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„The Simon Effect in Natural Scenes Using Moving
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Abstract

This eye tracking experiment tries to find a Simon Effect in natural scenes using moving stimulus material. Videos of persons interacting with objects on a table were used and cut after some seconds. After this a stimulus appeared which had to be fixated. Eye movements were recorded. The reaction time on the stimuli is considered to be smaller when the direction of the cut matches the side the stimulus is presented on. A cut to the right for example should facilitate the reaction to a stimulus on the right, but should not facilitate to look at a stimulus on the left. So a Simon Effect should become apparent between the congruent and the incongruent condition. Different approaches to explain this effect are based on the assumption of different spatial codes or talk about the resulting general compatibility and incompatibility of stimulus material. 19 subjects were tested and an ANOVA was conducted to find differences in reaction time and location of fixation. Neither a Simon Effect concerning reaction times, nor one concerning the coordinates on the horizontal x-axis was found in this experiment.

Keywords: Simon Effect, spatial codes, moving stimuli, Dual Route Model

Zusammenfassung (German Abstract)

Dieses Experiment versucht einen Simon Effekt in sich bewegendem Stimulusmaterial nachzuweisen. Videos von an Tischen sitzenden Personen die mit Objekten interagieren wurden nach einigen Sekunden geschnitten und der erscheinende Stimulus musste angesehen werden. Währenddessen wurden die Augenbewegungen des Teilnehmers aufgezeichnet. Die Reaktionszeiten auf den Stimulus sollten kleiner ausfallen wenn die Richtung des Schnittes die gleiche ist wie die Seite auf der der Stimulus erschienen ist. Ein Schnitt nach rechts sollte also eine Reaktion auf einen Stimulus auf der rechten Seite

vereinfachen, jedoch nicht auf einen Stimulus auf der linken Seite. Dies sollte einen Simon Effekt zwischen der kongruenten und der inkongruenten Bedingung aufzeigen können.

Unterschiedliche Erklärungen die vorgebracht wurden gehen auf räumliche Codes ein und analysieren die generelle Kompatibilität und Inkompatibilität des Stimulusmaterials. 19

Personen nahmen an der Studie teil und eine ANOVA wurde durchgeführt um Unterschiede in den Reaktionszeiten und dem Ort der Fixationen aufzuzeigen. In dieser Studie wurde weder ein Simon Effekt in den Reaktionszeiten auf die Stimuli, noch ein Effekt an den Koordinaten der horizontalen x- Achse festgestellt.

Stichworte: Simon Effekt, räumliche Codes, bewegte Stimuli, Dual Route Model

1. Introduction

In everyday life we have to pay attention to the world around us. We have to notice stationary things and even more often we have to react to moving objects around us. Our world is a moving one and we have to react to the things that happen around us and to the stimuli and objects in it.

There are many studies that try to analyse the interesting effects that arise when stimulus and reaction come together. Very well-known examples for this are studies about stimulus- response compatibility and in particular the Simon Effect. Under Simon Effect we understand that there is a tendency in humans to react to the source of a stimulus (Simon, 1990) even if the location of the stimulus did not need processing.

The experiment that follows will try to shed light on one more aspect of the Simon Effect. As moving stimuli are an important part of the world around us we will try to investigate the effect using videos with cuts and try to find out if the direction of those cuts has an influence on the reaction time to a stimulus displayed on the side of the cut or on the opposite side.

2. Theory

On the following pages we will discuss when exactly and why this effect shows up and discuss stimulus response compatibility, dual route models and different accounts for spatial coding.

2.1.1 Stimulus-response compatibility

But first of all we have to go further back to understand the Simon Effect. We have to go back to the stimulus-response compatibility experiments of Fitts and Seeger (1953). They were the first to examine directional motor responses to spatial stimulus pattern, and found

out that giving a response is easier, faster and more accurate when the stimulus and the hand that is used to respond to this stimulus are on the same side, which they called stimulus-response compatible condition, rather than on the opposite side, which they called stimulus-response incompatible condition.

As an example it should be easier to react to a relevant spatial cue with the right hand when it is presented on the right side, and to react with the left hand when it is presented on the left. It was also found that fewer errors occur that way. The authors argue that the results are the best, manifested in faster reaction time and less errors, when least information needs processing (Fitts & Deininger, 1954). Fitts and Seeger (1953) were therefore the first ones to describe *Stimulus-Response Compatibility* (SRC). The authors argue that their findings are due to intervening information transformation processes like coding and decoding and also require “the correspondence of stimulus sets and response sets in respect of the dimension along which stimulus and response categories are selected” (Fitts & Deininger, 1954, p. 491). What is important to notice here is that they are always talking about sets of stimuli, and not about which response code is better than the other (Fitts, 1959). Kornblum, Hasbroucq and Osman (1990) try to give a very easy explanation of SRC.

Stimulus –response compatibility refers to the fact that some tasks are easier or more difficult than others either because of particular sets of stimuli and responses that are used or because of the way in which individual stimuli and responses are paired with each other (Kornblum et al., 1990, p. 253).

2.1.2 The Simon Effect

But what happens when the location of the stimulus does not need to be processed? What happens when the location is completely irrelevant to the task at hand? There are indeed similar findings for compatible and incompatible stimulus and response interactions when the

location of the target didn't need processing (Simon, 1990), making the spatial attributes of the target stimulus task irrelevant. In their first experiments, Simon and Rundell (1967) did not search for this effect to occur, they wanted to find a connection between handedness and therefore laterality in the brain, and the influence of handedness on the reaction times to auditory stimuli presented on the left and right ear. Faster reaction times to verbal auditory stimuli, they argue, should lead to faster reaction times on the side of the dominant hand (Simon & Rundell, 1967). Contrary to their hypotheses they found not the effect they searched for, but what was the foundation of a well-known effect, the Simon Effect (sometimes also Simon's Effect). Reactions were faster when the verbal command "left" was presented on the left ear, and the command "right" on the right ear, independently of the side of the subject's dominant hand. The effect also was present when the subjects knew which ear was going to be stimulated. Simon and Rundell (1967) stated that these stimulus features which were irrelevant to the task but were very influential to change speed of processing. The authors attribute this to a natural tendency to react towards the source of a stimulus.

This was an interesting finding but isn't exactly what we call a Simon Effect today, which is especially because words were presented as auditory stimuli. There are a lot of variables that could have been interfering and there could be other explanations for these results. There could have been an interaction between spatial stimulus and spatial response. Or the semantic incongruence between meaning of the word presented and the location of the reaction could have had an influence (Hommel, 2011). The latter would count as *Stroop effect*, which is present when a subject responds to related stimulus features that could be congruent or not. If a word representing a colour, for example "yellow", is displayed in another colour than its meaning, for example green, it is more difficult to report the meaning of the word, than it would be, when the word was displayed in the colour of its meaning (Stroop, 1935).

Simon and Small (1969) made another version of that experiment later on, to replicate the effect in a clearer way. They changed the auditory input of meaningful words (“left” and “right”) to low and high frequency tones. The subject now had to react to low frequency tones with one hand, and to high frequency tones with the other hand. So the conflict between stimulus features, and also the conflict that arises through the presented words, was not present in this experiment, which lead to the assumption that there was only the fitting of the stimulus side to the response side that influenced the results (Hommel, 2011). From the beginning, the Simon Effect was a valuable target of psychological research and theories, and also very important when it comes to investigation of attention and its mechanisms (Hommel, 2011).

2.2 What leads to the Simon Effect?

In the following some models that try to explain the Simon Effect are brought forward. First we will take a look at the Dual Route Model, then on different accounts of spatial coding.

2.2.1 The Dual Route Model

One of the more well-known models to explain this effect and the mechanisms behind it is the *Dual Route Model*. Kornblum et al. (1990) argue that the Simon Effect is due to conflicting response codes. In the Dual Route Model, two response codes are generated, one for the irrelevant dimension of the stimulus and one for the relevant dimension. Here “the irrelevant spatial feature of the stimulus automatically activates its response code. The code for the relevant dimension is intentionally translated into the correct response” (Kornblum et al., 1990; quoted from Bosbach, Prinz & Kerzel, 2004, p.39).

Taking the experiments of Simon and Small (1969) as example, the irrelevant stimulus dimension would be the side the high or low frequency tones are applied on, and the relevant dimension would be their frequency for which the subjects should discriminate them. The side

of the noises activates a response code for the irrelevant dimension. To reply if the frequency of the noise is high or low, which works as the relevant dimension here, one has to intentionally translate the side of the automatically activated response into the correct reaction.

So it is assumed that there are two routes for the selection of a response. One of them is assumed to be faster and is automatically activated, the other one is slow and guided by the person's intentions (Kornblum et al., 1990; Bosbach, Prinz & Kerzel, 2005). The automatic response is activated regardless of the study's mapping. If the automatic response (automatic orienting to the audio input) is the required one (intentionally selected side of response), the responses are faster and more accurate. If the automatic response is not the required one a conflict between these two arises and leads to longer reaction times and in case more false responses.

Kornblum et al. (1990) also argue that dimensional overlap is necessary for the effect to occur. Under dimensional overlap they understand the similarity, physical properties and conceptional similarity between stimulus and response.

2.2.2 Two accounts on spatial code

We also have to consider what makes the Simon Effect appear when dealing with visual spatial stimuli. Do we need attention for the Simon Effect to appear?

The *attention shifting account* states that for spatial coding the location where the attention is focused on is used as reference point (Niccoletti & Umiltà, 1994, also see Lu & Proctor, 1995). If a point appears in the middle or on one side, this point is used as a reference. If after the point in the middle a point on the side appears, it would produce a spatial code for its side. So a fixation point in the middle and a target on the left would form a LEFT spatial code because the target is on the left side in reference to the fixation point in the middle (Bosbach et al., 2005).

Hommel (1993) on the other hand argued that relative position plays an important role for the Simon Effect. Following the *referential coding account* a stimulus is coded in terms of relative position with respect to a reference object or frame (Lu & Proctor, 1995). This account denies a role of attention in spatial coding. So a fixation point in the middle with a stimulus appearing to its left would automatically make the spatial code *left*. That is because the stimulus is related to the fixation point (Lu & Proctor, 1995).

2.2.3 Is the Simon Effect about direction or position?

A lot of further experiments have been conducted since Simon and Small (1969) made the first experiments concerning the effect, to find out more about the Simon effect and its origins, but not many tried to examine the effect with moving stimuli.

Some authors, for example Michaels (1988), tried to add the component direction to the location and position based theories of the Simon Effect. She tried to test whether motion towards a certain position can lead to faster reaction times at that particular position, and found that the destination of the stimulus was an important influence to form the effect.

But what is more important for the Simon Effect? Is it the position or can it also be the direction of the stimulus presented that causes the effect? Recent studies were made by Bosbach et al. (2004). They wanted to find out if motion and position have different and separate influences on the resulting Simon Effect, because former studies were not able to take the difference between those two into account. Furthermore they tried to discriminate between *to* a side, representing direction-based correspondence, and *on* a side, representing position-based correspondence.

In their first experiment they used a sine wave function fixed in a stationary Gaussian window resulting in a sine wave grating and a Gaussian function which they called *Gabor patch* (Bosbach et al., 2004). With a drifting Gabor patch in the direction of key press and the

task of reporting its frequency they found a Simon Effect, even if processing of the direction of the drift was not necessary in the experiment. The authors argue, “that the spatial codes are not exclusively based on (relative) position, but that purely motion-based codes , such as *to the left*, do exist” (Bosbach et al., 2004, p.44).

Also well-known are their experiments with light point walkers. Those stationary moving stimuli make it possible to examine motion in which the “relative displacement of a single element has no relation to the overall direction of motion” (Bosbach et al., 2004, p.49). In other words through the point light walker it became possible to examine motion with no overall change in relative position over time. With the point light walkers they were able to examine whether a high level representation of motion, in this case seeing the walkers form and not only the forward and backwards moving unconnected lights, needs to be there for the effects to show. They were also able to investigate that motion signals have a separate influence and are independent from the position of the object.

2.3 Hypotheses

As stated at the beginning our world is a moving one, and our world consists of many very complex stimuli and objects, which move and are moved. The effects and theories above show that it is necessary to investigate this effect using natural pictures and scenes. In the following experiment we try to find a Simon Effect using cut videos and a stimulus appearing either on the left or right. We try to examine if a cut *to* a particular side can elicit a Simon Effect when natural scenes are used. We will measure the effect on subject’s reaction time with the eye tracker. There will also be a non-moving stimulus similar to the Gabor patch in the study of Bosbach et al. (2004) used in this experiment.

Based on those studies presented above one can deduce the hypotheses, that following the theory of the Simon Effect it should be easier for an observer to see a stimulus if the

direction of the cut in a video is the same as the side the stimulus is presented on. If the direction of the cut and the position of the stimulus are not congruent, it should result in higher reaction times. This means if the video is cut to the right side, it should be easier to react to a stimulus on the right side of the screen, than to react to one presented on the left side. The same counts for a cut to the left side and a stimulus presented left.

3. Methods

3.1 Subjects

The subjects were recruited via the platform LABS, an online Platform of the University of Vienna to find participants for psychological experiments. They got one credit point for their participation, which they needed to collect as part of their courses.

There were 14 women and five men participating in this study forming an N of 19. The subjects mean age was 23.3 years (19 - 30 year olds). All with normal or corrected to normal vision and no colour blindness. All but one were right handed. When the dominance of their eyes was tested, seven reported their right eye as dominant, 12 their left. The Experiment took twenty minutes to half an hour.

3.2 Instruments

The direction of the gaze was recorded with Eye Link 1000 Desktop Mount (SR Research, Ontario, Canada). Recording was monocular on the dominant eye with 1000Hz rate. The Experiment was conducted on a CRT 19-inch screen (Sony Multisan G400) on which the stimuli were presented with a resolution of 1024 x 768 Pixel and a rate of 100 Hz. Matlab in the version of 7.7.0 (MathWorks Inc., Massachusetts, USA) was used, as well as its Psychophysics toolbox (Brainard, 1997). The experiment was conducted on a computer running Windows XP.

3.3 Procedure

Videos with cuts were presented. After the cut a stimulus appeared that had to be fixated till it vanished. The gaze location and reaction times to the stimuli were recorded with the eye tracker.

Before starting the experiment, the subject's dominant eye was chosen to be recorded by the eye tracker during the experiment. Eye dominance is the preference of the input of one eye over the signals of the other. Before the experiment started participants were asked to look at a little cross on the wall a few meters away through a circle made by touching the tips of their thumb and index finger of one hand when their arm was stretched out. Then they needed to close one eye after the other without moving their hand to the left or right. The eye which was open when they reported the cross moving less in any direction was selected to be tracked by the eye tracker afterwards. This has the advantage of better and more exact signals when measuring reaction times and gaze location.

Before showing the first video a nine-point calibration was used. Here the subject had to fixate nine white points on different locations of a black screen which were displayed one after another. When one point vanished the next one appeared, until the calibration was over. If necessary a five-point calibration was used between the videos when the eye tracker drift check was not able to notice when the gaze was fixing the single point in the middle of the screen, or when the subject moved his or her head in a way that the calibration had to be used again to ensure good data. To prevent head movement a chin rest was used to fixate the subjects head in 57 cm distance to the screen. Before each video an eye tracker drift check was performed to calibrate the eye tracker and to be sure that the subject looked at the middle of the screen. This was ensured by showing a single white point on a black screen which the subject had to look at till the eye tracker located the subjects gaze in the middle of the screen.

72 Videos of a length of eight seconds each were shown. Those videos had a cut after three, four or five seconds. There were four groups, in which the videos were shown in different order to control effects that may arise when the videos would be left in the same position.

The videos showed different persons sitting at a table who engaged in activities with every-day objects, for example watering a plant or cutting food in pieces. In half of the videos there was a woman interacting with the objects, in the other half a man. This was done to control gender influences in gaze direction. The person's face was not included in the video. The action was focused on hands and upper body. The videos were black and white and the cuts were set 45° to each other (one cut frontal, one cut 45° left, and one cut 45° right, see figure 2). The cuts were within-scene and matched-action cuts. A within-scene cut is one where the same scene is shown from a different view when the activity stays the same. In addition a matched-action cut is a cut where an action of a person begins before the cut and the exact action is continued after the cut (Smith & Henderson, 2008, for an example cut see figure 2).

The stimulus was a semi-transparent sine wave grating similar to the Gabor-patch used in the study of Bosbach et al. (2004) with narrow stripes with a size of 2°x2° visual angle which is 64x64 pixel. The stripes were ranging from black and grey to white in the colour spectrum and did not move (see figure 1). The stimulus, which was displayed with 50% transparency is also called Gabor. The tolerance of the eye tracker was 1° of the visual angle horizontally and 1.5° of visual angle vertically. The Gabor was shown at the left or right side of the screen in the middle of its vertical axis, and appeared 10 ms after the cut in the post-cut scene. It appeared equally often on the right and on the left side. The subject was asked to look at it until it disappeared again, which was, when the eye tracker measured that the stimulus was fixated for 100ms non-stop. There was also a balance between the side of the

cut and the side of the Gabor, resulting in four different combinations that had same chance to appear. Fitting: cut to the left / Gabor left, cut to the right / Gabor right. Non Fitting: Cut to the left / Gabor right, Cut to the right / Gabor left.

Also the side of the cut and the positions of the camera before and after the cut was balanced. A cut to the right could be made up by a switch from the camera on the left to the camera in the middle, or by a switch from the camera in the middle to the camera on the right. A cut to the left could be a switch from the right to the middle camera, or a switch from the middle to the left camera (see figure 1). All four cut combinations were balanced.

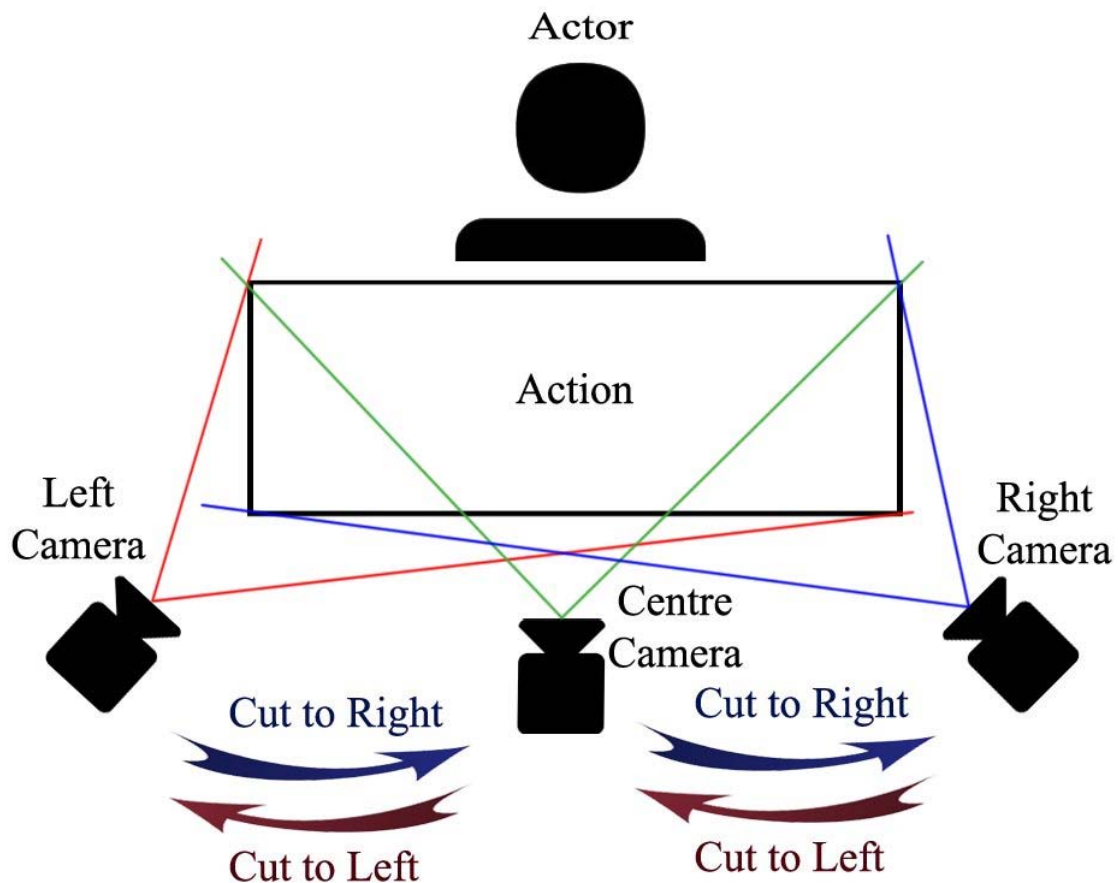


Figure 1: Three different perspectives were used to record the videos. Cuts to the right could be Left camera to Centre, or Centre to Right camera. Cuts to the left were Right to Centre, or Centre to Left camera changes.

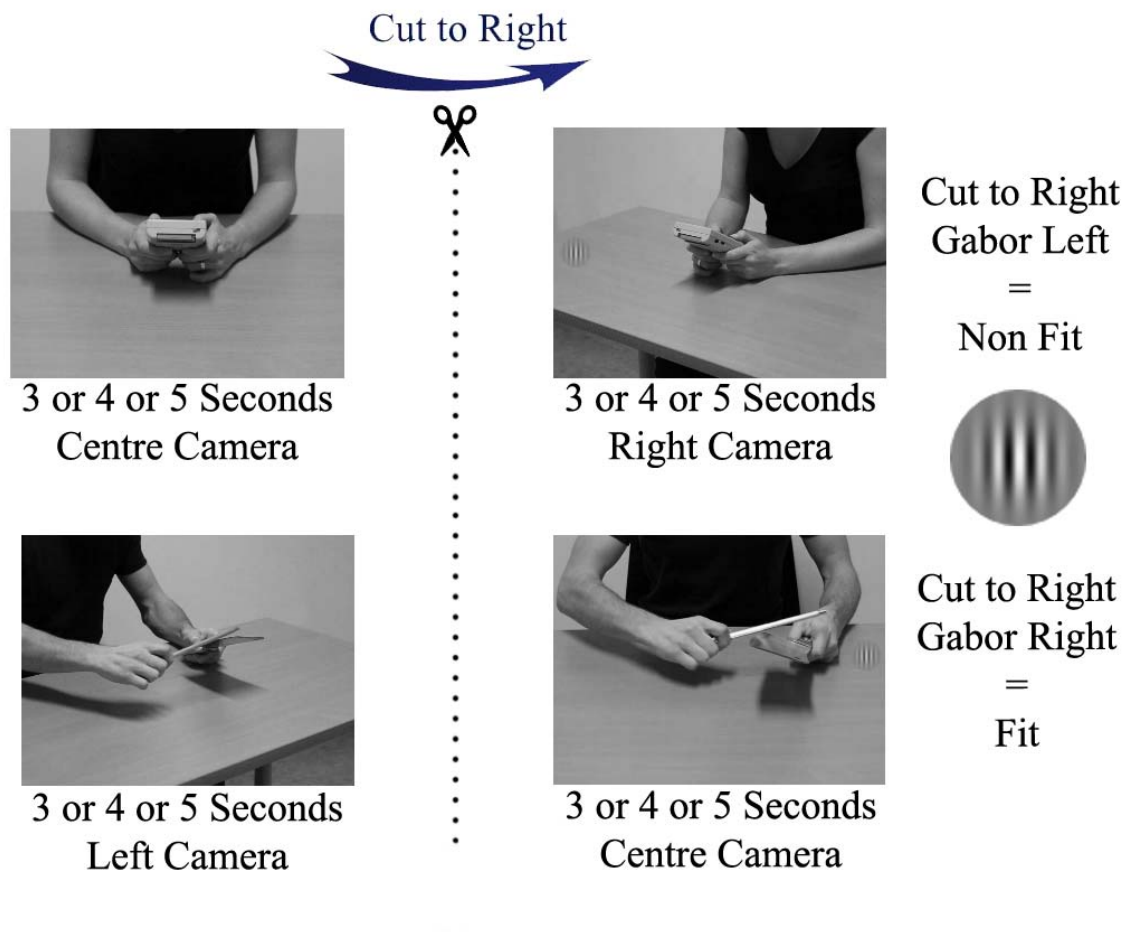


Figure 2. Examples for cuts to the right in incongruent and congruent conditions. Top: Cut to the right (centre to right camera) with Gabor on the left side after the cut as example for incongruent condition. Bottom: Cut to the right (left to centre camera) with Gabor on the right side after the cut as example for a congruent condition. The Gabor which had to be fixated is displayed on the right side.

4. Results

Of interest is, if there is a difference between congruent and incongruent trials. In detail we want to know if the direction of the cut (to the left, to the right) has an influence on the time needed to look at the Gabor depending on its side which is either on the left or right. Those two factors together form a congruent or an incongruent trial. Therefore an

analysis of variance (ANOVA) with repeated measurements and two factors (direction of cut and side of Gabor) was conducted to explore differences in resulting reaction times.

After exploring the reaction time differences on the Gabor, we will look at the differences in gaze location on the x-axis immediately before and after the cut. Therefore a repeated measurement ANOVA will be conducted, to see if they differ significantly from each other, and if there is an effect of the direction of the cut, the side of the Gabor, or if those factors stand in interaction.

All of those analyses will be split into the ones where the Gabor was hit with the first fixation after the cut, and in those where the Gabor was hit with the second fixation after the cut.

4.1 ANOVAs of reaction times

First we look closely at the effects of the side of the cut afterwards at the effect of Gabor side and at their interaction. Therefore two Analysis of Variances (ANOVAs) with repeated measurement were conducted with the factor side of cut and the factor side of Gabor, both with two manifestations (to the right and to the left; right and left). These ANOVAS were calculated for the subjects looking at the Gabor with the first, and the second fixation separately.

4.1.1 ANOVA of the reaction times for the first fixation

The reaction times of the trials in which the subjects gaze hit the Gabor with the first fixation are calculated first. An two factorial ANOVA with repeated measurement was used to calculate reaction time differences between the factor cut side with its two manifestations (to the left side and to the right side) and the factor Gabor side which also had two manifestations (Gabor on the left side and Gabor on the right side). The independent

variable was formed by those two factors, the dependent one is the resulting reaction time. All variables were normally distributed and the α -niveau was at 5%. Sphericity was tested for with the Mauchly-Welch test. And the p -values were corrected with the Greenhouse-Geissner correction.

For the trials hitting the Gabor with the first fixation the ANOVA showed that there was neither an effect on the reaction times of the side of the cut, $F(1,18) = 3.690$; $p = .071$, nor of the side of the Gabor, $F(1,18) = 0.940$; $p = .345$. There was no effect of the interaction of the factor cut side and Gabor side either, $F(1,18) = 1.078$; $p = .313$.

4.1.2 ANOVA of the reaction times for the second fixation

For when the second fixation hit the Gabor an ANOVA similar to the first one for the first fixation hitting the Gabor was calculated. Reaction time differences between the two factors were tested on significance.

For the trials where the subjects hit the Gabor with the second fixation the ANOVA showed also neither an effect of side of the cut, $F(1,18) = 3.271$; $p = .087$, nor of the side of the Gabor, $F(1,18) = 1.258$; $p = .227$, or their interaction, $F(1,18) = 1.035$; $p = .322$.

4.1.3 Reaction time – Means

To give a better scheme of which conditions were faster than others, the means and standard deviations of the resulted reaction times are listed here (see Table 1) for those who hit the Gabor with the first and second fixation.

Table 1. To the left the mean reaction times and standard deviations for the first fixation hitting the Gabor, to the right the means and standard deviations for those who looked at the Gabor with the second fixation in all four conditions.

	1 st fixation		2 nd fixation	
	Mean	SD	Mean	SD
Towards left /left	364.88 ms	58.01 ms	542.90 ms	94,09 ms
Towards left / right	346.94 ms	54.96 ms	643.50 ms	365.73 ms
Towards right /left	370.67 ms	67.54 ms	509.81 ms	168.58 ms
Towards right / right	369.87 ms	66.87 ms	515.12 ms	126.88 ms

4.2 A visual inspection of the resulting coordinates

In Figure 3. we can see the mean of the fixation points over all subjects for the last 5 fixations before the cut, and the first five fixations after the cut. The number 500 marks the middle of the screen horizontally. The lower the number the more left the subjects looked, the higher, the more on the right side the subjects gaze. In this graph the Gabor is looked at in the first fixation after the cut.

In Figure 4. We can also see the last five fixations before the cut and the first five fixations after the cut. But this time the Gabor is fixated with the second fixation. We can see here that the saccades go from the middle of the screen into the direction of the Gabor. This happens in all four conditions. Interesting here is, that only by looking at the fixations, we can get a first glimpse that there might be no obvious Simon Effect visible in the fixation pattern of the subjects. If there would be a Simon Effect, the first fixation that didn't hit the Gabor would have been found more on the side of the cut's direction. So, if the cut goes to

the right, the first fixation would be drawn by the cut to the right side of the screen before the Gabor is hit with the second fixation. This means that even if the Gabor is shown on the other side, in this case left, the cut to the right would result in a fixation which is further on the right side. A cut to the left would result in fixations further on the left. All this does not seem to be the case here.

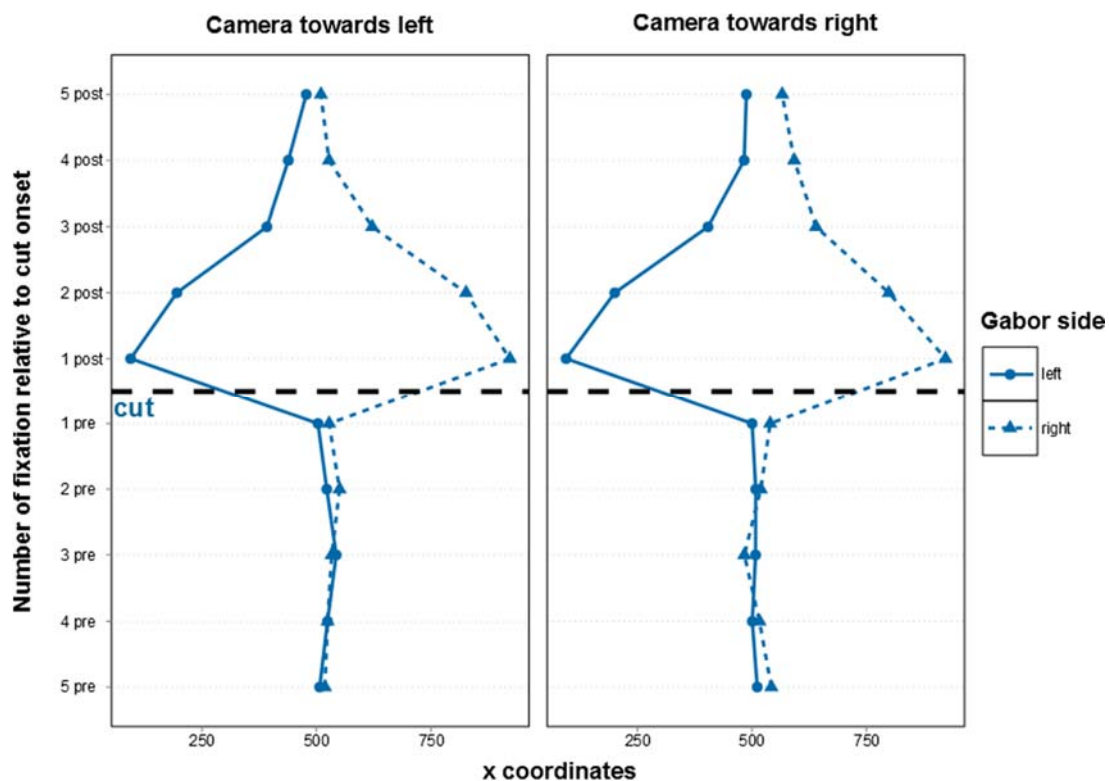


Figure 3. First fixation after the cut hitting the Gabor. The last five fixations before the cut and the first five fixations after the cut are displayed. To the left we can see camera movement to the left and its congruent condition in this case is the left one (full line). On the right side is camera movement to the right side, the congruent condition is displayed on the right side (dotted line).

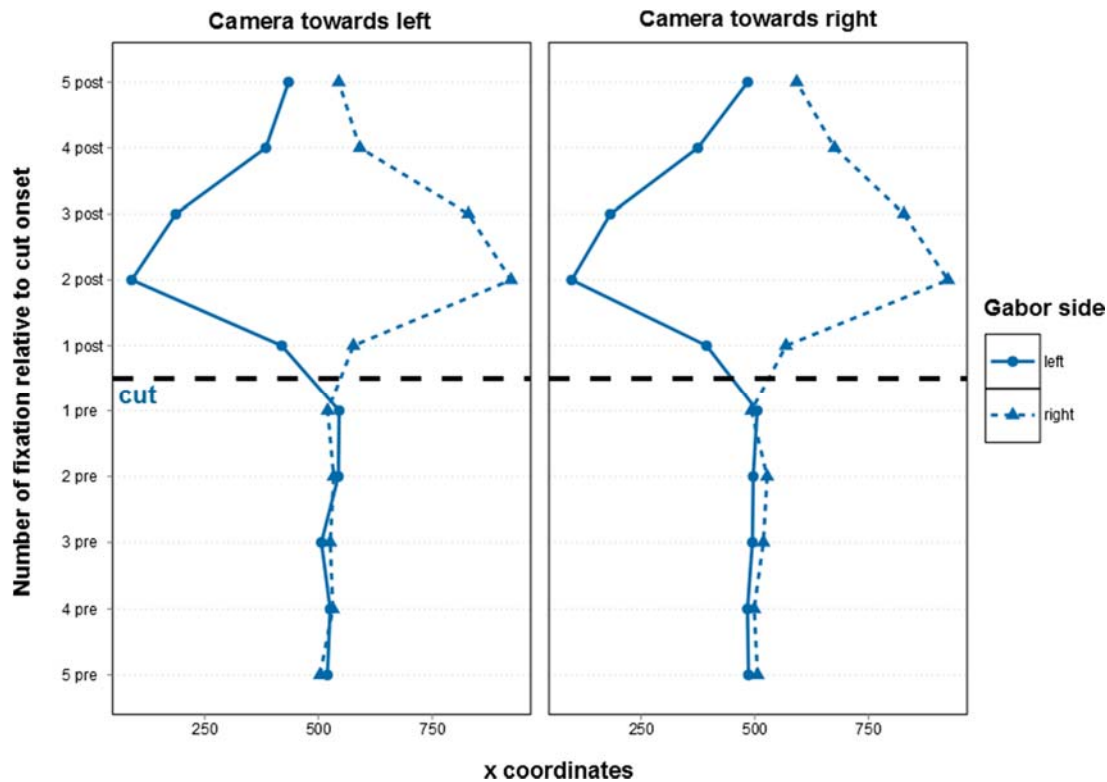


Figure 4. Second fixation after the cut hitting the Gabor. The last five fixations before the cut and the first five fixations after the cut are displayed. To the left we can see camera movement to the left and its congruent condition in this case is the left one (full line). On the right side is camera movement to the right side, the congruent condition is displayed on the right side (dotted line).

4.3 ANOVA of coordinates of fixation on the x-axis

Now to see if the different fixation points in the graphs (see figure 3 and figure 4) show differences between cut direction and Gabor side repeated measurement ANOVAs were calculated for the first fixation before the cut, the first fixation after the cut, and the second fixation after the cut. Also the means and standard deviations of the coordinates of fixation involved will be displayed. Table 2 for first fixation hits and Table 3 for second fixation hits.

The two factors involved were again cut direction and Gabor side forming the independent variable. The dependent variable in this case are the different coordinates on the x – axis.

4.3.1 ANOVA of coordinates of fixation on the x-axis, Gabor hits with first fixation

To see if there are differences in the fixation points even before the cut and display of the Gabor we will first look at the last fixation point before the cut. Therefore an ANOVA was calculated and it showed that there was no effect on the fixation points from the side of the cut, $F(1,18) = 0.022$; $p = .885$, but there was one of the side of the Gabor, $F(1,18) = 5.168$; $p = .035$, but none of the interaction of cut side and Gabor side, $F(1,18) < 0.001$; $p = .998$.

Now, the first fixation after the cut hit the Gabor, still we are going to look at the resulting fixations and interactions. The ANOVA showed no effect of the side of the cut, $F(1,18) = 0.445$; $p = .513$, and of course one of the Gabor side as the Gabor was displayed now, $F(1,18) = 26504.531$; $p < .001$. But there was no interaction of cut side and the Gabor side, $F(1,18) = 0.070$; $p = .795$.

For the second fixation after the cut, the ANOVA showed also no effect of the side of the cut, $F(1,18) = 0.007$; $p = .932$, and still showed an effect of the Gabor-side, $F(1,18) = 248.096$; $p < .001$. But there was no interaction of cut-side and the Gabor-side either, $F(1,18) = 0.307$; $p = .586$.

For clarity reasons follows a table of means and standard deviations of the coordinates of fixation on the x-axis for those who hit the Gabor with the first fixation.

Table 2. The means and standard deviations of the coordinates on the horizontal x - axis for the last fixation before the cut (left), first fixation after the cut (middle), and second fixation after the cut (right) in all four conditions. This table shows those who hit the Gabor with the first fixation.

	Last before cut		1 st after cut		2 nd after cut	
	Mean	SD	Mean	SD	Mean	SD
Towards left /left	501.9	48.9	92.9	28.7	179.6	111.3
Towards left / right	529.9	49.5	926.5	26.7	833.2	116.3
Towards right /left	503.6	38.6	95.7	22.8	189.7	117.1
Towards right / right	532.6	76.1	927.7	25.8	826.2	113.0

4.3.2 ANOVA of coordinates of fixation on the x-axis, Gabor hits with second fixation

For those who hit the Gabor with the second fixation the calculated ANOVA showed for the last fixation before the cut an effect of cut side, $F(1,18) = 9.132$; $p = .007$. There was no effect of Gabor side, $F(1,18) = 2.672$; $p = .119$, or an effect of the interaction of Gabor side and cut side, $F(1,18) = 0.811$; $p = .380$.

At the first fixation after the cut the effect of the cut side disappears, $F(1,18) = 0.840$; $p = .372$. But there is an effect of Gabor side, $F(1,18) = 42.696$; $p < .001$. as the gaze adjusts into the direction of the Gabor. There is no interaction effect, $F(1,18) = 1.162$; $p = .295$.

An ANOVA for the second fixation where the Gabor was hit showed no effect of cut side, $F(1,18) = 1.094$; $p = .309$, and of course an effect of Gabor side, $F(1,18) = 26393.498$; $p < .001$. There was no interaction between cut side and Gabor side, $F(1,18) = 1.917$; $p = .183$.

It follows a table of means and standard deviations of fixation points on the x-axis for those who hit the Gabor with the second fixation.

Table 3. The means and standard deviations of the coordinates on the horizontal x - axis for the last fixation before the cut (left), first fixation after the cut (middle), and second fixation after the cut (right) in all four conditions. This table shows those who hit the Gabor with the second fixation.

	Last before cut		1 st after cut		2 nd after cut	
	Mean	SD	Mean	SD	Mean	SD
Towards left /left	555.8	95.8	413.0	132.9	91.9	23.8
Towards left / right	519.7	66.0	628.6	178.2	928.6	32.6
Towards right /left	513.1	68.1	419.4	131.4	98.1	26.6
Towards right / right	498.6	44.3	570.4	88.9	926.9	27.4

4.3.3 ANOVAs of coordinates of fixation on the x-axis, first and second fixation hits Gabor

To control influences of small samples we will also look at the first fixation before the cut when the first or the second fixation hit the Gabor. Here the conducted ANOVA found neither an effect for the direction of the cut, $F(1,37) = 3.488$; $p = .070$, nor for the side of the Gabor $F(1,37) = 0.015$; $p = .903$, nor for the interaction of the direction of the cut and the side of the Gabor, $F(1,37) = 0.387$; $p = .538$.

For clarity reasons follows a table of means and standard deviations of fixation points on the x-axis for both conditions.

Table 4. The means and standard deviations of the coordinates on the horizontal x - axis for the last fixation before the cut in all four conditions. This table shows both those who hit the Gabor with the first fixation and second fixation together.

	Last fix before the cut	
	Mean	SD
Towards left /left	528.9	79.9
Towards left / right	524.8	57.8
Towards right /left	508.4	54.7
Towards right / right	515.1	63.6

5. Discussion

First and foremost there was no interaction of the direction of the cut, and the side of the Gabor found in this experiment. Neither for the reaction times, nor for the coordinates on the x-axis. This leads to the conclusion that there was no Simon Effect present in this experiment.

5.1 About reaction times

There was no significant effect for the reaction times of those hitting the Gabor with the first or with the second fixation. There was no effect of the direction of the cut, or the side of the Gabor and no significant effect of the interaction between those two factors. Concerning the reaction times there is no Simon Effect to be found in any of the conditions.

There might be a slight advantage in resulting reaction times of the cut to the left for those who hit the Gabor with the first fixation, and a slight advantage for the cut to the right for those who hit the Gabor with the second fixation, but both effects of cut side did not reach significance.

5.2 About coordinates

At the last fixation before the cut we found, concerning the coordinates on the x- axis, that the factor direction of the cut got significant when the first fixation after the cut hit the Gabor. Also, Gabor side was found to be significant at the last fixation before the cut for the trials where the Gabor was hit with the second fixation. Taking both those who hit the Gabor with the first and second fixation into account, there was neither a significance for cut side, not for the side the Gabor appeared on. This makes it possible that the resulting significances in the last fixation before the cut were due to the small sample size. We especially have to keep in mind that the videos were not cut at this point of time, and the Gabor has not appeared yet. Resulting differences and significances can therefore not be due to cut direction or Gabor side because those two factors have not even appeared yet, and the effect also disappeared completely when taking both first and second fixation hits into account.

Neither the trials in which the subject's gaze hit the Gabor with the first fixation nor those fixated with the second fixation showed an interaction between cut direction and Gabor side concerning the coordinates on the x-axis, leading to the conclusion that there is no Simon Effect present when looking closely at the coordinates of the fixations. But we were able to see that there was an effect for Gabor side, because the subjects had to look onto the Gabor as soon as it appeared. Interesting here is that for those who hit the Gabor with the first fixation after the cut a trend to still look near the Gabor with the second fixation was present. For those who looked at the Gabor with the second fixation after the cut, also the first fixation after the cut was significant for Gabor side. In this case this means that the subjects tend to look into the direction of the Gabor even if they did not manage to look at the Gabor directly with the first saccade they made. In both conditions there is no

interaction between Gabor side and the direction of the cut, which strengthens the assumption of no Simon Effect in this experimental setup.

5.3 Dimensional Overlap

But why have we found no Simon Effect in this study, shouldn't the cut be able to influence the reaction times and the location of gaze between congruent and incongruent trials? The Dual Route Model suggests, as Kornblum et al. (1990) argue, we need at least four factors to achieve performance differences between congruent and incongruent conditions. Those four factors are:

“(a) The degree of dimensional overlap between stimulus and response sets, (b) the response identification process for the correct response, (c) the automated activation process for the congruent response, and (d) the abort process for the congruent that this necessitates in incongruent mapping conditions.” (Kornblum et al., 1990, p.262)

So it could be possible that the dimensional overlap was not strong enough, which means the conceptional similarity and/or physical properties between stimulus and response were not high enough. The identification process for the correct response could therefore be not disturbed by the automated activation process of the congruent response. So the Gabor was identified and the video cuts did not elicit better reaction times in the congruent response condition and worse in the incongruent one. This also means that there could have been no abort process necessary in the present experiment, as following the Dual Route model we would need the abort of the focus of the direction of the cut to look at the Gabor to find an a Simon Effect. Those reasons could explain the lack of Simon Effect under the present conditions and stimuli.

5.4 Viewing Tendencies

There are different theories of where fixations are found when stimulus material is presented on a screen.

First of all there is the centre bias. Bindemann (2010) claims that one has a central viewing tendency when analysing a scene. He also states that it is a significant factor and artefact when exploring the facets of visual perception. He showed pictures of scenes a bit left or right of the centre of the screen and found that even if the fixation is always towards the direction of the picture, it fails to reach the middle of it. This could also apply for the cuts and the videos in the experiments which were conducted here. Because the initial fixation on the screen could also be a strategic artefact that happens independently of the location of the fixation cross, Bindemann (2010) found that this also happens with fixation points on the side of the screen. At least our calibration point which is displayed in the middle of the screen would therefore not particularly interfere with the results, but the central viewing tendency would.

Second it could be possible that an initial fixation on the centre of the screen could be an advantage for information extraction which makes it easier to detect stimuli on both sides of the screen (Najemnik & Geisler, 2005). The positioning of the gaze in the middle of the screen could therefore have an advantage over any other position in a detection and reaction task.

Which leads us to another explanatory approach. One could presume that the subjects only focused on the detection of the Gabor without really watching the videos. Therefore a fixation of the middle of the screen would be advantageous to detect the onset of the Gabor on both sides as fast as possible (Najemnik & Geisler, 2005) and would be a good strategy to fulfil the task at hand as the videos did not need active processing.

Other viewing tendencies include a tendency to saccade left when looking at photographs of scenes. They also found that the first saccade tends to go to the left side (Foulsham, Gray, Nasiopoulos and Kingstone, 2012). As there is a nearly significant effect for the side of the cut in favour of the left side concerning the reaction times for those who hit the Gabor with the first fixation, this should be taken into account. This could also be due to the participants reading direction (Chockron & De Agostini, 1995).

Neurological patients with hemispatial neglect often have damage in their right parietal lobe which leads to a bias in their attention to the right side of the world, while neglecting the left (Corbetta & Shulman, 2002). But with most healthy individuals the opposite tendency is found. When asked to dissect lines in the middle, healthy individuals tend due to the right hemispheric dominance to part the line on the left of the centre more often (Fischer, 2001).

To take all the viewing tendencies into account while working to understand a single effect, or better, the absence of an effect, in this case might go too far, but it is important to understand how many influences one can think of when interacting with the world around us.

5.5 Limitations of the cuts and videos as Stimulus Material

There is also a chance that the stimulus material had its flaws to test the hypotheses. As the direction of the cut should have an influence on how fast we look at the Gabor, it would be important to see this cut and to be able to process its direction.

First, motion attracts attention and makes it easier for a cut to go undetected (Levin & Varakin, 2004). The motion of the action, in this case the person's hands manipulating various objects took place in the middle of the screen. And it took place in the middle before and after the cut, because hands and objects were displayed in the middle of the screen, but

from different viewpoints. This kind of cut is also called matched-action cut, because the motion displayed is used to give the imagination of continuous flow.

A study of Smith and Henderson (2008) even shows that a third of all matched-action cuts were not detected by the participants. Sadly we do not have any information about the percentage of cuts detected in the present study, which would maybe be good to include in further research concerning the present topic.

Second, Tatler & Land (2011) argue that a change in viewpoint, which is easily and instantly possible with a cut, would, be accompanied by a change of the body and head of the person viewing the scene in real life. Those movements take some time to conduct and even during these movements the representation of the viewer's spatial position is updated regularly. To achieve a complete mental representation of the scenes shown from another viewpoint, we would have to rotate the whole representation of the scene in our head which would be a great effort to do so (see also: Smith, Levin & Cutting, 2012). Therefore it is easier for a person to focus at the action or objects themselves and wait for the Gabor to appear in a central position, than thinking of the position they obtain and change in the videos presented.

5.6 Attention shifts and Smooth Movement

As stated above it is possible that a cut is not always detected, especially a cut where the action stays the same and approximately at the same place between pre-cut scene and post-cut scene, is not always obvious. This brings other findings to discuss.

Ehrenstein (1994) showed in his study that the smooth motion of a Stimulus was not able to elicit a Simon Effect. To call the cut from pre to post cut scene a smooth movement might go too far, but Ehrenstein (1994) also emphasises the role attention shifts that tend to precede saccadic eye movements. In his study, and maybe also in this one we can argue that

the absence of the Simon Effect was due to the absence of a shift of attention (Rizzolatti, Riggio, Dascola & Umiltà, 1987). On the other hand Kerzel, Hommel and Bekkering (2001) showed “that the Simon Effect does not depend on the preparation of saccadic eye movements or attention shifts” (quoted from Bosbach et al., 2005, p.470).

6. Conclusion and Lookout

There was no Simon Effect found in this study. The cuts were not able to elicit a Simon Effect when the person had the task to look at the Gabor till it vanished. We argued that this could be due to lacking dimensional overlap between stimulus and response, different kind of viewing tendencies or impairments of the stimulus material to test the hypotheses.

Still this is an important topic and further studies should be conducted to find out what makes a Simon Effect happen and to explore the role attention plays in all this, or if it plays not a role at all, as the referential coding account claims.

If we are able to understand these topics of fundamental research, we will be able to understand better how we react to our world. An example for using resulting findings would be to understand mechanisms better that arise when people watch TV or maybe how to place things right in advertisements.

This thesis tried to shed light on the Simon Effect using natural stimuli and if it is able to be elicited by perspective change. Further research is still necessary to understand this topic completely.

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8. Appendix

Table with movement direction, perspective change, the names of the objects and actions involved. Followed by the sex of the actor, the information if the video was mirrored (0 = no, 1 = yes), and the seconds the video was shown before the cut.

#	Movement	Perspective	Object/Action	Sex	Mirror	Cuttime
1	towards left	centre -> left	ballon	m	0	3
2	towards left	centre -> left	book	m	1	3
3	towards left	centre -> left	bowl	m	1	3
4	towards left	centre -> left	candle	m	1	4
5	towards left	centre -> left	CarvedWood	m	0	4
6	towards left	centre -> left	chicken	m	1	4
7	towards left	centre -> left	controller	m	0	5
8	towards left	centre -> left	cuke	m	0	5
9	towards left	centre -> left	dish	m	0	5
10	towards left	centre -> left	egg	f	0	3
11	towards left	centre -> left	lotion	f	1	3
12	towards left	centre -> left	seal	f	0	3
13	towards left	centre -> left	gameboy	f	0	4
14	towards left	centre -> left	madarin	f	1	4
15	towards left	centre -> left	shoe	f	0	4
16	towards left	centre -> left	glas	f	1	5
17	towards left	centre -> left	muffin	f	1	5
18	towards left	centre -> left	silverware	f	0	5
19	towards left	right -> centre	egg	m	0	3
20	towards left	right -> centre	gameboy	m	0	3
21	towards left	right -> centre	glas	m	1	3
22	towards left	right -> centre	harmonica	m	0	4
23	towards left	right -> centre	ikea	m	1	4
24	towards left	right -> centre	keyboard	m	0	4
25	towards left	right -> centre	key	m	1	5
26	towards left	right -> centre	knife	m	1	5
27	towards left	right -> centre	lego	m	1	5
28	towards left	right -> centre	ballon	f	0	3
29	towards left	right -> centre	music	f	0	3
30	towards left	right -> centre	soup	f	0	3
31	towards left	right -> centre	book	f	1	4
32	towards left	right -> centre	paperplane	f	0	4
33	towards left	right -> centre	telephone	f	1	4
34	towards left	right -> centre	bowl	f	0	5

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35	towards left	right -> centre	plant	f	1	5
36	towards left	right -> centre	textmarker	f	0	5
37	towards right	centre -> right	lotion	m	1	3
38	towards right	centre -> right	mandarin	m	1	3
39	towards right	centre -> right	muffin	m	1	3
40	towards right	centre -> right	music	m	1	4
41	towards right	centre -> right	paperplane	m	0	4
42	towards right	centre -> right	plant	m	0	4
43	towards right	centre -> right	raspMetal	m	1	5
44	towards right	centre -> right	salt	m	0	5
45	towards right	centre -> right	scissors	m	0	5
46	towards right	centre -> right	candle	f	1	3
47	towards right	centre -> right	harmonica	f	1	3
48	towards right	centre -> right	watch	f	0	3
49	towards right	centre -> right	carvedWood	f	0	4
50	towards right	centre -> right	ikea	f	0	4
51	towards right	centre -> right	water	f	1	4
52	towards right	centre -> right	chicken	f	1	5
53	towards right	centre -> right	keyboard	f	1	5
54	towards right	centre -> right	wood	f	1	5
55	towards right	left -> centre	seal	m	1	3
56	towards right	left -> centre	shoe	m	1	3
57	towards right	left -> centre	silverware	m	1	3
58	towards right	left -> centre	soup	m	0	4
59	towards right	left -> centre	telephone	m	1	4
60	towards right	left -> centre	textmarker	m	0	4
61	towards right	left -> centre	watch	m	0	5
62	towards right	left -> centre	water	m	1	5
63	towards right	left -> centre	wood	m	1	5
64	towards right	left -> centre	controller	f	1	3
65	towards right	left -> centre	key	f	1	3
66	towards right	left -> centre	raspMetal	f	1	3
67	towards right	left -> centre	cuke	f	0	4
68	towards right	left -> centre	knife	f	1	4
69	towards right	left -> centre	salt	f	0	4
70	towards right	left -> centre	dish	f	1	5
71	towards right	left -> centre	lego	f	1	5
72	towards right	left -> centre	scissors	f	0	5

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