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*Laterality.*

## **Reading and writing direction effects on the aesthetic appreciation of photographs**

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## **Abstract**

Does reading and writing direction (RWD) influence the aesthetic appreciation of photography? Pérez González (2012) showed that 19th century Iranian and Spanish professional photographers manifest lateral biases linked to RWD in their compositions. The present study aimed to test whether a population sample showed similar biases. Photographs with left-to-right (L-R) and right-to-left (R-L) directionality were selected from Pérez González's collections and presented in both original and mirror reversed forms to Spanish (L-R readers) and Moroccan (R-L readers) participants. In Experiment 1, participants rated each picture for its aesthetic pleasingness. The results showed neither effects of lateral organisation nor interactions with RWD. In Experiment 2, each picture and its mirror version were presented together and participants chose the one they liked better. Spaniards preferred rightward versions and Moroccans preferred leftward versions. RWD therefore affects aesthetic impressions of photography in our participants when people pay attention to the lateral spatial dimension of pictures. The observed directional aesthetic preferences were not sensitive to the sex of the model in the photographs, failing to support expectations from the hypotheses of emotionality and agency. Preferences were attributable to the interaction between general scanning strategies and scanning habits linked to RWD.

**Keywords:** aesthetics, reading and writing direction, spatial biases, photography, fluency.

Can the aesthetic appreciation of a piece of visual art be affected by reading and writing directional habits? Many spatial dimensions are relevant to aesthetics in visual art. For example, Gaffron (1956) discusses horizontal, vertical, and diagonal lines, and Christman and Pinger (1997) discuss the spatial distribution of directionality, weight, and interest. Moreover, people show clear biases on some spatial choices. A dimension that has received much empirical attention is the lateral organisation of an image: its left-to-right (L-R) or (R-L) directionality. An example of a well-known bias on lateral organisation is the left-cheek bias, McManus and Humphrey (1973) showing that European portrait painters more often painted the left (as opposed to the right) cheek, the person turning towards the left side of the viewer, showing their left cheek, which we will call a “leftward” or “R-L pose”. This bias has since been linked to the emotional value that artists, posers, and the public assign to the pose (see McManus, 2005; Suitner & McManus, 2011; and Lindell, 2013, for reviews and discussions of possible mechanisms). However, emotional connotations are not the only cause of lateral biases. For example, brain lateralisation and handedness can also induce lateral biases (see, e.g., Levy, 1976). In this paper we focus on the lateral biases produced by reading and writing direction (RWD), the effects of which on aesthetic appreciation have received little attention in the literature.

Since reading and writing are highly practiced skills with a strong systematic directionality, it makes intuitive sense that the direction of the script might induce aesthetic lateral preferences. RWD has indeed been shown to generate lateral spatial biases that affect how people draw (Vaid, Singh, Sakhuja, & Gupta, 2002), visually explore (Abed, 1991), pay attention to (Pérez, García, Valdés-Sosa, & Jaśkowski, 2011), and comprehend descriptions both of events (Maass & Russo, 2003) and of static scenes (Román, El Fathi, & Santiago, 2013), and how they mentally represent time (Ouellet, Santiago, Israeli, & Gabay, 2010) and number (Zebian, 2005).

Most studies exploring the effects of RWD on aesthetic preferences have used simple line drawings, and most of them have adopted variants of the same strategy: one image and its mirror

version are presented (either side by side or one on top of the other) and participants are asked to indicate which one they prefer. RWD is manipulated pseudo-experimentally by presenting these images to users of L-R or R-L scripts. Chokron and De Agostini (2000) compared drawings of objects which can move (e.g., a truck or a fish facing toward one side), static objects (e.g., a statue with an arm extended to one side), and landscapes (e.g., a beach with a salient object located on one side). They observed clear lateral preferences congruent with RWD in French and Hebrew participants in the drawings of moving and static objects: French users preferred L-R drawings whereas Hebrew participants preferred their R-L versions (see also De Agostini, Kazandjian, Cavezian, Lellouch, & Chokron, 2010, for mediating factors such as sex and handedness; Ishii, Okubo, Nicholls, & Imai, 2011, for a replication with Japanese readers; and Heath, Mahmasanni, Rouhana, & Nassif, 2005, for an exploration of spatial dimensions specific to landscapes). Nachshon, Argaman, and Luria (1999) used profile drawings of people (which correspond to the category of objects with potential motion) and found similar results: L-R readers preferred L-R profiles, and R-L readers preferred R-L profiles. Friedrich, Harms, and Elias (2014) used drawings of objects that can move and actual clips with moving objects, and observed an overall preference for L-R directionality, which was much reduced or even null in users of R-L scripts. Movies showed stronger biases than drawings, which is probably due to the greater saliency of directional cues in film. To our knowledge, only one study has presented materials individually. Maass, Pagani, and Berta (2007) showed movie clips of lateral actions, and asked their participants to rate each one on three Likert scales: strength, speed, and beauty. L-R readers rated L-R actions as stronger, faster, and more beautiful than R-L actions, with R-L readers showing a completely reversed pattern in their ratings. Taken together this literature suggests that readers of L-R and R-L scripts differ in their directional preferences when judging how aesthetically pleasing are stimuli, with L-R readers showing a clear preference for L-R drawings, and R-L readers showing either a reduced L-R bias, no bias, or the opposite R-L bias.

Only one study so far has assessed the influence of RWD on aesthetic preferences in visual art. Pérez González (2011) analyzed two corpora of 19th-century studio photographs, one from Spain (where the language is written L-R) and another from Iran (where the writing is R-L). She analyzed five kinds of compositions with clear directionality: *Linear Orderings* (a group of more than two people, often siblings, arranged by their height), *Couples* (one person standing and one sitting), *Chairs* (a single person standing and resting an arm on a chair), *Tables* (a single person sitting and resting one arm on a table), and *Portraits* (a single person portrayed with no props). The results showed clear effects of RWD on the number of photographs with a L-R and R-L directionality in each condition. The proportions of L-R and R-L in Linear Orderings and Couples was perfectly predicted by RWD. Chairs, Tables, and Portraits showed clear modulation by RWD as well as an overall R-L bias (an overrepresentation of leftward poses). These data support the idea that professional photographers are sensitive to the lateral spatial dimension in photographic compositions and are affected by biases that arise as a result of their habitual RWD. The first and foremost question asked in the present study is whether a population sample also shows directional aesthetic preferences when observing the type of photographic materials collected by Pérez González.

#### *RWD and the causes of the left-cheek bias*

In addition to revealing the workings of directional biases acquired from exposure to the script, the effects of RWD can also be used to shed light on the causes of the left-cheek bias reported in painted and photographic portraits (McManus & Humphrey, 1973). There are currently two main proposals on the origins of the left-cheek bias. Nicholls, Clode, Wood, and Wood (1999) proposed what we will call the ‘emotionality account’. They suggested that the bias is related to the intuitive knowledge that the left side of the face is more emotionally expressive, so that when participants were asked to express emotionality, they tended to offer their left cheek, whereas when

they were asked to conceal emotions and look more serious and professional, they tended to offer their right cheek. As women tend to be more emotional than men and feel more comfortable expressing their emotions, this proposal can account for the greater left-cheek bias observed in female than male portraits (McManus & Humphrey, 1973). Within this account, there are no reasons to expect that the left-cheek bias will change depending on the RWD of the model or the artist.

A second account, of the left-cheek bias, the ‘agency account’, does predict an interaction with RWD. Chatterjee (2002) proposed that the left-cheek bias was related to a wider predisposition that arises from repeated exposure to the sequence Subject-Object when reading sentences along the left-right axis. In most languages the Subject precedes the Object in the sentence, and the Subject typically mentions the agent of the action whereas the Object encodes the grammatical patient. Thus, extended practice in reading generates a directional schema for the flow of action along the lateral axis. In L-R readers, this schema places agents and causes on the left and patients and consequences on the right, generating a L-R spatial agency bias (Chatterjee, Maher, Rothi, & Heilman, 1995). Maass and Russo (2003) showed that the spatial agency bias does reverse with RWD, arabic (R-L) readers tending to place agents on the right of patients and to depict actions following a R-L directionality. Applying the spatial agency bias to pieces of visual art is straightforward, with a leftward pose being chosen (be it by the model, the artist, or both) because the model is in a passive attitude. When trying to look more agentic, a rightward pose may be chosen. Moreover, the left-cheek bias is expected to be stronger in women than in men, as women are stereotypically considered less agentic social groups than men (Chatterjee, 2002). An additional advantage is that the spatial agency bias can be applied to compositions where more than one person is depicted, such as a man and a woman. Maass, Suitner, Favaretto, and Cignacchi (2009) observed that Italian readers tend to represent social groups differing in agency (men vs. women,

old vs. young) placing the more agentic group on the left, whereas Arabic readers prefer to locate the more agentic group on the right.

It is important to emphasize that the two accounts are not mutually exclusive, and Pérez González's (2012) data are partially consistent with both. In her corpus, the directionality of photographs of Linear Orderings and Couples was perfectly predicted by RWD. In contrast, Chairs, Tables, and Portraits showed an overall R-L bias together with variations linked to RWD. This suggests an interesting possibility: when several people are depicted in a work of art, it is their relative agency what affects the lateral organisation of the image, but when only one person is depicted, the emotionality of the left side of the face exerts an additional effect to the agentivity gradient. The present study aims to shed some light on this question.

The ability of the present study to contribute to this discussion however depends also on a more general question which is still open to debate. It is known that lateral biases in portraits affect the impression of emotionality and agency, but the evidence on whether they also affect the aesthetic pleasantness aroused in the perceiver is scant and inconsistent. Benjafield and Segalowitz (1995) found effects of portrait direction on potency and activity scales, but not on evaluation scales using a Semantic Differential. In contrast, using a forced choice between mirror versions of the same portraits, McLaughlin and Murphy (1995) observed a preference for L-R poses (contrary to the left-cheek bias) that was also independent from the sex of the model. Blackburn and Schirillo (2012) reported higher aesthetic ratings and greater pupillary sizes for R-L than L-R poses in photographs, but again their measures did not differ between male and female models. These results also fail to converge with findings by Powell and Schirillo (2011) using Rembrandt's painted portraits, who observed that the evaluation of female, but not male, portraits was affected by directionality, but evaluation did not correlate with pupillary sizes. It is, therefore, rather unclear what, if any, are the effects of lateral organisation on the aesthetic evaluation of portraits. The



present study manipulated lateral organisation of portraits, as well as the sex of the poser, in an effort to distinguish the various possibilities.

*How is the directionality of a picture defined?*

A methodological question of central importance is how to define the directionality of an image. The studies reviewed above have used different criteria. The most obvious criterion is actual movement, as in the movie clips used by Maass et al. (2007), where there is direct evidence for motion. A bit more indirect is the directionality implied by objects with an intrinsic front and back which are capable of forward movement, such as people (Nachshon et al., 1999), trucks, or animals (e.g., Chokron & De Agostini, 2000). Even more indirect are pointing objects, such as a statue with an extended arm (Chokron & De Agostini, 2000) or an elongated triangle (Christman & Pinger, 1997). More difficult still is the case of static compositions containing several objects. In their landscape condition, Chokron and De Agostini (2000) coded the directionality of the image as moving toward the position of a small and interesting object (e.g., an umbrella on a beach). In contrast, Christman and Pinger (1997) compared three kinds of directional cues: weight (the location of the tallest and heaviest object), interest (the location of the object of focal interest), and pointing. Their results were complex and suggested that aesthetic pleasantness is affected by the interaction of different directional cues. The use of people in compositions brings about yet other considerations. In single-person compositions (Portraits), facing direction serves as a clear criterion. In multi-person compositions, Pérez González (2012), following Maass, Suitner, Favaretto, and Cignacchi (2009), located the directional origin at the point of greater agency (which correlates with height and also with social group). For example, different-sex couple compositions with the taller person (the man) on the left were considered to have L-R directionality. Pérez González (2012) also suggested that agency was at work even in single person compositions (Portraits) where a prop such as a table or chair was used, as the human object would be more agentive than the inanimate prop.

For example, in R-L Tables and Chairs compositions the model would be leaning the right arm on a table or chair, adopting a leftward pose. As these examples illustrate, it is often difficult to disentangle different criteria of directionality such as agency, weight (height), and facing direction. Finally, Pérez González (2012) used still one more directionality criterion for the multi-person compositions called Linear Orderings, which was related to the number line: from smaller to greater height (i.e., compositions of siblings ordered from youngest on the left to oldest on the right were coded as L-R directionality). In this case, the number line criterion clashes with the agency and weight (height) gradients, which flow in the opposite direction.

In the present study we opted for a definition of directionality in scanning terms, which follows from what we term the ‘scanning hypothesis’. In single-person compositions (Portraits), face direction defines the directionality of the photograph. In multi-person compositions, the person who achieves greater height in the image is considered the origin and the directionality of the image flows from this person toward the smaller models. In compositions showing standing couples of different sex, usually the man is the person achieving greater height in the image, so a picture with the man on the left and a woman on the right should be coded as L-R directionality. A composition with a standing woman on the right and a sitting man on the left would have R-L directionality.

We believe the scanning criterion of directionality is based on universal preferences of visual scanning and exploration. In the single-person case, it is well established that gaze acts as a powerful and automatic attentional cue (Ansorge, 2003). In the multi-person case, it is also well known that the height of people, and hence, size, is highly associated with status and power (Dannenmaier & Thumin, 1964; Petersen, Sznycer, Sell, Cosmides, & Tooby, 2013) and even preverbal infants use height/size to predict social dominance (Thomsen, Frankenhuys, Ingold-Smith, & Carey, 2011). Therefore, we suggest that scanning a social scene is likely to start from the person of greatest height and proceed toward those of lesser height. In both the single- and multi-person cases these putative universal scanning principles provide a directionality gradient to the picture.

Fortunately, it is possible to test empirically the nature of the directionality gradient or gradients that are at work in the present study by assessing the effects of RWD, the sex of the models and their interactions. Firstly, the emotionality account predicts a stronger R-L bias for women than men, and does not predict any effect of RWD nor interaction between the two factors. In contrast, both the agency and scanning accounts predict an effect of RWD and an interaction between RWD and the sex of the models, but for different reasons: the former because sexual stereotypes differ in agency, and the latter because height is highly correlated with social groups which vary in agency (men vs. women, but also adults vs. children, young vs. old). However, the scanning hypothesis predicts that the critical factor is not sex, but universal gaze- and height-based scanning gradients. Therefore, the two factors can be dissociated, for example, when the woman is standing and the man sitting. Moreover, the data should also be able to reveal whether Linear Orderings require the use of a specific directional criterion (the number line), as that would predict the opposite pattern of directional aesthetic preferences in this kind of composition.

### *The present study*

Photography, both professional and amateur, poses many problems for the understanding of aesthetics (McManus & Stöver, 2014), but also allows opportunities for testing hypotheses (e.g., McManus, Stöver, & Kim, 2011). Photography may actually be a better test case than other kinds of visual art (e.g., paintings) to examine questions related to RWD-linked spatial biases because of the irrelevance of other factors which may also induce lateral biases, such as the handedness of the artist or lighting conditions. In this study we asked several questions regarding lateral biases in the aesthetic appreciation of photographs:

- 1) Our more general question is: Do members of the general public show RWD-linked lateral biases in their aesthetic appreciation of professionally produced photographs?

2) The second question is specific to portraits: Does the lateral organisation of portraits affect their aesthetic evaluation? If so, we will ask three questions that will let us assess whether there are directional biases due to emotionality, agency, and scanning:

2.a) Is there an overall R-L preference, which is not present in multi-person compositions? If so, this will be consistent with an influence of facial emotionality.

2.b) Is the R-L preference stronger for portraits of women than men? If so, this will be consistent with both facial emotionality and social agency.

2.c) Does R-L preference interact with RWD? If so, this will be consistent with influences of social agency and scanning.

3) The third question applies to multi-person different-sex compositions, where directionality biases induced by facial emotionality are not as likely (because of the use of frontal views or inconsistency between directionality of faces): Do RWD-linked biases vary as a function of the spatial arrangement of the sexes, or do they interact with the height of the models in the image? The former case (sex) will support the influence of an agency gradient and the latter (height) will support general scanning preferences. The finding that biases vary with the location of man and woman in different-sex standing couples will be consistent with both possibilities, because the man is always taller than the woman in our materials. Compositions of different-sex couples where one member is standing and the other is sitting will allow us to dissociate height and sex, and therefore, independently to assess the effects of agency and general scanning directional preferences.

4) The fourth question is specific to Linear Orderings: Do RWD-linked biases in Linear Orderings follow ascending height, as suggested by a number line gradient, or instead do they follow descending height, as expected from the scanning and agency accounts? In this case, as both accounts make incompatible predictions, the data will be consistent with only one of them.

In order to answer these questions, we selected L-R and R-L Spanish and Iranian photographs of four different composition types from Pérez González's collections and presented them both in

their original and mirror-reversed forms to young adults from Spain (who read an L-R script) and Morocco (who read an R-L script). In the first experiment, photographs were presented one by one to participants who were not expert photographers. They were asked to rate their aesthetic impression. In the second experiment, participants were asked to compare each photograph with its mirror image and choose the one they thought was more aesthetically pleasing.

## **Experiment 1**

In Experiment 1, participants rated the aesthetic pleasingness of each photograph. In an attempt to avoid participants only focusing on salient aspects of the pictures, such as the physical beauty of the characters, the instructions framed the study as selecting items for an exhibition of antique photographs and asked them to pay attention to all dimensions that make a photograph beautiful as a photograph.

### **Methods**

#### *Participants*

Eighty university students, 40 from Spain (16 males, 3 left-handers, mean age 23.8 years) and 40 from Morocco (20 males, 2 left-handed, mean age 21.6 years). Handedness was assessed by self-report. The Spanish participants were psychology students from the University of Granada who received course credit in return for their collaboration. Only two of the Spanish participants reported knowing a R-L language (Arabic). The Moroccan participants volunteered to participate without compensation. Most of them were university students from the National School of Business and Management or the Abdelmalek Esaadi University, both at Tangier, and all of them were highly proficient in at least one L-R language, and all but four participants were highly proficient in two or more L-R languages (French, English, and Spanish, in decreasing order of frequency). The study was approved by the Committee for Ethics in Human Research of the University of Granada.

## *Materials*

Pérez González's personal collection of 19th-century Iranian and Spanish photography was used to select the materials for this study. A total of 167 pictures were selected, belonging to different types of compositions, as described below. In each type, roughly half the stimuli had L-R and the other half had R-L directionality; half were of Iranian origin, half of Spanish origin. Some composition types were further divided into subgroups depending on whether the models were of the same or different sex and on the sex of the model achieving greater height in the image. We aimed to have the same number of items in each cell, although this was not always possible. Table 1 shows the whole design and the number of items in each cell.

Photographs with four different compositions were selected (see examples in Figure 1):

1. Linear Orderings: A group of more than two people (most often siblings) arranged by their height (it corresponds to the Linear Ordering category of Pérez González, 2012).
2. Couples: A standing couple, either of the same or different sex.
3. Sittings: Couples where one person is sitting and the other standing, also of the same or different sex. In different-sex couples, either the man or the woman could be standing (it corresponds to the Couple category of Pérez González, 2012).
4. Portraits: A single person is portrayed, either a man or a woman (it corresponds to the Portrait category of Pérez González, 2012).

The directionality of Linear Orderings, Couples and Sittings was coded as flowing from the location of the person achieving a greater height in the image. The directionality of Portraits depended on the direction of the face.

From the original 167 photographs, a second set was derived by reversing them horizontally, creating a mirrored image. Two sets of photographs were created containing only one version of each picture, such that one half of the originally L-R items were presented in their original form and

the other half was reversed (the same was done with the originally R-L items). Half the participants saw one set and half saw the other. All pictures were adjusted to have the same vertical size (500 pixels), while the horizontal size varied freely. They were presented centred on a 16-inch computer monitor with a grey background and viewed from a distance of approximately 50 cm.

### *Procedure*

Each group was tested in their own country by the same experimenter (S.Ch.) and using the same laptop computer. All interactions with the experimenter took place in the local native language (Spanish in Spain, and Darija, the local Arabic dialect, in Morocco). The experiment was programmed and run using E-prime. In each session, the participant received the following oral instructions in their native language:

“Thank you for taking part in this study. We will show you a series of antique photographs of people. We are preparing an exhibition about 19th-century Spanish and Iranian photographers, and we want to ask your help to select the most attractive works. There are many factors that make a photograph to be beautiful as a photograph, and while the person in the picture is part of them, the composition, organisation, context, and technical aspects, all help to give some pictures a special quality that makes them particularly attractive. Remember that they are all antique pictures so please do not take too much into account the quality of the image. Follow your intuition and evaluate each picture in a scale that goes from 1 (horrible picture, I would never select it) until 9 (very beautiful, I would select it for sure). Try to use all values in the scale”.

After clarifying any questions, the 167 pictures were presented, one at a time in a random order. In each trial, a fixation point was first presented for 500 ms, followed by the picture, and then the participant gave their aesthetic judgement by pronouncing aloud a number from 1 to 9. The experimenter sat behind the participant out of sight and entered the responses by means of the computer keyboard. Both the use of oral instructions as well as the response collection procedure

were meant to avoid the presentation of any visual stimulus with left-right directional characteristics (such as text or numbers). The picture stayed on screen until the experimenter entered the participant's rating, which started a new trial.

After the experimental block was finished, participants answered a debriefing sheet which included questions about the hypotheses of the study as well as an evaluation of how much they liked and practiced photography using a 4 point scale (from 1, not at all experienced, to 4, expert).

### *Designs*

In order to assure a good match between L-R and R-L photographs in all variables that may affect their aesthetic appreciation (beauty of the characters, image quality, and so on), we did not include in the design whether the picture was originally L-R or R-L (89 pictures were originally L-R and 78 were originally R-L pictures). When mirror-reversed, the resulting sets of 167 L-R and 167 R-L pictures only differ in their lateral organisation.

Photograph ratings were assessed by means of several separate analyses. The overall design was aimed to test for the presence of the interaction between habitual RWD and the directionality of the photographs (Question 1). This design factorially crossed Country of the picture (Spain, Iran), Type of composition (Linear Orderings, Couples, Sitings, Portraits), and Directionality (L-R, R-L) as within-participant factors, and RWD of the participant (L-R Spanish, R-L Arabic) as between-participant factor. Table 2 shows the number of items per cell in this design.

If the analysis of the overall design shows a significant three-way interaction between RWD, Directionality, and Type of composition, it can be further analysed using independent ANOVAs for each type of composition. That would allow testing of Question 2.a: Whether the interaction between RWD and Directionality is present in all types of composition, whereas the main effect of Directionality is present only in single-person compositions (Portraits). The independent analysis of



Linear Orderings allows testing of Question 4: Whether the directionality of Linear Orderings should be defined following a decreasing or increasing gradient of height.

To test for the effects of the location of man and woman in different-sex compositions (Question 3) and the sex of the model in Portraits (Question 2.b), we selected three relevant types of compositions which had a high enough number of items: different-sex Couples (12 Spanish and 9 Iranian pictures), different-sex Sitings (22 Spanish pictures, 10 with the man standing and 12 with the woman standing; there were not enough different-sex Iranian Sitings varying in the sex of the standing person to be used in this analysis), and Portraits (24 Spanish and 24 Iranian, half depicting men and half women). Data from each kind of composition were analysed independently. The ANOVA for Couples included Country of the picture (Spain, Iran) and Directionality (L-R, R-L) as within-participant factors, and RWD of the participant (L-R Spanish, R-L Arabic) as between-participant factor. The ANOVA for Sitings included Directionality and the sex of the standing person (man, woman) as within factors, and RWD as between factor. The ANOVA for Portraits included Country, Directionality, and the sex of the model (man, woman) as within factors, and RWD as between factor.

## Results

As handedness may affect lateral biases in aesthetic experience (De Agostini et al., 2010), the analysis was restricted to right-handed participants were (37 Spaniards and 38 Moroccans). Their self-rated level of expertise in photography was 1.13 ( $SD = 0.79$ , range 0-3, with only 6 participants rating themselves with a 3, and 11 with a 2). Spaniards and Moroccans did not differ on this variable ( $F < 1$ ). No participant suspected any connection of the study with RWD.

The analysis of the overall design revealed differences in the aesthetic ratings given to different kinds of compositions ( $F(3,219)=79.78, p < .001, \eta^2_p = .52$ ): photographs of Linear Orderings were the most appreciated ( $M=5.88$ ), followed in descending order by Couples ( $M=5.60$ ), Sitings

( $M=4.97$ ), and Portraits ( $M=4.59$ ). Additionally, Spanish photographs were preferred over Iranian photographs (5.61 vs. 4.90;  $F(1,73)=82.56$ ,  $p<.001$ ,  $\eta^2_p=.53$ ). There were no other main effects nor interactions (all  $p>.10$ ). Therefore, the directionality of the photograph, the habitual RWD of the participant, and their interaction, all failed to significantly affect aesthetic ratings, and this occurred in all types of compositions. This null result rules out the independent analysis of each type of composition.

In order to test for the effects of the sex of the models, we carried out three independent ANOVAs. A first analysis submitted photographs of different-sex Couples to an ANOVA including Country of the picture, Directionality, and habitual RWD of the participant. This ANOVA showed again a preference for Spanish vs. Iranian photographs (5.73 vs. 5.02;  $F(1,78)=59.90$ ,  $p<.001$ ,  $\eta^2_p=.43$ ) and no other significant effect nor interaction (all  $p>.18$ ).

A second analysis selected different-sex Sittings of Spanish origin, and submitted them to an ANOVA including Directionality, the sex of the standing person, and RWD. This ANOVA found only a greater appreciation of pictures where the woman (vs. the man) was standing (5.41 vs. 5.24;  $F(1,73)=6.15$ ,  $p=.02$ ,  $\eta^2_p=.08$ ; all other  $p>.17$ ).

A third analysis focused on Portraits, and submitted them to an ANOVA including Country of the picture, Directionality, the sex of the model, and habitual RWD of the participant. This ANOVA also failed to reveal any effect of Directionality nor any interaction between Directionality and RWD. The only significant findings were an overall preference for Spanish over Iranian photographs (4.97 vs. 4.26;  $F(1,78)=61.66$ ,  $p<.001$ ,  $\eta^2_p=.44$ ) and an interaction of Country of origin and the sex of the model ( $F(1,78)=53.75$ ,  $p<.001$ ,  $\eta^2_p=.41$ ). This showed that the preference for Spanish photographs was restricted to pictures of women ( $M=5.26$ ), but not of men ( $M=4.67$ ). The data, therefore, did not show any sensitivity to either RWD or lateral organisation, even when taking into account the sex of the models in the analyses.

## **Discussion**

Experiment 1 showed very clear, but null, results: there were neither effects of RWD and lateral organisation nor interactions between them on the aesthetic appreciation of photographs. This occurred in spite of the instructions emphasizing that participants should pay attention to all the aspects of a photograph that make it aesthetically pleasing, including its composition. Directionality and RWD also did not interact with the arrangement of men and women in photographs of couples neither standing or with one member sitting, nor with the sex of the model in portraits. As such, these results do not support any of the hypotheses that motivated this experiment. This null result is consistent with two possibilities: either those biases do not exist, or the present procedure was not sensitive enough to detect them.

Therefore, before concluding that RWD, agentivity, and emotionality do not affect the aesthetic impressions of the general public, we decided to test our hypothesis under conditions that facilitate paying attention to the spatial aspects of the compositions, while matching the influence of any other factors. In Experiment 2, therefore, participants were asked to compare directly each photograph and its mirror-reversed version and choose which one they liked better.

## **Experiment 2**

In this study, the same set of materials was presented, but each participant saw both the original and the mirror-reversed version of each photograph and chose the one that they preferred. However, we wanted to avoid presenting both pictures side by side or one directly above the other, firstly, because either layout may create rather artificial viewing conditions; and secondly, because the layout may induce configurational effects (such as a preference for pictures which are inward-looking versus outward-looking, pictures on upper versus lower locations, and so on) that may increase noise in the data. Therefore, we opted for presenting individually each version of each photograph, but letting the participant switch between them at will (a technique used in a previous

study of photography; McManus et al., 2011). After alternating between the two views of the picture as many times as desired and for as long as the participant wished, a key was pressed to indicate the overall preference for the version of the picture which was currently displayed, after which the participant moved on to the next pair of pictures.

If RWD interacts with the directionality of the photograph, we would expect that Spanish participants would prefer the original version of L-R pictures, and the mirror-reversed version of originally R-L pictures, whereas Moroccan participants would show opposite preferences. Thus, Question 1 can be answered positively in this design if a main effect of RWD on the proportion of choices of the L-R version is found in the overall analysis. The subsequent independent analysis of each kind of composition allows answering the remaining questions. A positive answer to Question 2.a would require Portraits, but not other kinds of compositions, to show a preference for the L-R version significantly smaller than 50% (hence, an increased preference for the R-L, more emotional, version). Regarding Question 4 about Linear Orderings, the use of general scanning preferences is supported if L-R readers prefer L-R orderings (which in our materials are defined using the descending height criterion); if they prefer R-L orderings, the number-line criterion is supported.

In Experiment 2 we tested whether the effect of RWD is modified by the sex of the models using the same three composition types as in Experiment 1: Couples, Sittings, and Portraits. Regarding Portraits, the emotionality account can be supported if the R-L preference is stronger for female than male faces (Question 2.b). If agency is at work (Question 2.c), L-R readers should show a greater preference for men looking rightwards and women looking leftwards, and R-L readers should show the opposite pattern (therefore, there should be an interaction between RWD and the sex of the model on the proportion of L-R choice). Different-sex Couples and Sittings are relevant to answering Question 3. If L-R readers prefer men (taller) standing on the left, and R-L readers prefer them standing on the right, both agency and height-based scanning preferences are supported. In different-sex Sittings, the agency account predicts that L-R readers should have a greater

preference for photographs with the man on the left and R-L readers should prefer those with the man on the right. In other words, the proportion choosing the L-R version (standing person on the left) should be greater in L-R readers when the standing person is a man than when it is a woman, and it should be greater in R-L readers when the standing person is a woman. The height-based scanning account predicts that L-R readers should prefer photographs with the standing person on the left, and R-L readers should prefer those with the standing person on the right, independently of sex. Agency and scanning might interact, leading to a magnified effect of height when the standing person is a man and a diminished effect of height when it is a woman.

## **Methods**

### *Participants*

Two new groups were drawn from the same populations as in Experiment 1: there were 40 Spanish participants (10 males, 6 left-handed, mean age 20.0 years) and 39 Moroccan participants (21 males, 5 left-handed, mean age 24.9 years). Spaniards were compensated with course credit, and Moroccans participated without compensation. No Spaniards spoke any language with a R-L writing system, whereas all Moroccans were highly proficient in at least one (often two) L-R languages (mostly French, followed by English and Spanish). The study was approved by the Committee for Ethics in Human Research of the University of Granada.

### *Materials*

The same set of materials as in Experiment 1 was used. Each participant saw all photographs, both original and mirror-reversed.

### *Procedure*

As in Experiment 1, Spanish participants were tested in Spain using Spanish, and Moroccan participants were tested in Morocco using Darija, as well as the same laptop computer (but not the same experimenter: A.F. tested Spaniards and S.Ch. tested Moroccans).

The pictures were presented in pairs formed by the original and the mirror-reversed version. Each trial started with the presentation of a single picture on the screen. The participant could then press the down-arrow key to move to the next member of the pair, and could then press the up-arrow to return to the prior image. There were no restrictions on the number of times that the participant could switch between pictures nor any time pressure to decide. Once he or she felt that they knew which one was the preferred picture, and having that picture on the screen, they pressed a key (the “I” key) that was covered with a yellow sticker. The program then started the next trial.

A random half of the participants saw the original version for half of the pictures and the mirror-reversed version for the other half. The versions seen by the remaining participants were the inverse of those seen by the first set of participants. The order of presentation of the pairs was randomized for each participant.

The instructions were given orally in the participant's native and local language. They informed the participants that two mirror versions of each picture would be presented, and that their task was just to choose the one they liked better. Instructions also explained how to switch between pictures and select one of them, and emphasized that participants could take as long as they wished in making their judgements.

### *Design*

The proportion of choices for the L-R version of photographs (be they original or mirror-reversed) in each condition by each participant was computed. Those proportions were analysed using an overall ANOVA including Country of the picture (Spain, Iran) and Type of composition

(Linear Orderings, Couples, Sittings, Portraits) as within-participant factors, and RWD of the participant (L-R Spanish, R-L Arabic) as a between-participant factor. This analysis was complemented with t-tests against the 50% chance level to ascertain the presence of directional bias. As the direction of the bias was clearly predicted from our hypotheses, we used one-tailed t-tests.

Independent analyses were carried out to test the influence of the sex of the model. Different-sex Couples were analysed by means of an ANOVA including Country of the picture and RWD. Spanish different-sex Sittings were analysed by an ANOVA including the sex of the person standing and RWD. Portraits were analysed by an ANOVA including Country, the sex of the model, and RWD.

## **Results**

As in the previous study, data were analysed only from right-handed participants, of whom 34 were Spanish and 34 Moroccan. The main result of the overall ANOVA was a main effect of RWD: there was a clear difference in the proportion of L-R choices between Spaniards and Moroccans ( $F(1,66)=9.75, p=.003, \eta^2_p=.13$ ). Overall, Spaniards chose the L-R version of the experimental photographs in 57.9% of cases, which was significantly above the 50% chance level ( $t(33)=2.72, p<.01$ ). Moroccans chose the L-R version in 44.0% of cases, which was significantly below 50% ( $t(33)=-1.75, p=.04$ ). The overall ANOVA also showed a significant interaction between Country of origin of the photograph and Type of composition ( $F(3,198)=2.83, p=.04, \eta^2_p=.04$ ). This interaction was due to participants showing a stronger L-R preference in Iranian Linear Orderings ( $M=55.9%$ ) than in the rest of Spanish and Iranian compositions (independently of their habitual RWD; overall  $M=50.8%$ ). There were no other significant results in the overall ANOVA (all  $p>.11$ ). Therefore, the directionality bias linked to RWD did not differ in strength in photographs from Spain or Iran, nor between the four kinds of compositions (Linear Orderings, Couples, Sittings, and Portraits).

However, contrasts between L-R and R-L readers across the four compositions showed that the effect of RWD was not equally strong in all of them: it was significant in Linear Orderings ( $t(66)=2.85, p=.005$ ), Couples ( $t(66)=3.50, p<.001$ ), and Sittings ( $t(66)=2.76, p<.007$ ), but not in Portraits ( $t(66)=1.59, p<.12$ ; see fig. 2).

The lack of a main effect of Type of composition in the overall analysis suggests that there are no additional effects of emotionality in Portraits that are over and above those directional biases linked to RWD, against the prediction of the emotionality account. The predictions of agency and emotionality were further explored by independent analyses of subsets of stimuli. In the first analysis, different-sex Couples were submitted to an ANOVA including Country of origin of the picture and habitual RWD, which confirmed the main effect of RWD observed in the overall analysis ( $F(1,66)=7.73, p=.007, \eta^2_p=.11$ ). In this type of composition, Spanish participants (L-R readers) showed again a significant L-R bias ( $M=62.6\%$ ;  $t(33)=3.20, p=.003$ ) whereas Moroccan participants (R-L readers) showed no significant bias ( $M=45.3\%$ ;  $t(33)=-1.05, p=.30$ ). There was also a significant interaction between RWD and Country of the picture ( $F(1,66)=4.18, p=.04, \eta^2_p=.06$ ). Moroccan participants showed the same levels of preference for the L-R version of photographs from Spain (44.9%) and Iran (45.8%). In contrast, Spanish participants preferred L-R pictures more strongly when the models were Spaniards (67.4%) than when the models were Iranian (57.8%). The main effect of Country of origin failed to be significant ( $p>.09$ ).

Therefore, RWD modulated the preference for pictures with a man and a woman, as expected by both the agency and the scanning accounts. A clearer test is provided by different-sex Sittings and by Portraits of men and women. Spanish Sittings were analysed by means of an ANOVA including the sex of the standing person and RWD. There was an effect of RWD (L-R readers  $M=56.5\%$  vs. R-L readers  $M=43.3\%$ ;  $F(1,66)=5.76, p=.02, \eta^2_p=.08$ ) that was not modulated by the sex of the standing person ( $p>.93$ , see fig.3). The main effect of sex was also non-significant ( $p>.97$ ). Sitting pictures therefore provided no support for agency-linked biases. In Portraits, the



ANOVA included Country, Sex of the model and RWD. In consonance with the finding of a null effect of RWD in Portraits in the overall analysis, the main effect of RWD was also non-significant in this analysis ( $p > .11$ ). The only significant finding was the interaction between Country of origin and the Sex of the model ( $F(1,66) = 5.38, p = .02, \eta^2_p = .08$ ): Whereas L-R and R-L photographs of Iranian and Spanish women were considered equally pleasant (51.4% vs. 52.5% choices of the L-R version), and that was also the case for Iranian men (53.1%), Spanish men were judged more pleasant in a R-L pose (47.1% choice of the L-R version). This pattern of results does not support expectations from either the emotionality or agency accounts.

## **Discussion**

Experiment 2 asked participants to compare directly the original and mirror-reversed versions of each photograph, and thereby forced them to pay attention to the only difference between them: their composition along the left-right axis. Under these conditions, a clear difference in directional preferences arose between the two groups with contrasting RWD: Spaniards chose more L-R versions of the photographs than did Moroccans. The L-R preference of Spaniards was significantly above the chance level, showing a L-R bias, whereas the L-R preference of the Moroccans was significantly below chance, showing a R-L bias. The difference between the two RWD groups was qualified by the type of composition, with portraits being the least sensitive to RWD. Additionally, all composition types showed a null overall directional bias, against the prediction from the emotionality hypothesis that Portraits, and only portraits, should show an overall preference for R-L orientations. As predicted from both the agency and the height-based scanning accounts, photographs containing couples of different sex showed an effect of RWD. In order to disentangle both sources of bias, we turned to compositions that can dissociate the effect of sex from the effects of location. That is not possible with Portraits, but when the sex of the model was introduced in their analysis, participants preferred Portraits of women to the same extent in

both L-R and R-L poses. Only Spanish (but not Iranian) men were considered more aesthetically pleasing depending on the direction of looking, but this direction was R-L, contrary to what could be expected from sexual stereotypes. Unfortunately, conclusions from Portraits are limited by the overall lack of sensitivity of the measure. Sittings provided clearer results: against predictions from the agency account, Sittings showed lateral preferences linked to RWD but no modulation whatsoever by the arrangement of the sexes in the composition.

A final point that should be noted is that the culture of origin of the picture had only a very small influence on directionality preferences. One of them is the preference for R-L over L-R Spanish male portraits, and another is the greater preference for L-R Iranian Linear Orderings over Spanish Linear Orderings. These effects are difficult to interpret and they are probably related to the less-than-perfect control that can be exercised when designing experiments using already existing works of visual art.

### **General Discussion**

*Do people in general have lateral biases in their aesthetic appreciation of photography which are linked to their habitual RWD?*

This was our Question 1, and the present results provide a positive, but qualified, answer to this question. Spanish readers do show an aesthetic preference for studio photographs that flow from left to right over those that flow from right to left. Arabic readers show the opposite preference. However, these RWD-linked differences in lateral biases only occurred when participants directly compared the original and mirror-reversed version of each photograph, thereby focusing their attention on this particular aspect of the composition. When they were assessing how aesthetically pleasing is a single photograph, any possible effect of the lateral organisation was apparently over-shadowed by the many other factors that are relevant to the aesthetic appreciation of a piece of visual art. It is important to note that although the effect was statistically significant in

the forced-choice task, it was also not particularly large ( $\eta^2_p=.13$ ). That suggests that participants had not merely guessed at the purposes of the experiment and then chosen a particular directionality on an automatic basis. The judgements were indeed aesthetic, and depended on the individual photographs.

The null effect of RWD when photographs were individually rated contrasts with prior results by Maass et al. (2007) for movies with lateral motion, which were also individually rated and still showed effects of RWD on aesthetic evaluations. A possible way to reconcile them is suggested by Friedrich et al.'s (2014) study. They compared drawings of objects with potential motion and movie clips that actually showed motion, and observed that movies generated stronger effects. As motion automatically captures attention (Jonides, 1981), it makes sense that film clips with sideways motion are very effective stimuli for attracting attention to the directionality of that motion, and thereby, open the door to influences of habitual RWD on the appreciation of the stimulus. In contrast, the lateral directionality of the static compositions studied here must inevitably be much less salient.

*Are there lateral biases in the aesthetic evaluation of portraits?*

Present results also shed light on Question 2. The overall left-cheek bias in portraits is well established in the choices that artists make, both in paintings (McManus & Humphrey, 1973) and photographs (Labar, 1973) and it has been shown to be affected by RWD (Pérez González, 2012). However, the aesthetic judgments of our participants showed neither an overall preference for a particular directionality nor an interaction with RWD. When the sex of the model was included in the analysis, it did not interact with portrait directionality nor with RWD. This is consistent with some prior findings, which show that portrait orientation can affect the impression of emotionality (Nicholls, Wolfgang, Clode, & Lindell, 2002) as well as potency and activity (dimensions highly related to agency; Benjafield & Segalowitz, 1995), but fails to affect consistently their aesthetic

evaluation, neither for men nor women (Benjafield & Segalowitz, 1995; McLaughlin & Murphy, 1995). Present results, therefore, support the suggestion that portrait directionality has very little effect on the aesthetic impressions aroused in the perceiver. This is consistent with the possibility, as described by McManus (1979; chapter 14), that there are differences between left and right facing portraits, not in the perceptions of the viewer, but in the original choice by the artist to portray a left or right cheek for a particular image.

*Is there an overall preference for R-L poses in portraits? Does this preference interact with the sex of the model?*

The lack of sensitivity of aesthetic judgments to portrait directionality even in conditions of high attention to the lateral dimension limits the utility of the present results to answer Questions 2.a, 2.b, and 2.c, related to the prediction from the emotionality account that there should be an overall preference for R-L poses in portraits (the left-cheek bias) both in L-R and R-L readers, but which should not be present in multi-person compositions, and which should interact with the sex of the model. We did not find clear evidence of either the overall R-L preference or its interaction with the sex of the model, but this might be due to the poor sensitivity of our measure in this kind of composition.

*Are RWD-linked biases in multi-person compositions affected by the arrangement of the sexes and/or by their height in the image?*

In contrast to Portraits, the present data from multi-person compositions allow a clear answer to Question 3. RWD-linked biases occurred in all kinds of multi-person compositions (Couples, Sitings, and Linear Orderings). This finding is consistent both with the existence of an agency gradient (the person achieving greater height in the image is the more agentic) and with universal scanning preferences (start scanning the image from the more salient person, which depends on

height). The agency gradient is suggested to originate in repeated experiences of reading Subject-Object sentences either R-L or L-R, together with the universal preference of languages to place agents as syntactic Subjects and patients as syntactic Objects (Chatterjee et al., 1995; Chatterjee, 2002; Maass et al., 2009). However, RWD can also inculcate directional habits of scanning and exploration that are independent of Subject-Object order in sentences (Abed, 1991; Kugelmass & Lieblich, 1970; see also, Dickinson & Intraub, 2009). When there are people in the scene, the character with greater height in the image looks heavier and more important (Dannenmaier & Thumin, 1964; Petersen et al., 2013), and therefore is more likely to attract attention, and thus to lead during the exploration of the image. If this scanning pattern agrees with RWD-linked directional preferences, the outcome may particularly result in a better aesthetic impression.

In principle, both agency- and scanning-based gradients can exert their influences simultaneously and independently (some recent data do suggest the existence of independent biases arising from RWD and Subject-Object order in sentences, see Maass, Suitner, & Nadhmi, 2014). One way specifically to test whether there is an agency gradient at work is to compare photographs of couples of different sex. As men are stereotypically more agentive than women, L-R readers should prefer images with the man on the left and the woman on the right, whereas R-L readers should show the opposite preference (testing this prediction was our Question 3). Data from photographs of different-sex standing couples supported this prediction, but because men are also taller than women (at least in all photographs in the present study), this finding can also be predicted by a general scanning bias. The key contrast was provided by different-sex sitting couples, in which either the man or the woman is standing, thereby achieving greater height in the image. If sexual stereotypes of men and women vary in agency, the arrangement of the sexes should affect at least to some extent the aesthetic preferences of L-R and R-L readers for this kind of composition. However, in this condition there was a clear effect of RWD, but no hint of modulation by the position of the man and the woman. Such a pattern of results is more consistent with general

directional biases in aesthetic evaluation, which are linked to RWD but are independent from agency.

Why should observers find a photograph more aesthetically pleasing when it is scanned in a way that agrees with their RWD-linked directional scanning preferences? A possible mechanism is scanning fluency. Several studies have shown that the feeling of cognitive fluency (the easiness at performing a cognitive task) is associated with an enhanced preference for the materials and contents of the task (see Reber, Schwarz, & Winkielman, 2004, for a review; see also Forster, Leder, & Ansorge, 2013, for recent evidence). When attention is paid to the lateral dimension of space, this dimension is more fluently processed when it affords actions (scanning patterns) which are congruent with highly practiced habits arising from the experience of reading and writing. The weaker effect of RWD observed in Portraits can be related to this composition requiring less scanning than multi-person compositions. Future research using eye tracking may submit this scanning fluency account to a direct test.

*Do RWD-linked biases in Linear Orderings follow ascending or descending height?*

Finally, our Question 4 concerned which is the better way to define lateral directionality in photographs of Linear Orderings: should it be defined as starting from the person with greater height in the image, as suggested by the scanning account, or from the shortest to the tallest person, as suggested by the mental number line? Pérez González (2012) used the latter and found supporting evidence for it. Present data also provide a clear answer to this question: L-R readers prefer Linear Orderings that locate the tallest person on the left and the shorter on the right, and R-L readers have the opposite preference, supporting universal scanning biases.

This poses a puzzle as to why professional photographers, as studied by Pérez González (2012), should prefer an ascending arrangement but observers prefer a descending arrangement. The first possibility is that we are comparing the production of historical photographs with their

reception more than one hundred years later. It is an open question what would have been the aesthetic preferences of the general public in the 19th century. A second possibility is that the contrast arises from the different dynamics of aesthetics in the mind of artist and observer. The artist, either consciously or unconsciously, is imposing their idea of an aesthetically pleasing organisation onto the composition. In doing so for a group of people differing in height, probably the photographer follows well-practiced habits of ordering magnitudes along the mental number line. The observer is just looking at an image, armed with well-practiced scanning habits. In doing so, the observer's eyes are caught by the tallest person, and feels maximum fluency when they slide along the series in the same direction as when they scan words in a line of text. Why do the other kinds of compositions not show dissociations between the preferences of artist and observer? It is also possible that those other compositions are not as effective in activating the mental number line in the mind of the artist, because they contain only one or two people. The advantage of this second account is that it makes testable predictions for future research.

Before closing, two caveats of the present study must be mentioned: First, we only analysed data from right-handed participants. Thus, the potential effect of handedness, both along and in interaction with other factors, remains to be explored. Handedness has been shown to interact with image directionality in affecting aesthetic preferences of drawings and visual art, although the shape of the interaction is still unclear (Levy, 1976; McLaughlin, Dean, & Stanley, 1983; McLaughlin, 1986; Mead & McLaughlin, 1992). A second caveat is that our Arabic readers from Morocco were all highly fluent in at least one, very often two, L-R languages (modally French), and so, they should be considered more a multi-directional group than a R-L group. However, because the study was run in their home country and language, we have reasons to believe that their most active directional tendencies would be R-L (Román et al., 2013). In any case, it must be noted that this kind of confounding would, if anything, work against the finding of differences between the two RWD groups, and R-L biases should be expected to be stronger in monolingual readers of Arabic.

To conclude, members of the general public show an influence of their habitual RWD when aesthetically appreciating photographic works of art. This effect depends on the deployment of attention to the lateral spatial dimension, and thus the present study emphasizes the importance of studying how attention modulates the influence of factors that affect the aesthetic experience. An additional conclusion is that the effect of RWD on aesthetic evaluation is not mediated by agency, and therefore, not linked to the order of Subject and Object in written language. We suggest that it may be caused by the greater fluency with which people scan and explore works of art, which are directionally congruent with their writing system.

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Table 1.- Description of the whole set of materials. *Same/Diff. Sex*: Whether people depicted is of the same or different sex; *SexOrigin*: the sex of the person located at the position achieving greater height in the image; *Original direction*: Directionality of the original version of the photograph. Cell numbers indicate the amount of photographs belonging to each combination of features.

Composition	Same/Diff. Sex	SexOrigin	Original direction	Country of origin	
				Spain	Iran
Groups	Same	Man	LR	1	3
			RL	2	2
	Different	Woman	LR	5	
			RL	3	
Couples	Same	Man	LR	1	2
			RL	1	1
		Woman	LR	5	4
			RL	5	1
	Different	Man	LR	6	5
			RL	6	4
		Woman	LR		2
			RL		2
Sittings	Same	Man	LR	6	6
			RL	4	6
		Woman	LR	2	
			RL	2	
	Different	Man	LR	5	5
			RL	5	1
		Woman	LR	6	4
			RL	6	3
Portraits	Same	Man	LR	6	6
			RL	6	6
		Woman	LR	6	6
			RL	6	6

Table 2.- Number of items per cell in the overall design. The directionality of the photographs comprises roughly equal numbers of pictures that originally had that directionality and others who had the opposite directionality and were mirror-reversed. Thus, the comparison between L-R and R-L conditions comprises the same items differing only on their horizontal composition.

Composition	Country of origin			
	Spain		Iran	
	L-R	R-L	L-R	R-L
Linear Orderings	12	12	6	6
Couples	24	24	19	19
Sittings	34	34	25	25
Portraits	24	24	24	24

Figure captions:

Figure 1.- Examples of photographs used in the experiments. All of them are in their original version. Upper row: Iranian pictures. Lower row: Spanish pictures. Columns from left to right: Groups, Couples, Sittings, and Portraits. Specific coding of each example (from left to right and top to bottom): 1) Iran, Linear Ordering, L-R; 2) Iran, Couple, R-L, Different sex; 3) Iran, Sitting, L-R, Different sex, Woman standing; 4) Iran, Portrait, L-R, Man; 5) Spain, Linear Ordering, R-L; 6) Spain, Couple, L-R, Same sex, 7) Spain, Sitting, R-L, Same sex, Women; 8) Spain, Portrait, R-L, Woman.

Figure 2.- Average proportion of choices of the L-R version of the four composition types in the groups of Spaniards (L-R readers) and Moroccans (R-L readers). Chance level (50%) is indicated by the dotted line. Error bars show standard error of the mean.

Figure 3.- Average proportion of choices of the L-R version of Spanish Sittings with either the man or the woman standing in the groups of Spaniards (L-R readers) and Moroccans (R-L readers). Chance level (50%) is indicated by the dotted line. Error bars show standard error of the mean.

Figure 1



Figure 2

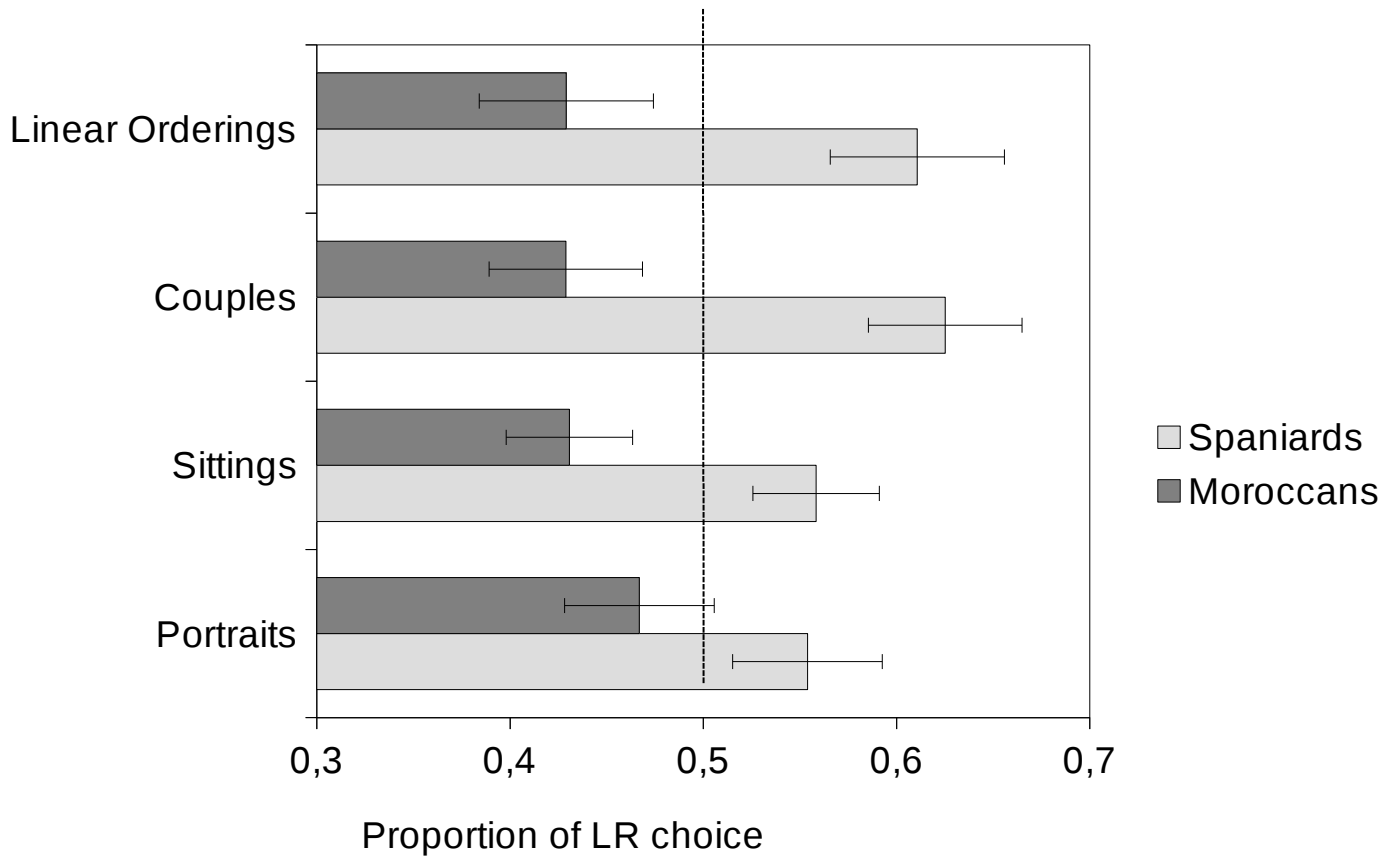




Figure 3

