Extraordinarily Quick Visual Startle Reflexes of SkipperButterflies (Lepidoptera: Hesperiidae) are Among the FastestRecorded in the Animal Kingdom

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EXTRAORDINARILY QUICK VISUAL STARTLE REFLEXES OF SKIPPER BUTTERFLIES (LEPIDOPTERA: HESPERIIDAE) ARE AMONG THE FASTEST RECORDED IN THE ANIMAL KINGDOM

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The abilities of animals in movement and coordination frequently surpass our own abilities and fascinate us. New record speeds found among animals, when recorded by the scientific literature, tend to be widely publicized. Such is the case of the trap-jaw ant, *Odontomachus bauri* Emery, whose mandibles close in 0.13 s at a rate of 35.5 meters per second (ms^{-1}) during a predatory strike, the fastest movement recorded among all animals (Patek et al. 2006). The fastest tactile reflex time belongs to the star-nosed mole, *Condylura cristata* L., which uses 22 nasal appendages to navigate through soil and can react in just 120 ms, when one of these appendages comes in contact with food (Catania & Remple 2004). Here, I would like to report the startle reflex time in skipper butterflies, which is among the fastest recorded for the animal kingdom and which is at least twice as fast as startle eye-blink reflex of humans.

Startle reflexes have evolved as fast defensive (usually escape) responses in animals, engaging subcortical reflex mechanism that bypasses cerebral processing and voluntary movement. Because circuits involved are shorter, the latencies of the startle reactions are much shorter than those of voluntary reactions. In terms of electromyographic responses recorded *in vitro*, acoustic startle reflexes tend to be very short. In rats, for example, electromyographic responses can be as fast as 5-10 ms, and in humans as fast as 14 ms (Yeomans & Frankland 1995).

The actual behavioral responses recorded *in vivo* tend to be longer. For example, in the African butterfly fish, *Pantodon buchholzi* Peters, the fastest response time to an acoustic startle stimulus recorded on an electromyogram is 5 ms. The fish's fins initiate a motion 10 ms later, hence with the possible reflex time (ballistic jump) ca. 15 ms (Starosciak 2008). The eye-blink reflex of humans elicited by an air puff is 30-50 ms (e.g., Halmagyi & Gresty 1983).

Compared to that, voluntary reaction time to a visual 'go' signal in humans is around 150 ms (Brown et al. 1991), and it takes an average of 700 ms for a human driver to move the foot from the accelerator to the brake peddle after seeing a red light (Green 2000).

Just like butterfly fish, skipper butterflies rely on jumping ballistic movements to evade predators, but they propel themselves through the air, not the water. They are, in fact, named for their quick, darting flight habits. They differ in several morphological characters from other butterflies (e.g., Ackery et al. 1999), most notably in having stockier bodies with stronger wing muscles. While photographing butterflies with a digital camera for several years, I have become convinced that skippers possess an extraordinary reflex time when startled by a photographic flash. Their startle reflex is faster than I have observed in any other butterfly.

Even though other butterflies and other insects are frequently startled by a photographic flash and flee after their picture is taken, their motor response is normally slower than the shutter speed of the camera. Thus, even if they are startled by the flash, they appear still in photographs. Skippers, however, react so quickly to the flash, that their reaction is frequently captured by the camera.

In the specific camera settings I used in the photographs in Fig. 1, the shutter was open for 1/60 sec = 17 ms. The flash, synchronized with the shutter, occurred during this time. During this exposure time, skippers startled by the flash frequently "jumped" into the air, and their image was captured in flight near the substrate. They tended to return to their original position immediately, so that they appeared still to the human eye, and their jumping movement was captured only by the camera.

In pairs of photographs (Fig. 1: A1-A2, B1-B2, and C1-C2), one individual was recorded in the act of "jumping" above the same plant when startled repeatedly. These shots were captured by firing the camera with intervals of ca. 20 s. It was noted by previous studies that habituation (decline and disappearance of response during repetitive stimuli) occur with other types of startle reflexes (Yeomans & Frankland 1995). I observed the same with the "jumping" skippers: if they did not escape after the first shot, their "jumping" response ceased after 2-3 repeated firings of the flash (Fig. 1: C3, D2).

These photographs illustrate the unique quickness of skipper reflexes among all the other insects that I have photographed. They document what might be one of the fastest reflex times (<17 ms) so far recorded for the animal kingdom.

Fig. 1. Four different species of skippers perched on plants "jumped" into the air when startled by the photographic flash, exhibiting startle reflex response. The response time is <17 ms.
A. *Anthoptus epictetus* Fab., A-1, A-2, one individual "jumping" above the same plant when startled repeatedly (photographed in Misiones, Argentina); A-3, same species Bahia, Brazil, normal resting position; B. Hesperiidae sp., Bahia, Brazil, B-1, B-2, one individual "jumping" above the same plant when startled repeatedly; B-3, normal resting position; C. Hesperiidae sp., Bahia, Brazil. C-1, C-2, one individual "jumping" above the same plant when startled repeatedly; C-3, normal resting position is maintained as a result of habituation; D. *Miltomiges cinnamomea* (Herrich-Schaeffer), Bahia, Brazil, D-1, "jumping" when startled; D-2, normal resting position is maintained as a result of habituation.

SUMMARY

Skipper butterflies exhibit a fast startle reflex time in response to a photographic flash (<17 ms). This reflex time is twice as fast as the fastest startle reflex of humans. Color photographs of Fig. 1 as well as those of other skipper species exhibiting similar behavior are available as Supplemental material online at http://www.fcla.edu/FlaEnt/fe924.htm#InfoLink1.

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