Müller-Lyer illusion: Cognitive style, attentional and temperamental determinants data

Hanna Bednarek*, Magdalena Przedniczek

Department of Psychology, University of Social Sciences and Humanities, Warsaw, Poland

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ABSTRACT

While the cognitive predictors of visual illusions have been widely researched, thus far, the temperamental ones have not been studied. The dataset provides data on cognitive and temperamental determinants of the Müller-Lyer illusion recorded in a group of 170 participants aged 20–33. The cognitive predictors included: the field dependent-independent cognitive style and the efficacy of attention networks: alerting, orienting, and executive control. The dataset is related to the research findings in the paper ‘Cognitive and temperamental determinants of susceptibility to the Müller-Lyer illusion’ published in Personality and Individual Differences.

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* Corresponding author.
E-mail address: hanna.bednarek@swps.edu.pl (H. Bednarek).

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**Specifications Table**

| Subject | Experimental and Cognitive Psychology |
|---------|--------------------------------------|
| Specific subject area | Visual illusion, Attentional Networks, Temperament |
| Type of data | Figures |
| How data were acquired | The procedure was composed of three parts in the following order: (1) a computer version of EFT on an NVIDIA SHIELD 16 GB 8 inch tablet, (2) VIS and ANT tasks on a desktop computer with Java, E-prime, and a 21.5 inch LCD monitor / TFT active matrix (model HP S2231), and (3) FCB-TI(R) in a paper and pencil version. There were 10 min rest and refreshment breaks between individual parts. |
| Data format | Raw and Analyzed |
| Parameters for data collection | The participants were 170 healthy persons aged 20–33, composed of 93 females and 77 males who were right-handed and without self-reported vision defects. |
| Description of data collection | The data was collected in the university laboratory. Participants performed the three-part procedure in the following order: (1) a computer version of EFT on an NVIDIA SHIELD 16 GB 8 inches tablet, (2) VIS and ANT tasks on a desktop computer with Java, E-prime, and a 21.5 inches LCD monitor / TFT active matrix (model HP S2231), and (3) FCB-TI(R) in a paper and pencil version. |
| Data source location | Institution: University of Social Sciences and Humanities City/Town/Region: Warsaw Country: Poland |
| Data accessibility | Repository name: Mendeley Data Data identification number: DOI:10.17632/4js9b8pkrr.3 Direct URL to data: http://dx.doi.org/10.17632/4js9b8pkrr.3 |
| Related research article | M. Przedniczek, H. Bednarek, Cognitive and temperamental determinants of susceptibility to the Müller-Lyer illusion, Pers Individ Dif. https://doi.org/10.1016/j.paid.2020.110555 |

**Value of the Data**

- The data allow broader understanding of determinants of the Müller-Lyer illusion, which is one of the most frequently analysed visual illusions in cognitive science.
- The dataset fills a lack of data on susceptibility to illusions that depend on the resistant/non-resistant and stimulated/unstimulated temperament types, which take into account the importance of rhythmicity for each of these types.
- The data provide information on susceptibility to visual illusions that concern several professions such as pilots, drone operators, laparoscopy surgeons, dentists, and doctors operating USG equipment and CT scanners. Broader understanding of cognitive and temperamental determinants of illusions may allow the design of appropriate cognitive training for those particularly likely to experience illusions.

1. **Data Description**

The dataset contains information about participants (id number and sex: 1 = female, 2 = male) and results obtained in four tasks: Visual Illusion Simulation (VIS), Embedded Figure Test (EFT), Attention Network Test (ANT), The Formal Characteristics of Behavior-Temperament Inventory (FCB-TI).

List of variables in the dataset:

- VIS_ML_reference_line-length (in inches) of the reference line (top component) in the Müller-Lyer illusory figure.
- VIS_ML_time 1–15-number of milliseconds participant took to estimate the line length in the Müller-Lyer illusory figure in each trial.
VIS_ML_under 1–15-the participant's underestimation of the bottom line length in the Müller-Lyer illusory figure in each trial.
VIS_ML_over 1–15-the participant’s overestimation of the bottom line length in the Müller-Lyer illusory figure in each trial.
VIS_ML_error 1–15-the participant’s estimation of the bottom line length in the Müller-Lyer illusory figure in each trial. The estimation was converted into percentage of error in the database.
VIS_ML_error_total-the participant’s mean percentage of error of one trial in estimation of the line length in the Müller-Lyer illusory figure across 15 trials.
VIS_ML_time_total-the participant’s mean reaction time (in milliseconds) of one trial in estimation of the line length in the Müller-Lyer illusory figure across 15 trials.
EFT_Witkin-total number of seconds participant took to find the simple figure in the complex figure in all 12 tasks.
ANT_no_cue-participant’s mean reaction time (in milliseconds) of the no cue condition (measure of tonic alertness).
ANT_double_cue - participant's mean reaction time (in milliseconds) of the double cue condition (measure of phasic alertness).
ANT_center_cue-participant’s mean reaction time (in milliseconds) of the center cue condition.
ANT_spatial_cue-participant’s mean reaction time (in milliseconds) of the center cue condition.
ANT_congruent-participant’s mean reaction time of all congruent flanking conditions.
ANT_incongruent-participant’s mean reaction time of all incongruent flanking conditions.
ANT_alerting-participant’s mean reaction time of the double cue condition subtracted from the mean reaction time of the no cue condition.
ANT_orienting-participant’s mean reaction time of the spatial cue condition subtracted from the mean reaction time of the center cue condition.
ANT_executive-participant's mean reaction time of all congruent flanking conditions subtracted from the mean reaction time of incongruent flanking conditions.
FCBTI_Bruskness-total number of participant’s points on the Briskness temperament trait scale.
FCBTI_Perseverance-total number of participant’s points on the Perseverance temperament trait scale.
FCBTI_Rhythmicity - total number of participant’s points on the Rhythmicity temperament trait scale.
FCBTI_Sensory_Sensitivity-total number of participant’s points on the Sensory Sensitivity temperament trait scale.
FCBTI_Endurance-total number of participant’s points on the Endurance temperament trait scale.
FCBTI_Emotional_Reactivity-total number of participant’s points on the Emotional Reactivity temperament trait scale.
FCBTI_Activity-total number of participant’s points on the Activity temperament trait scale.

2. Experimental Design, Materials and Methods

2.1. Participants

The participants were 170 healthy persons aged 20–33 (M = 24.75, SD = 3.29), composed of 93 females (M = 24.97; SD = 3.46) and 77 males (M = 24.48; SD = 3.06) who were right-handed and without self-reported vision defects. Recruitment advertisements were posted on social media and the websites of SWPS University as well as websites contracted by SWPS University.
2.2. Procedure

The research took place in the university laboratory and took about two hours that included two short breaks. Participants performed the three-part procedure in the following order: (1) a computer version of EFT on an NVIDIA SHIELD 16 GB 8 inches tablet, (2) VIS and ANT tasks on a desktop computer with Java, E-prime, and a 21.5 inches LCD monitor / TFT active matrix (model HP S2231), and (3) FCB-TI(R) in a paper and pencil version. There were 10 min rest and refreshment breaks between individual parts.

3. Materials

3.1. Visual illusion simulation

Susceptibility to the Müller-Lyer illusion was diagnosed using a computer version of the Visual Illusion Simulation, prepared by H. Bednarek and P. Sobecki in 2016. The task was displayed on a 21.5-inch screen and participants were seated about 50 cm from the monitor. The participants’ task was to adjust the length of the bottom line to appear equally long as the upper one. The line lengths were set using the arrows keys and confirmed with enter (15 trials). Participants had no time limit to complete the VIS task.

The illusory figure was black and was presented on a white background. Both reference and adjusted lines were placed above each other. Spacing between the top and bottom lines was 3 inches. The reference line length (top component) was presented with inward-pointing arrows and its length was 300 px (about 3.08 inches). The adjusted line (bottom component) was presented with outward-pointing arrows and its starting length varied randomly between 250 and 350 px. The update speed (change of the length of stimuli for 1px) was 60 msec. Arrows angles were 40° and thickness of the lines was 2 px. Resolution of the screen was 1920 × 1080. The refresh rate was 60 Hz. An illustration of the stimuli is presented in Fig. 1.

The size of error was expressed in inches. Susceptibility to the illusion was determined as an overestimation or underestimation of the length of the bottom line. A higher score meant a larger error and indicated susceptibility to the illusion. The raw data was transformed into percentage of error for each participant and trial as proposed by Grzeczkowski and co-workers [1]: the value of the reference line length was subtracted from the adjusted line length and then the difference was divided by the value of the reference line length and multiplied by 100. Positive results were achieved by subjects who overestimated the length of the adjusted line (bottom component), while negative results were achieved by participants who underestimated the bottom line length.

![Fig. 1. Visualization of the Müller-Lyer illusion in VIS task.](image-url)
3.2. Embedded figure test

Field-dependent/independent cognitive style was diagnosed using a computer version of the Embedded Figure Test (EFT) [2], prepared by H. Bednarek and W. Uliajnow in 2016. The task was performed on a NVIDIA SHIELD 16 GB 8-inch tablet with the NVIDIA SHIELD Direct Stylus 2 pen provided and used to trace the simple figure.

The task was to find and outline a simple geometric figure concealed in a complex figure. Example of one simple and complex figure is presented in Fig. 2. The test comprised a training stage and the proper test that contained 12 tasks. The complex figure was displayed for 5 s, then the simple figure was revealed for 10 s, and, finally, the complex figure appeared on the screen again. The time limit for finding the simple figure hidden in the complex one was 180 s. The participant was able to return to the view of the simple figure five times during one task (five attempts counted to the time limit). After that time, if the participant did not find the simple figure, another card with a complex figure was displayed.

The performance indicator was the total time needed to solve all 12 tasks.

3.3. Attention network test

The Attention Network Test (ANT) was used to assess the participants’ alerting, orienting, and executive function systems [3]. Participants were seated 50 cm from a computer screen. The test was administered using E-Prime® software. The test consisted of 24 practice trials with full feedback that included a summary of feedback for speed and accuracy with 3 blocks of 96 trials each (2 repetitions × 4 cue conditions × 3 flanker conditions × 2 target positions × 2 target directions) that gave no feedback. There was a short break between blocks.

The stimulus appeared above or below the point of fixation and consisted of a central arrow and surrounding arrows that pointed in the same direction as the middle one (congruent condition) or in the opposite direction (incongruent condition). The participants’ task was to press the appropriate key—either (<) or (>)—on the keyboard as quickly as possible to specify whether the middle arrow was pointing to the left or right.

The central arrow occurred in one of three conditions: (a) neutral – no flanks (e.g., →→), (b) congruent – flanked by pairs of arrows pointing in the same direction (e.g., →→→→→→), or (c) incongruent – flanked by pairs of arrows pointing in opposite directions (e.g., →→←←←←←←). There were four cueing conditions: (a) no cue (fixations cross only)—a temporally uninformative condition, (b) center cue (black asterisk at the fixation cross)—temporally informative, (c) double cue (one black asterisk above and one below the fixation cross)—temporally informative, and (d) spatial cue (single black asterisk above or below the fixation cross)—temporally and spatially informative as it indicated the upcoming location of the subsequent target.

The efficacy of alerting system function was calculated by subtracting the mean reaction time of the double cue condition (measure of phasic alertness) from the mean reaction time of the no cue condition (measure of tonic alertness). The orienting system efficacy was calculated by subtracting the mean RT of the spatial cue condition from the mean RT of the center cue one.

**Fig. 2.** Example of a simple geometric figure and a complex figure in EFT task.
The conflict (executive control) effect was calculated by subtracting the mean RT of all congruent flanking conditions from the mean RT of incongruent flanking conditions.

Each trial began with presentation of a fixation cross for a variable duration (400–1600 ms). A cue was then presented for 100 ms in the cue conditions or the fixation cross remained unchanged for the same duration in the no cue condition. After another short fixation period lasting 400 ms, the target with or without flankers (neutral versus congruent/incongruent conditions, respectively) was presented until the participant responded or 1700 ms elapsed. The post-target fixation period then appeared for a duration equal to 3500 ms minus the duration of the initial fixation and reaction time. A single session lasted approximately 20 min.

3.4. The formal characteristics of Behavior-Temperament Inventory

To diagnose temperament types, the participants completed The Formal Characteristics of Behavior-Temperament Inventory in the revised version (FCB–TI(R)) [4] which measures seven temperamental traits that refer to the formal aspects of behavior. They are manifested in the energetic level meaning intensity of reactions (traits: Briskness, Perseverance, and Rhythmicity) and temporal features referring to time characteristics of reactions (Sensory Sensitivity, Endurance, Emotional Reactivity, and Activity) [5].

The FCB–TI(R) consists of 100 items and is rated on a 4-point scale: 1-I strongly disagree, 2-I disagree, 3-I agree, and 4-I definitely agree. The results of each scale are calculated by totalling the number of points accorded by the answer key. Higher test results on each scale equals a greater intensity of a temperament trait.

Ethics Statement

The work was approved by the local Ethical Commission at the University of Social Science and Humanities (permission no 11/2016, registered as 12/04/2016). It fulfilled the stipulations of the Declaration of Helsinki: Medical Research Involving Human Subjects. All participants provided their written informed consent prior to the study.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships which have or could be perceived to have influenced the work reported in this article.

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