent and congruent condition. If this is possible we are able to keep the frequency the same between the two dynamic conditions. This way the two light conditions will look exactly the same, but the congruent condition will be in phase with the sound stimuli and the incongruent condition will be out of phase with the sound stimuli.

#### Participants

Five subjects participated in the following experiment, one female and four males. Age ranged from 23 to 37, with a mean age of 27. All participants were right handed. Participants were recruited from the Philips Research intern population. We used a within-subjects design.

#### Materials

The materials used in this pilot-test were exactly the same as in our main experiment, except for the conditions we tested. Light spots would follow a sine-shaped light pattern of either 5 seconds (0.2 Hz) or would remain static. The sine-shaped lights minimum value was 50 lm, the maximum value was 500 lm, it was to repeat. For the control condition the light inside of the column would remain static and was set to 500 lm. The dynamic light spots, following a sine-shaped pattern, differed 90º in phase from each other.

Sound would follow an identical sine-shaped pattern of 5 seconds (0.2 Hz) and was set to repeat. Sound was measured and had a minimum value of 45 dB and went up to a maximum value of 60 dB. Sound came from one side of the room, the right side, where the columns were positioned.

### Design

Light was our independent variable, we manipulated the phase of the lamps inside of our columns. We created three conditions. In our 'congruent column condition', synchronization was obtained by presenting the light and sound in the same phase. For our 'incongruent column condition light and sound was presented out of phase. The frequency of the light was the same in the congruent and incongruent condition. On the 'control column condition', light was presented continuously at a fixed value. Sound was not varied, it had the same frequency in all of the conditions.

The dependent variables were the same as in our main experiment, the selection for one of two audiovisual conditions, and a questionnaire about the participant's preferences. We also asked certain open ended questions to get an indication for preferences of each condition opposed to just the selection of a condition (Appendix p.33).

### Procedure

The procedure was exactly the same as in our main experiment.

**Results**

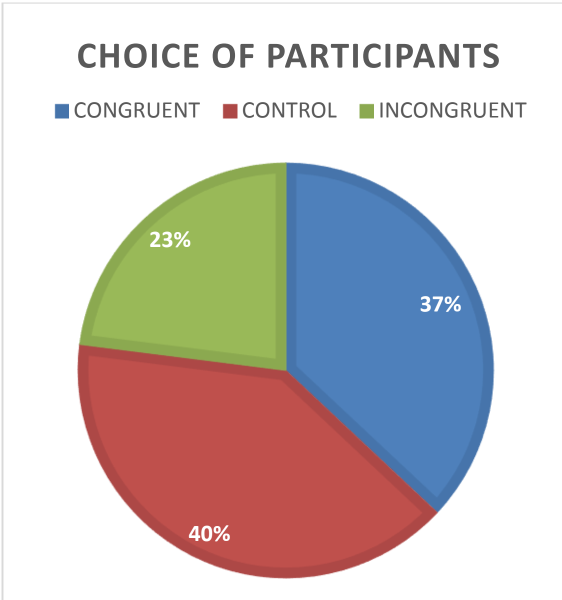


*figure 8. Preferred conditions as a percentage.*

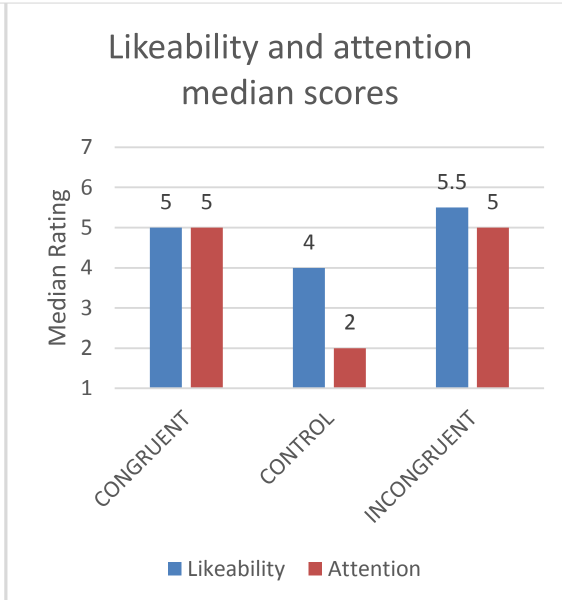


*figure 9. Median values for likeability and attention from the questionnaires.*

**Discussion**

People seem to have difficulty noticing the actual congruency, when participants do not have a preference for control they pick congruent and incongruent interchangeably. Some participants also noted on the open questions that they did not notice a difference between our two dynamic conditions. This can also be concluded from the results, median scores for likeability and attention are almost equal between the congruent and incongruent conditions. It could be that our brain is correcting for the phase difference. If this is the case then our incongruent condition actually also is perceived as congruent (van Ee et al., 2009).

Participants did score attention higher for the dynamic conditions. In this experiment likeability is almost equal across the conditions, we hope this means we improved the likeability of our dynamic conditions compared to pilot-test 1.

### Pilot-test 3

Because participants had difficulty noticing the phase difference from the previous pilot-test we decided to go ahead with testing different frequencies of light. We were satisfied with the congruent condition of 5 seconds we had previously used. For this pilot-test we created two new incongruent frequencies, 3 and 7 seconds. We wanted to see what participants thought of these conditions before we decided to use them in our main experiment.

## Method

### Participants

For this pilot-test we tested two groups.

Group 1 consisted out of twelve participants, seven females and five males. Two participants were removed from this group, one because the participant failed to understand the instructions and only chose the right most column and evaluated it the same independent of the light condition. The other participant was removed because he was not consistent throughout the trials, halfway the experiment he started answering all the questions regarding likeability and attention with 1. Age ranged from 22 to 35, with a mean age of 25. Seven out of ten participants were right handed.

Group 2 consisted out of five participants, two females and three males. Age ranged from 23 to 33, with a mean age of 26. All participants were right handed. Participants were recruited from the Philips Research intern population. We used a within-subjects design.

### Materials

The materials used in this pilot-test were exactly the same as in our main experiment.

For group 1 the light spots would follow a sine-shaped light pattern of either 5 seconds (0.2 Hz), 3 seconds (0.33 Hz) or would remain static. For group 2 the light spots would follow a sine-shaped light pattern of either 5 seconds (0.2 Hz), 7 seconds (0.14 Hz) or would remain static. The sound was the same for both groups, it was a sine-shaped pattern of 5 seconds (0.2 Hz) that was set to repeat.

### Design

Light and sound were our independent variables. We manipulated the intensity and the frequency of each lamp in our different columns. For group 1 the factor light contained three levels, a sine-shaped pattern of 3 seconds (0.33 Hz), 5 seconds (0.2 Hz) or static light. For group 2 the factor light also contained three levels, a sine-shaped pattern of 7 seconds (0.14 Hz), 5 seconds (0.2 Hz) or static light. Light was measured within-subjects. We also manipulated the intensity and the frequency of our sound speakers. Factor sound contained only one level, a sine-shaped pattern of 5 seconds (0.2 Hz).

The congruent column condition was the same for both groups. In our 'congruent column condition', the frequency of the light and sound were identical (congruent) for the 5 second (0.2 Hz) pattern. For our 'incongruent column conditions' the frequency of the light and sound would not match each other. This was the 3 second (0.33 Hz) light pattern for group 1 and the 7 second (0.14 Hz) light pattern for group 2. In each trial of the two pilot-tests one column would be congruent, one would be incongruent and hence the third would be control.

### Procedure

The procedure was exactly the same as in our main experiment.

### Results

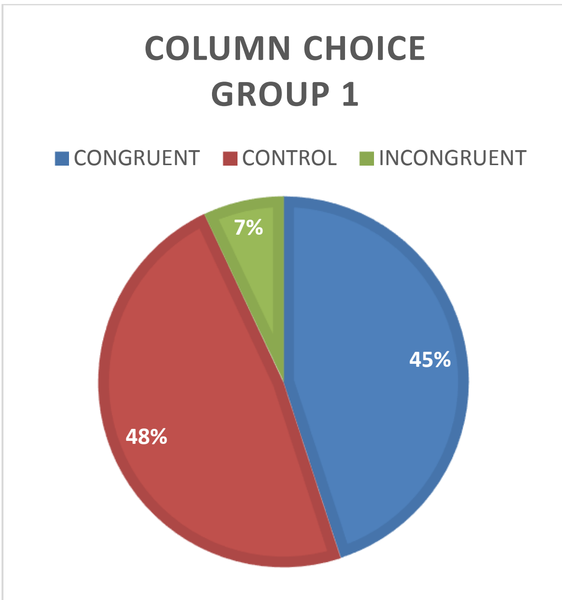


*figure 10. Preferred conditions as a percentage. Incongruent 3 seconds.*

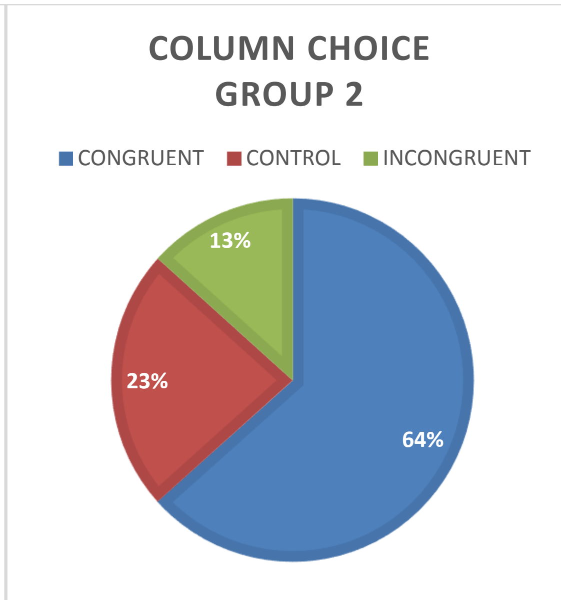


*figure 11. Preferred conditions as a percentage. Incongruent 7 seconds.*

If we look at the percentual choices of group 1 the number of control and congruent picks are almost equal, the incongruent condition is only chosen in 7 percent of the choices. For group 2 the congruent condition is larger at the expense of the control condition. We did not expect this as these conditions were identical for group 1. The incongruent condition is also larger with 13 percent.

The sine-shaped light of 7 seconds is pretty slow, it’s appearance is a lot closer to our control condition than the sine-shaped light of 3 seconds.

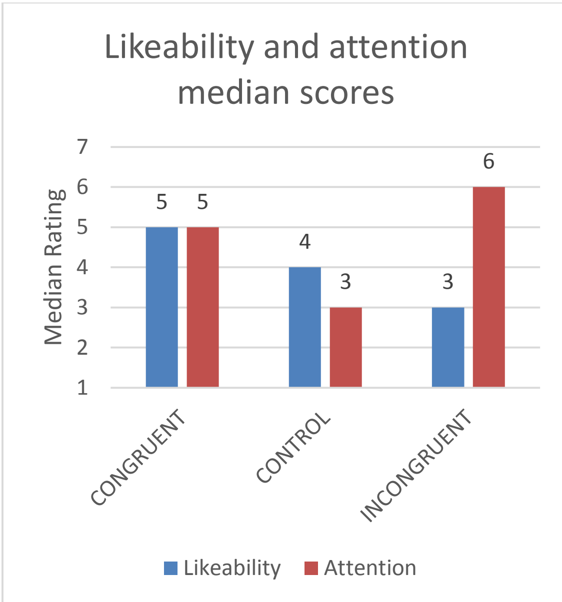


*figure 12. Median questionnaire scores. Group 1, Incongruent 3 seconds.*

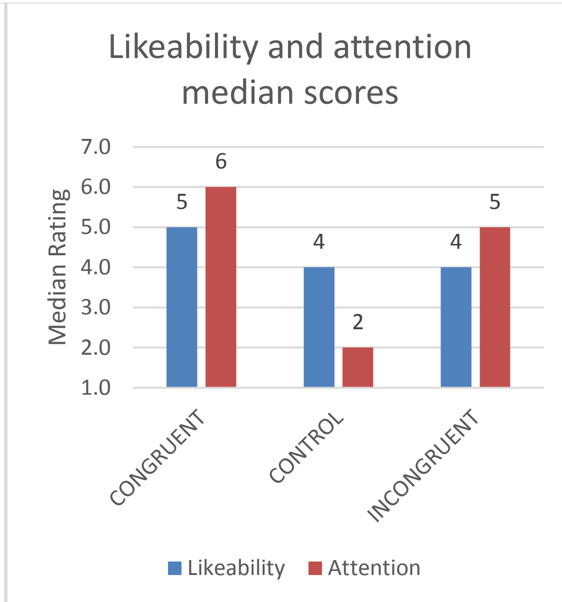


*figure 13. Median questionnaire scores. Group 2, Incongruent 7 seconds.*

If we look at the median scores the difference in likeability between congruent and incongruent seems to be bigger for group 1 that contained the condition incongruent 3 seconds. In group 1 all our conditions were rated different on likeability and attention.

## Discussion

After testing frequencies 3 (0.33 Hz) and 7 seconds (0.14 Hz) we decided to use the frequencies 3 and 5 seconds for our main experiment. We did this because the difference between 3 and 5 second sine-shaped light pattern were more noticeable compared to the 5 and 7 second sine-shaped light pattern. Participants from group 1 also noted they disliked the light frequency of 3 seconds.

**Identifier:** ID ………

**Condition:** …………………………………..

**Age:** ……

(To be filled in by experimental staff)

# Questionnaire about Light & Sound settings

Below are some questions about the light & sound settings. Please answer honestly what you think. If you are not sure, follow your first impressions. (Left and right are defined from the point where you entered the shop!)

(1) Which light & sound setting do you think is **best** to sell the products?

| o | o |
|---|---|
| **left** | **right** |

(2) Do you **like** this light & sound setting that you've chosen?

| o | o | o | o | o | o | o |
|---|---|---|---|---|---|---|
| **don't like** | | | **neutral** | | | **like** |

(3) What do you like & dislike about this light & sound setting that you've chosen?

**Left**:…………………………………………………………………………………………………
…………………………………………………………………………………………………………
**Right**:………………………………………………………………………………………………..
…………………………………………………………………………………………………………

(4) Do you **dislike** the light & sound setting that you have <u>NOT</u> chosen?

| o | o | o | o | o | o | o |
|---|---|---|---|---|---|---|
| **like** | | | **neutral** | | | **dislike** |

(5) Which **differences** do you think there are between the left and the right light & sound settings?

**Left**:…………………………………………………………………………………………………
…………………………………………………………………………………………………………
**Right**:………………………………………………………………………………………………..
…………………………………………………………………………………………………………

(6) Did you notice a big **difference** between the left and the right light & sound setting?

| o | o | o | o | o | o | o |
|---|---|---|---|---|---|---|
| **no difference** | | | | | | **big difference** |

(7) How much do you have a **preference** for this light & sound setting that you've chosen?

| o | o | o | o | o | o | o |
|---|---|---|---|---|---|---|
| **no clear preference** | | | **a little bit prefered** | | | **very clearly referred** |

(8) Do you think that your customers will have more **attention** for the product if you apply the light & sound setting that you've chosen?

| o | o | o | o | o | o | o |
|---|---|---|---|---|---|---|
| **no more attention** | | | **little bit more** | | | **much more attention** |

(9) Do you think that the **attractiveness to buy** the product will increase if you apply the light & sound setting that you've chosen?

| o | o | o | o | o | o | o |
|---|---|---|---|---|---|---|
| **no more attractive** | | | **little bit more** | | | **much more attractive** |

(10) In the box below you may fill in your remarks/comments that you find relevant.

.......................................................................................................................
.......................................................................................................................
.......................................................................................................................
.......................................................................................................................
.......................................................................................................................

**Thank you for your participation.**

**Identifier:** ID ………

**Condition:** …………………………………..

**Age:** ……

**Handedness:** ……........................

**Male / Female**

(To be filled in by experimental staff)

# Questionnaire ShopLab

Below are some questions about the light settings you encountered just now. Please answer honestly what you think. If you are not sure, follow your first impressions. (A, B and C are defined on the columns from left to right)

(1) Which column do you think is **best** to sell the products?

| o | o | o |
|---|---|---|
| **A** | **B** | **C** |

(2) How much do you **like** column **A**?

| o | o | o | o | o | o | o |
|---|---|---|---|---|---|---|
| **don't like** | | | **neutral** | | | **like** |

(3) How much do you **like** column **B**?

| o | o | o | o | o | o | o |
|---|---|---|---|---|---|---|
| **don't like** | | | **neutral** | | | **like** |

(4) How much do you **like** column **C**?

| o | o | o | o | o | o | o |
|---|---|---|---|---|---|---|
| **don't like** | | | **neutral** | | | **like** |

(5) Do you think that customers will have more **attention** for column **A**?

| o | o | o | o | o | o | o |
|---|---|---|---|---|---|---|
| **no more attention** | | | **little bit more** | | | **much more attention** |

(6) Do you think that customers will have more **attention** for column **B**?

| o | o | o | o | o | o | o |
|---|---|---|---|---|---|---|
| **no more attention** | | | **little bit more** | | | **much more attention** |

(7) Do you think that customers will have more **attention** for column **C**?

| o | o | o | o | o | o | o |
|---|---|---|---|---|---|---|
| **no more attention** | | | **little bit more** | | | **much more attention** |

How did you come to your decisions?

| |
|---|
| ………………………………………………………………………………………………… |
| ………………………………………………………………………………………………… |
| ………………………………………………………………………………………………… |
| ………………………………………………………………………………………………… |

What do you like about the light and sound setting that you've chosen?

| |
|---|
| **Like:**…………………………………………………………………………………………… |
| ………………………………………………………………………………………………… |
| ………………………………………………………………………………………………… |
| ………………………………………………………………………………………………… |

What do you dislike about the light and sound settings you did not choose?

| |
|---|
| **Dislike:**………………………………………………………………………………………… |
| ………………………………………………………………………………………………… |
| ………………………………………………………………………………………………… |
| ………………………………………………………………………………………………… |

In the box below you may fill in additional remarks/comments that you find relevant.

| |
|---|
| ………………………………………………………………………………………………… |
| ………………………………………………………………………………………………… |
| ………………………………………………………………………………………………… |
| ………………………………………………………………………………………………… |
| ………………………………………………………………………………………………… |

**Thank you for your participation.**