Spider is not special comparing with other animals in human early visual attention: Evidence from event-related potentials

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Abstract

It has long been believed that both snakes and spiders are archetypal fear stimuli for humans. As to snakes, it has been assumed as stronger threat cue even for nonhuman primates. However, it is still unclear whether spiders hold a special status in human perception. The presented study aimed to explore whether spider is special threatening target when comparing with insects similar to spiders in human early visual attention by means of early posterior negativity (EPN). To measure the EPN, participants watched a random rapid serial presentation of pictures, which consisted of two conditions: spider condition (spider, wasp, bumblebee, beetle) and snake condition (snake, bird). EPN amplitudes revealed no significant difference among spider, wasp, bumblebee, and beetle pictures, whereas EPN amplitudes were significantly larger for snake pictures relative to bird pictures. In addition, EPN amplitudes were significantly larger for snake pictures relative to spider pictures. These results suggest that the early visual attentional capture of animate objects is stronger for snakes, whereas spiders do not appear to hold special early attentional value.

Keywords — Early posterior negativity (EPN), Event-related potential (ERP), Snake fear, Spider fear.

Introduction

Fear, as one of our basic emotions, is very important for our survival by alerting us when a situation is safe or potential risky. The debate about how fears and phobias are acquired has continued for long time. Early researches suggest that fear is acquired only via learning (Watson & Rayner, 1920). Nowadays, there exists evidence that certain fears and phobias are acquired innately, such as the case for threat relevant stimuli in particular (Coelho & Purkis, 2009; Öhman & Mineka, 2001; Seligman, 1971). Among various kinds of threat relevant stimuli, snakes and spiders are thought to be the evolutionary fear stimuli for humans (Öhman & Mineka, 2001; Seligman, 1971).

As to snakes, it had been thought as a stronger threat cue in human adults (Öhman, Flykt, & Esteves, 2001) and young children (Hayakawa, Kawai, & Masataka, 2011; Lobue & DeLoache, 2008; Masataka, Hayakawa, & Kawai, 2010), even in snake-naïve Japanese monkeys (Shibasaki & Kawai, 2009). In contrast, studies on spider recognition are limited compared with those on snakes. The quickly detection (Shibasaki & Kawai, 2009) and vicarious fear learning (Cook & Mineka, 1990) by non-human primates are limited for snakes, and no such evidence exists for spiders. Moreover, there is only evidence that snakes constituted a recurrent threat to humans (Isbell, 2006, 2009). Taken together, although both snakes and spiders have been used as evolutionarily threat-relevant stimuli, it is still unclear whether spiders hold a special status in human early visual attention.

The neurophysiological studies for fear using the early posterior negativity (EPN) suggested that snakes elicit stronger recruitment of early visual attention than other animals (Van Strien, Franken, & Huijding, 2009; Van Strien, Eijlers, Franken, & Huijding, 2014). The EPN is an event-related potential (ERP) component which reflects early selective visual processing of emotionally significant information (Junghöfer, Bradley, Elbert, & Lang, 2001) and it becomes larger when evolutionarily relevant threat stimuli are presented (Schupp, Junghöfer, Weike, & Hamm, 2003; Schupp, Öhman, Junghöfer, Weike, Stockburger, & Hamm, 2004). Van Strien et al. (2014) suggested that the EPN amplitudes were the largest for snake pictures, intermediate for spider pictures, and smallest for bird pictures. These results suggested that snakes have ancestral priorities to modulate the early capture of visual attention more innately. However, it is still unclear the reason why the EPNs for spider is stronger than for bird. It may be possible that the dangerous animal will elicit stronger EPNs than non-dangerous animal, since spider is more dangerous than bird. Or it may be possible that spider is a special threatening target so that elicits stronger EPNs than bird does. New evidence shows that even the entomologists are also scared of spiders (Vetter, 2013). To investigate these possibilities, it is crucial to compare the extent of EPNs for spider with dangerous animals in human early visual attention. Therefore, the dangerous insects will be selected to compare with spiders.

In this study, we compared EPNs for pictures of spiders, wasps (as dangerous insects), bumblebees and beetles (as non-dangerous insects) to investigate whether spider is a kind of special threatening target when comparing with insects similar to spiders. The spiders and wasps can be dangerous for humans, while bumblebees and beetles are not such fatal for humans except the engendering allergic reactions. We had four possible expectations; EPN amplitudes could be (a) the largest for spider pictures than for other three insects, since spiders are a kind of special threatening target as an evolutionarily threat-relevant animals (such as snake), (b) the largest for wasp pictures since wasp is the most fatality animal among these animals, (c) larger for pictures of dangerous animals (spiders and wasps) than for non-dangerous insects, and (d) no significant difference among the four animal pictures, since none of the four animals is strong enough to draw stronger EPN amplitudes. To check whether the appropriateness of the experimental procedure is accord with the previous research (Van Strain et al., 2014), we compared EPN amplitudes for snake and bird pictures as well.

Methods

Participants: Thirty students (16 males, 14 females, age: 23.2 ±5.3) from Nagoya University participated in the present experiment.

Stimuli: Stimuli were classified by six animal categories (spider, wasp, bumblebee, beetle, snake, and bird pictures). All the pictures were obtained from several internet sources of high quality on a natural background. Each animal category had eight different gray scale pictures. Brightness and contrasts were equated across all pictures. Picture size was about 400 × 300 pixels.

Procedure: Participants engaged in a passive viewing experiment, which contained two conditions (spider and snake). In spider condition, participants watched a rapid serial presentation of 480 spider, 480 wasp, 480 bumblebee and 480 scrub beetle pictures. In the snake condition, the manipulations are the same to spider condition, except the rapid serial presentation of 480 snake pictures and 480 bird pictures. Each picture was presented 60 times in random order and the duration was 300ms. Electroencephalogram (EEG) recordings were obtained during both conditions.

EEG recordings: An EEG was recorded by using HydroCel Geodesic Sensor Net from 64 sites (Electrical Geodesics, Inc). The signals from an EEG amplifier were sampled at 500 Hz with data acquisition software Net Station Ver.4.2 (Electrical Geodesics, Inc). Electrode impedances were below 50 kΩ. EEG was acquired using a Cz reference, and then re-referenced to the average reference in off-line analyses. For the data analysis, a digital band pass filtered (0.15–30 Hz) was applied. Ocular activity or movement artifacts of amplitude were excluded using the method of Gratton, Coles, and Donchin (1983) in Net station waveform tools (Electrical Geodesics, Inc). ERP averages were calculated from 50 ms before prestimulus to 300 ms after stimulus onset. The EPN was scored at occipital electrodes (O1, Oz, O2) and was measured as the mean activity in the three time windows (150-300/200-300/225-300 ms) after stimulus onset.

Results

<u>In spider condition</u>, Figure 1 shows the grand mean ERP waveforms and mean amplitudes for each stimulus category (spider, wasp, bumblebee, and beetle) at O1, Oz, and O2 in three time windows (150-300/200-300/225-300 ms). Black bars above the waveform represent the time window of the EPN amplitude. A large negativity was observed in the period of 225-300 ms for spider pictures. This negative amplitude was defined as EPN. We also expand the calculation to the other two time windows (150-300/200-300 ms) to check the accuracy of the result. Although this large EPN for spider pictures could be observed at three sites separately, there was no significant effect of stimulus category found among spider, wasp, bumblebee and beetle pictures by using repeated measures ANOVAs (Fs(3, 87) < 2.11, ps > .105).

<u>In snake condition</u>, Figure 2 shows the grand mean ERP waveforms and mean amplitudes for each stimulus category (snake, bird) at O1, Oz, and O2 in three time windows (150-300/200-300/225-300 ms). A large EPN for snake pictures was observed in the period of 225-300 ms at three sites separately, and the EPN amplitudes for snake pictures were significantly larger than for bird pictures in three time windows at all sites by using t-tests (ts(29) > 4.17, ps< .018). The asterisk above the bar graph represents p values from the t-test results.

We also conduct one-way orthogonal ANOVAs for the comparisons between dangerous animals (spiders and wasps) and non-dangerous animals (bumblebees and beetles) at O1, Oz, and O2 in three time windows (150-300/200-300/225-300 ms) independently. There was no significant difference between the two kinds of animals (Fs(1,116) < 3.104, ps> .081).

Finally, a t-test was conducted for the mean amplitudes of snake and spider pictures. In the period of 225-300 ms, we found a significant difference at the O1 site (t(29) = 2.266, p = 0.031). EPN amplitudes for the snake pictures were larger than for the spider pictures. A marginally significant difference was found at Oz; however, there was no significant difference at O2. Moreover, we found no significant difference at three sites in the period of 200-300/150-300 ms separately (ts(29) < 2.266, ps> .085).

Discussion and conclusion

The current study examined whether spider is a special threatening target comparing with other insects in human early visual attention with EPN. The major findings can be summarized as follows. (a) Results for

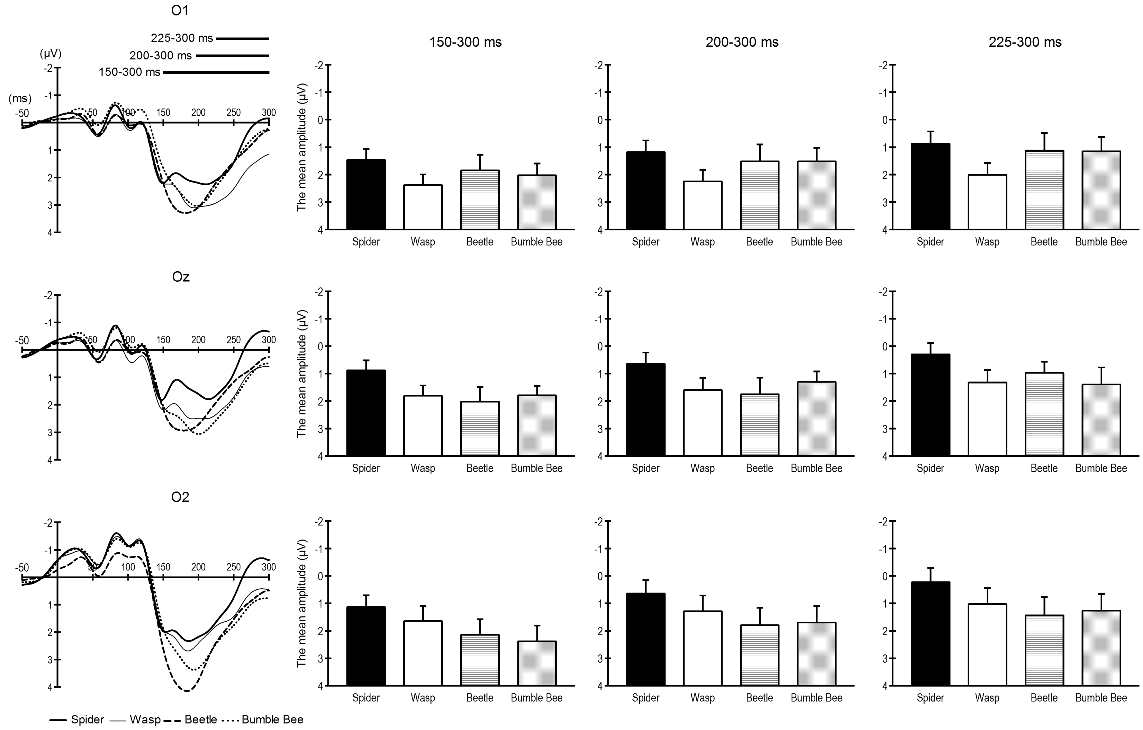

Figure 1. The grand mean ERP waveforms and mean amplitudes for each stimulus in three time windows (225-300/200-300/150-300 ms) at O1, Oz, and O2 in the spider condition (*N*=30).

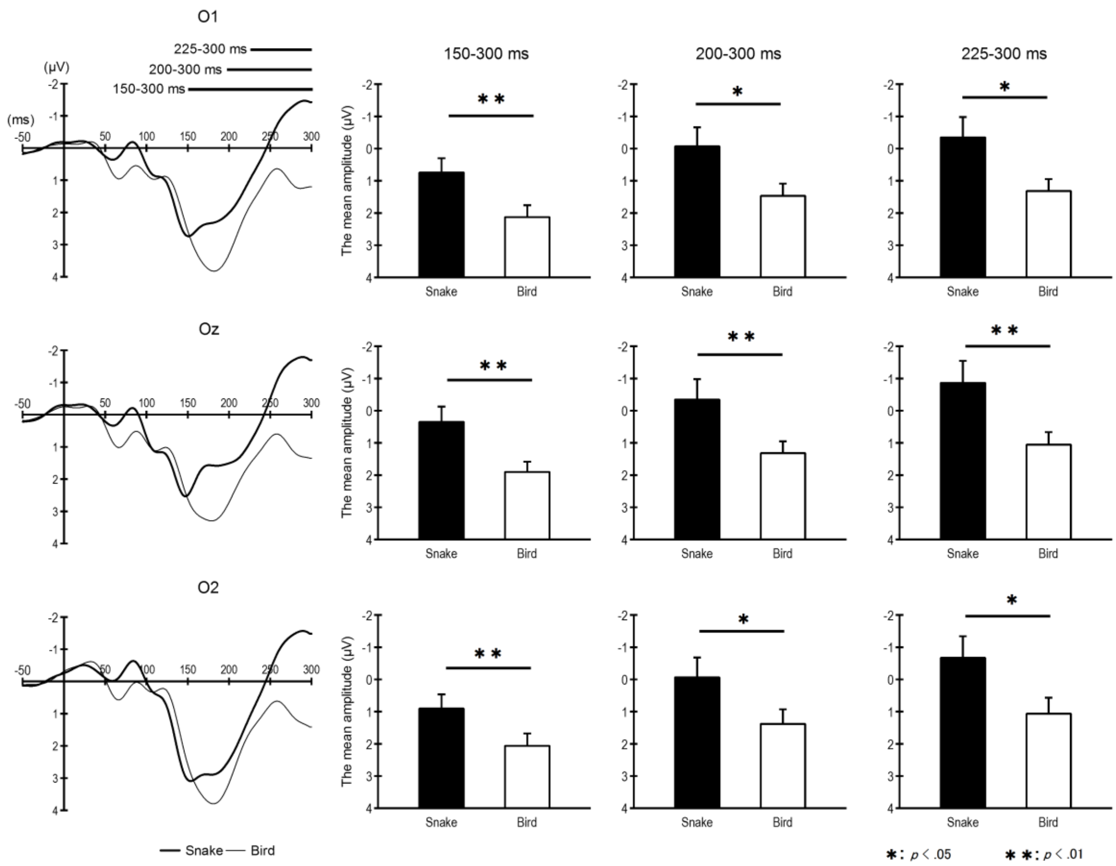

Figure 2. The grand mean ERP waveforms and mean amplitudes for each stimulus in three time windows (225-300/200-300/150-300 ms) at O1, Oz, and O2 in the snake condition (*N*=30).

the snake condition (snake, bird) showed that early visual attention for snake was larger than for bird at all sites and windows. These results are consistent with previous research (Van Strien et al., 2009), suggesting that our manipulation was reliable. (b) However, there was no significant difference among spider, wasp, bumblebee, and beetle in human early visual attention. (c) Finally, the early visual attention was larger for snake than for spider, replicating a previous study (Van Strien et al., 2009).

The present study extends previous findings (Van Strien et al., 2009; Van Strien et al., 2014) showing that spiders are not a special threatening target as snakes. The fact that spider does not draw stronger EPNs than other insects provide an exceptional case to a previous finding (Vetter, 2013). One may argue that the frequency of occurrence of the objects might yield the difference of EPN amplitude between the snake and spider pictures. The present experiment manipulated more frequently for the snake pictures (at a half of all) and less frequently for spider pictures (at one-fourth). However, the different presentation frequencies do not matter to the result of EPN amplitudes between snake and spider pictures. This proves that the frequency of occurrence of the objects does not yield the difference of EPN between snake and spider.

Another evidence from the present study also suggests that no difference exists between dangerous animals (spiders, wasps) and non-dangerous animals (bees and beetles), which proves that spider was similar in terms of being part of an ‘insect’ category but not special as snakes.

In summary, the presented study demonstrated that the early visual attentional capture of animate objects is stronger for snake, but spider which thought to be a great threat-stimulus cue, is not special to other animals including wasp, bumblebee and beetle.

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