HIGHER ANTICIPATORY RESPONSE AT 13.5 ± 1 H LOCAL SIDEREAL TIME IN ZEBRA FINCHES

By Fernando Alvarez

ABSTRACT: The ability for precognition in relation to local sidereal time (LST) was explored in 25 adult female zebra finches, *Taeniopygia guttata*. Their anticipatory response to a startle sound stimulus was tested in 2-hour segments at 13.5 ± 1 h LST, a period found by Spottiswoode (1997a) to correlate with maximum success in anomalous responses of humans, and at 18 ± 1 h LST, a period of low success. Birds were put individually in a testing cage, and after an accustoming period of 20 min, 10 randomly ordered "stimuli" were presented at 3-min intervals: 5 audio startle stimuli and 5 control moments of silence. Subjects were filmed and, in a double-blind fashion, the frequency of their behavior (change of gaze direction and locomotion) was registered 0-6 seconds immediately before stimulus presentation and before the controls. The results showed that at 13.5 ± 1 h LST, during the prestimulation period, the frequency of change of gaze direction was significantly higher and that of locomotion was significantly lower than their frequencies during the controls. At 18 ± 1 h LST the trend was the same as during 13.5 ± 1 h, although the difference in prestimulation versus control of gaze direction was slight and nonsignificant, and that of locomotion was only marginally significant.

Keywords: birds, gaze, locomotion, precognition, sidereal time

While trying to understand the physical mechanisms of information transfer in anomalous cognition (AC), I analyzed published information on remote viewing and ganzfeld responses in relation to local sidereal time (LST), that is, the position of the subjects on the earth relative to the fixed stars in the sky. In a first study, using a database of 2,483 free response trials, Spottiswoode (1997a) obtained a high effect size for trials within one hour of 13.5 LST. On the other hand, the results of a second analysis (Sturrock & Spottiswoode, 2007) of an expanded database (842 new trials were added to the earlier ones) were ambivalent. Although the feature of higher effect size at 13.5 ± 1 h LST was evident, the application of the running-wave power spectrum analysis (that can potentially differentiate real from spurious LST effects, Sturrock, 2004) did not produce significant evidence of an LST effect.

The question is complicated by the coincidence at approximately 13 h LST of the enhanced AC performance (Spottiswoode, 1997a) and a large increase in the magnitude of the negative correlation between AC performance and geomagnetic fluctuations (Spottiswoode, 1997b).

The ability for short-term precognition toward the presentation of a disturbing visual stimulus (a video clip of a crawling snake) has been detected in the Bengalese finch, *Lonchura striata* (Alvarez, in press). Here I shall try to replicate that study, using as subject another estrildine bird, namely the zebra finch, *Taeniopygia guttata*, testing its response towards a less idiosyncratic stimulus (an artificial sound). In an effort to replicate the LST studies, as well as to extend the focus of research to nonhumans, I will also explore the relationship between precognition and LST, taking advantage of the narrowness of the peak found by Spottiswoode (1997a) for humans.

The zebra finch is native to Australia and the South Pacific, and breeds exceptionally well in captivity. Today it is one of the most common subjects of research, being widely used in many scientific disciplines, ranging from anatomy to evolutionary ecology, both in the wild and in the laboratory (Zann, 1996), serving also as a model for research in neurology, genetics of behavior development and other biological processes and environmental variables that impact human health. The zebra finch is the second avian species (after the chicken) whose genome has been sequenced (Ensembyl, 2009; Mossman, Birkhead, & Slate, 2006).

Method

The methods of the present paper are inspired by those of Radin (1997), Spottiswoode and May (2003), and May, Paulinyi, and Vassy (2005), dealing with electrodermal activity and presentiment in humans. All subjects (25 adult female zebra finches) lived in a unisexual adult group of conspecifics in a 1.5 x 3 x 2 m aviarium near Seville, Spain (37º 17' 2" N, 6º 3' 58" W), and were fed a varied diet of seeds and vegetables. The experiments were carried out between October 29, 2009, and February 10, 2010. The choice of only females as subjects was done to avoid introducing the gender variable in the analysis.

Starting between 07:30 h and 11:00 h UT (again, to limit the potential effects of the UT time variable), the subjects (one at a time) were taken from their group and put into the 70 x 35 x 35 cm testing cage with transparent glass at one end (to film through it), and two external loudspeakers (see Figure 1), in a compartment out of sight from other birds. During each experimental session, after an accustoming period of 20 min and at 3-min intervals, 10 randomly ordered (order determined immediately before each presentation by a true random number generator by Orion Electronics) "stimuli" were presented: 5 audio startle stimuli (gunshot of 44100 Hz and 0.03 s duration, downloaded from internet) and 5 control stimuli of zero signal, or silence. The computer was located in an adjacent compartment and was connected to the loudspeakers by a long cable.

In order to detect a potential enhanced ability to predict the presentation of the startle stimuli during the period of maximum success found by Spottiswoode (1997a) in humans, each of the 25 subjects was tested twice, between October 29 and December 3, 2009, in the 2-hour window at 13.5 ± 1 h LST and, for comparison, between January 18 and

February 10, 2010, at 18 ± 1 h LST, a time segment of very low effect size in Spottiswoode's report.

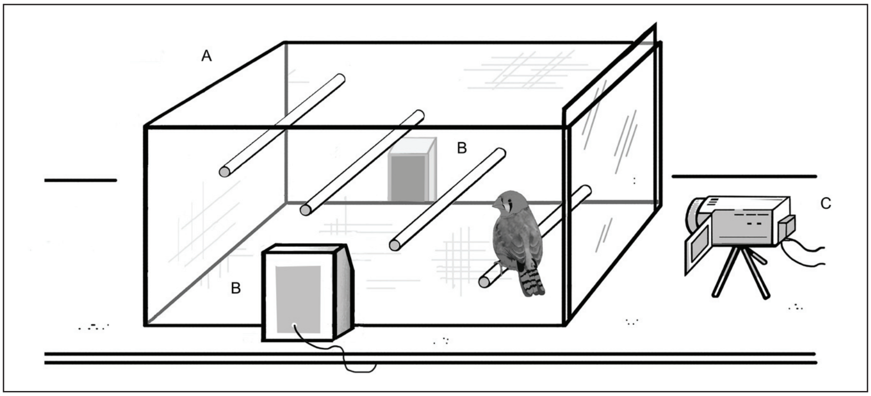

Figure 1. Testing situation. A: testing cage, B: loudspeaker, C: video camera.

Conversion from UTC to LST date and time was done with Calendar Date and Time to Julian Day and Sidereal Times (version 7.2.7), available at internet (http://www.csgnetwork.com/siderealjuliantimecalc.html).

Starting 1 min before the end of the 20 min accustoming period and during the whole trial, each subject was filmed with a 25 frames per second video camera (a Sony DCR-SR72E), located outside the testing cage (see Figure 1), and controlled by the experimenter from a hidden location in an adjacent compartment.

Video analysis was concentrated on quantifying the frequency of two patterns of behavior: the change in the direction of each bird's gaze and the number of acts of locomotion. Change in gaze direction is a form of environment exploration; in the zebra finch it can be estimated from head orientation (Eckmeier et al., 2008), and in this study was registered only when the birds were in standing position. This behavior can be easily recorded, since the birds move the whole head to fixate the eye from one point to the next, and due to the finches' characteristic jerky behavior, each orientation of the head is clearly separated from the next (see Figure 2), its observation being also facilitated by the conspicuous beak and head color markings. The characteristic down movement of the head immediately before flying was not considered, nor while the birds were either walking or jumping. Locomotion included jumping on the perch, walking on perch or cage floor, and flying between perches or toward the floor or walls of the cage. The number of jumps, steps, and flights were recorded.

The frequency of both behaviors in the 6-s period immediately before the presentation of the startle and control stimuli for each subject was counted (analyzing the video records frame by frame with an accuracy of 0.04 s, by using VirtualDubMod 1.5.10.2 computer program), and stimuli and control totals were obtained for each subject.

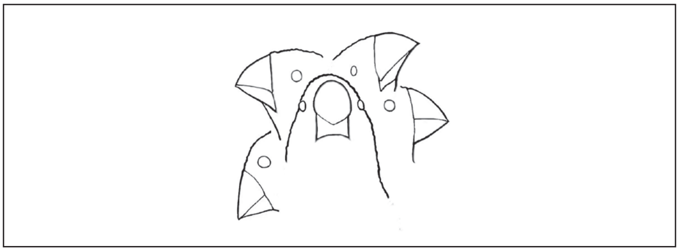

Figure 2. Changes in the direction of zebra finches' gaze.

To prevent experimenter subjective bias, a third person registered the time of initiation and order of the 5 startle sounds and the 5 controls in each session and provided me with the 10 times of initiation without telling whether each belonged to a stimulus or a control until I had analyzed the video clips without listening to the sounds and all trials had ended.

Statistical analysis

Frequency distributions for all variables did not deviate significantly from normality ($p > .20$, Kolmogorov-Smirnov test). The repeated measures ANOVA was used to test the null hypothesis that total frequencies before the startle stimuli and before the controls for the same subjects tested at 13.5 ± 1 h and 18 ± 1 h LST were drawn from the same population. For post hoc two-variables comparisons, the *t* test for dependent samples was applied (Sokal & Rohlf, 1995; Zar, 1996).

Data analysis was done using the STATISTICA 6.0 computer program. All reported *p* values are two-tailed.

Results

When total individual frequencies of the two behaviors for the four conditions of prestimulus and control at 13.5 ± 1 h LST and 18 ± 1 h LST were compared, they were found not to belong to the same population: gaze direction: $F(3,72) = 9.42$, $p < .0001$; locomotion: $F(3,72) = 2.98$, $p = .037$ (repeated-measures ANOVAs). Frequencies for both behaviors are presented in Table 1.

The post hoc two-variables comparisons of change of gaze direction, carried out to detect a potentially anticipatory response at each of the two LST time segments, yielded a significant result at 13.5 ± 1 h LST, prestimulation frequencies being systematically higher than their controls, $t(24) = 3.11$, $p = .005$ (dependent samples). On the other hand, prestimulation frequencies at 18 ± 1 h LST were only slightly higher, and nonsignificantly different than their controls, $t(24) = 0.54$, $p = .596$ (see Figure 3).

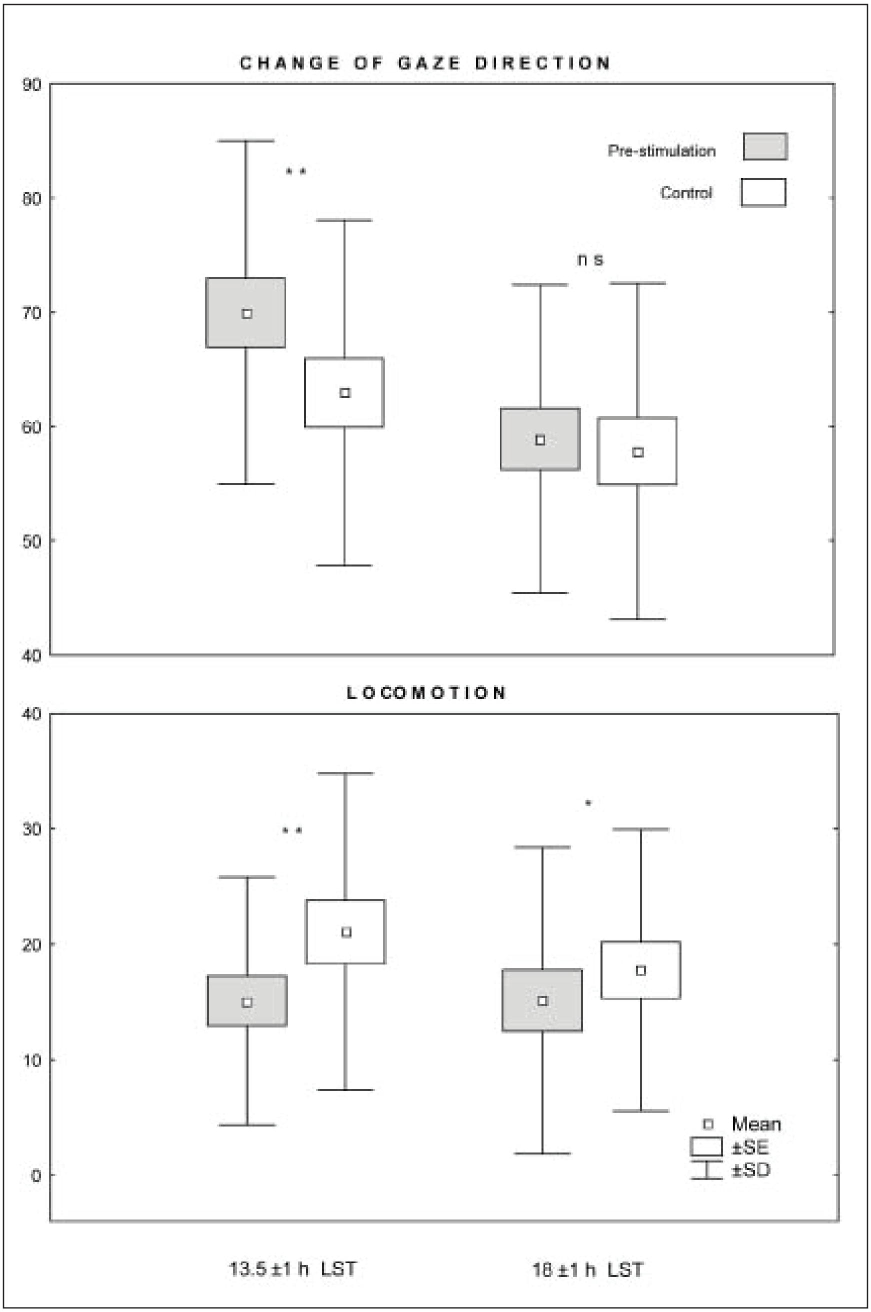

Figure 3. Frequencies of change of gaze direction and of locomotion of zebra finches in the 6-s blocks immediately preceding stimulation and control at 13.5 ± 1 h and 18 ± 1 h LST (**p* = .053, ***p* = .005, *ns*: not significant).

TABLE 1
FREQUENCY (MEAN AND STANDARD DEVIATION) OF CHANGE OF GAZE DIRECTION AND OF LOCOMOTION OF FEMALE ZEBRA FINCHES IN THE 6-S PERIOD IMMEDIATELY BEFORE PRESENTATION OF THE STARTLE AND CONTROL STIMULI

	Change of gaze direction			Locomotion		
	M	*SD*	*N*	*M*	*SD*	*N*
13.5 ± 1 h LST						
Prestimulation	69.7	15.0	25	15.1	10.7	25
Control	63.0	15.1	25	21.1	13.7	25
18 ± 1 h LST						
Prestimulation	58.9	13.5	25	15.1	13.3	25
Control	57.8	14.7	25	17.8	12.2	25

Post hoc two-variables comparisons of frequency of locomotion also produced a significant result at 13.5 ± 1 h LST, although in the opposite direction from the change in gaze direction: previous to stimulation, the birds' frequency of locomotion became depressed, as compared to control, $t(24) = 3.08$, $p = .005$. At 18 ± 1 h LST the frequency distribution during prestimulation was only slightly lower than that during the control, and only marginally significant, $t(24) = 2.04$, $p = .053$. (see Figure 3).

The results of the comparisons of prestimulation frequencies for both criteria of precognition between the two LST conditions provided a significant difference for change of gaze direction (13.5 ± 1 h LST: X ± SD = 11.66 ± 2.51 per minute, $N = 25$; 18 ± 1 h LST: 9.82 ± 2.24 per minute, $N = 25$; $t(24) = 4.10$, $p = .0004$, and a nonsignificant one for locomotion (13.5 ± 1 h LST: $M = 2.51$, $SD = 1.79$ per min, $N = 25$; 18 ± 1 h LST: $M = 2.52$, $SD = 2.21$ per min, $N = 25$), $t(24) = 0.02$, $p = .988$.

DISCUSSION

The outcome of this study shows that the zebra finch is able to anticipate the occurrence of an alarm sound stimulus, in the same way as the Bengalese finch does toward a disturbing visual stimulus (Alvarez, in press). Also, the significant differences between prestimulation and control frequencies of the zebra finches' behavior at 13.5 ± 1 h LST, as compared to their controls, and the reduced size of this effect at 18 ± 1 h LST appear to agree with the relationship reported by Spottiswoode (1997a) between human anomalous cognition (AC) and local sidereal time.

However, we must be cautious in reaching conclusions about the relationship of precognition ability and local sidereal time before other possibilities are ruled out. Other potential factors affecting the results could be seasonal changes in the birds' predilection to exploration and locomotion, or a modulation of the birds' precognitive ability by environmental variables such as geomagnetic activity. On the other hand, the successful initial experimentation (at 13.5 ± 1 h LST) followed by unsuccessful subsequent experimentation (at 18 ± 1 h LST) could be viewed as a "decline effect" in psychic performance, commonly observed in humans, and attributed to a variety of causes, from individual psychology, social attitudes, electromagnetic fields, and experimental artifacts to psi properties (Colborn, 2007).

A plausible effect put forward by Ryan (2008) on the observed correlation of AC and LST might be caused by the regular fluctuations in the geomagnetic field known as geomagnetic pulsations, which exhibit seasonal and/or seasonal/daily variation. Since, as in the present study, most of the experiments in Spottiswoode's (1997a) database were carried out in daylight hours, an influencing factor with seasonal variation, as found by Sturrock and Spottiswoode (2007) in Spottiswoode's former database, would generate an apparent variation of AC effect by LST.

One possible reason for the opposite direction of change of gaze direction and locomotion, when comparing frequencies before the startling stimulus and before the control in the 13.5 ± 1 h LST condition, could be the need to visually explore what is about to happen, and at the same time stopping locomotion, in this way reducing unwanted detection by potential predators. Since optimal visual recognition of objects is attained when animals are not locomoting (Gibson, 1979), they usually intersperse movement with pauses, which provide the opportunity for the sensory systems to detect relevant stimuli, adapting this intermittent behavior to changing circumstances (Kramer & McLaughlin, 2001).

Whether the zebra finch and other animal species show an effect of local sidereal time on AC performance will have to be definitely determined in future studies, preferably using a variety of subject species of different nervous system complexity and of more remote common ancestry than finches and humans. Some good candidate topics could be precognition in earthworms (Wildey, 2001) and dogs (Sheldrake & Smart, 2000), psychokinesis in insects (Metta, 1972) and chicks (Peoc'h, 1995), ESP and reinforcement in insects and rodents (Duval & Montredon, 1968; Parker, 1974; Schmidt, 1970), and homing and trailing in dogs and pigeons (Rhine & Feather, 1962; Sheldrake, 2002).

At first sight on inspecting Spottiswoode's (1997a) results, an enhancing influence (or signal) on AC performance could originate from the strip of sky with Right Ascension (RA, the cosmic equivalent of longitude) of 13.5 ± 1 h, and unknown declination (akin to latitude in the celestial sphere), an influence whose source could be outside the solar system.

Since we do not understand the nature of anomalous cognition and the processes related to it, it would be ideal to try to identify how the presumed signal would act. On the other hand, this signal, if finally demonstrated to exist, does not have to be of the same nature as AC, and therefore may not be subject to the same rules. For instance, both AC performance and the presumed signal may not decrease with distance, while the latter appears to be at least partially blocked by the earth (Spottiswoode, 1997a), but the former is not.

References

Alvarez, F. (in press). Anticipatory alarm behavior in Bengalese finches. *Journal of Scientific Exploration.*

Colborn, M. (2007). The decline effect in spontaneous and experimental psychical research. *Journal of the Society for Psychical Research,* **71**, 1–22.

Duval, P., & Montredon, E. (1968). ESP experiments with mice. *Journal of Parapsychology,* **32**, 153–166.

Eckmeier, D., Geurten, B. R. H., Kress, D., Mertes, M., Kern, R., Egelhaaf, M. & Bischof, H. J. (2008). Gaze strategy in the free flying zebra finch (*Taeniopygia guttata*). *PLos ONE,* **3**, e3956.

Ensembyl (2009). Zebra Finch (*Taeniopygia guttata*). Retrieved March 9, 2010 from http://www.ensembl.org/Taeniopygia_guttata/Info/Index.

Gibson, J. J. (1979). *The ecological approach to visual perception.* Boston: Houghton Mifflin.

Kramer, D. L., & McLaughlin, R. L. (2001). The behavioral ecology of intermittent locomotion. *American Zoologist,* **41**, 137–153.

May, E. C., Paulinyi, T., & Vassy, Z. (2005). Anomalous anticipatory skin conductance response to acoustic stimuli: Experimental results and speculations about a mechanism. *The Journal of Alternative and Complementary Medicine,* **11**, 695–702.

Metta, L. (1972). Psychokinesis on lepidopterous larvae. *Journal of Parapsychology,* **36**, 213–221.

Mossman, J. A., Birkhead, T. R., & Slate, J. (2006). The whole mitochondrial genome sequence of the zebra finch (*Taeniopygia guttata*). *Molecular Ecology Notes,* **6**, 1222–1227.

Parker, A. (1974). ESP in gerbils using positive reinforcement. *Journal of Parapsychology,* **38**, 301–311.

Peoc'h, R. (1995). Psychokinetic action of young chicks on the path of an illuminated source. *Journal of Scientific Exploration,* **9**, 223–229.

Radin, D. I. (1997). Unconscious perception of future emotions: An experiment in presentiment. *Journal of Scientific Exploration,* **11**, 163–180.

Rhine, J. B., & Feather, S. R. (1962). The study of cases of "psi-trailing" in animals. *Journal of Parapsychology,* **26,** 1–22.

Ryan, A. (2008). New insights into the links between ESP and geomagnetic activity. *Journal of Scientific Exploration,* **22**, 335–358.

Schmidt, H. (1970). PK experiments with animals as subjects. *Journal of Parapsychology*, **34**, 255–261.

Sheldrake, R., & Smart, P. (2000). A dog that seems to know when its owner is returning: Videotaped experiments and observations. *Journal of Scientific Exploration*, **14**, 233–255.

Sheldrake, R. (2002). *Seven experiments that could change the world.* Rochester, VT: Park Street Press.

Sokal, R. R., & Rohlf, F. J. (1995). *Biometry.* New York: Freeman.

Spottiswoode, S. J. P. (1997a). Apparent association between effect size in free-response anomalous cognition experiments and local sidereal time. *Journal of Scientific Exploration*, **11,** 109–122.

Spottiswoode, S. J. P. (1997b). Geomagnetic fluctuations and free-response anomalous cognition: A new understanding. *Journal of Parapsychology*, **61**, 3–12.

Spottiswoode, S. J. P., & May, E. C. (2003). Skin conductance prestimulus response: Analyses, artifacts and a pilot study. *Journal of Scientific Exploration*, **17**, 617–641.

Sturrock, P. A. (2004). Time-series analysis of a catalog of UFO events: Evidence of a local-sidereal-time modulation. *Journal of Scientific Exploration*, **18**, 399–419.

Sturrock, P. A., & Spottiswoode, J. P. (2007). Time-series power spectrum analysis of performance in free response anomalous cognition experiments. *Journal of Scientific Exploration*, **21**, 47–66.

Wildey, C. R. (2001). Biological response to stimulus. Unpublished Masters Thesis, University of Texas, Arlington.

Zann, R. A. (1996). *Zebra Finch: A synthesis of field and laboratory studies.* Oxford, England: Oxford University Press.

Zar, K. H. (1996). *Biostatistical analysis.* Upper Saddle River, NJ: Prentice-Hall

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Abstracts in Foreign Languages

German

HÖHERE ANTIZIPATORISCHE REAKTION UM 13.5 ± 1 H LOKALER STERNZEIT BEI ZEBRAFINKEN

ZUSAMMENFASSUNG: Die Fähigkeit zur Präkognition in Bezug auf die lokale Sternzeit (local sideral time, LST) wurde bei 25 erwachsenen weiblichen Zebrafinken, *Taeniopygia guttata*, untersucht. Ihre antizipatorische Reaktion auf einen Schreckreiz wurde in 2-stündigen Abständen um 13.5 ±1 h LST getestet, ein von Spottiswoode gefundener Zeitraum, während dessen Versuchspersonen bei anomalen Reaktionen am besten abschnitten, und um 18 ± 1 h LST, einem Zeitraum mit nur mäßigem Erfolg. Die Vögel wurden einzeln in Testkäfige gesetzt, und nach einer Eingewöhnungsphase von 20 min wurden ihnen im Abstand von 3 min in einer Zufallsabfolge 10 "Reize" dargeboten: 5 akustische Schreckreize und 5 Schweigeperioden zur Kontrolle. Die Versuchstiere wurden gefilmt, und unter Doppelblindbedingung wurde die Häufigkeit von Verhaltensweisen (Änderung der Blickrichtung und Fortbewegung) im Abstand von 0–6 s unmittelbar vor der Reizpräsentation und vor den Kontrollen aufgezeichnet. Die Ergebnisse zeigten, daß um 13.5 ± 1 h LST während der Prästimulationsperiode die Häufigkeit in der Änderung der Blickrichtung signifikant höher und diejenige der Fortbewegung signifikant geringer ausfielen als die Häufigkeiten während der Kontrollperioden. Um 18 ± 1 h LST zeigte sich der gleiche Trend wie während 13.5 ± 1 h, obwohl der Unterschied in der Prästimulation verglichen mit der Kontrolle der Blickrichtung nur gering und nichtsignifikant ausfiel und in Bezug auf die Fortbewegung nur schwach signifikant.

French

REACTION ANTICIPATOIRE AUGMENTEE A 13.5 ± 1 H TEMPS SIDERAL LOCAL AVEC DES DIAMANTS MANDARINS

RESUME : La capacité de précognition en relation avec le temps sidéral local (LST) a été explorée chez 25 adultes femelles de l'espèce diamants mandarins, *Taeniopygia guttata*. Leur réaction anticipatoire à un stimulus sonore brusque a été testée durant des segments de 2h à 13.5 ± 1 h LST, une période que Spottiswoode a trouvé en corrélation avec un succès maximal dans les réactions humaines anomales, et à 18 ± 1 h LST, une période associée à un faible succès. Les oiseaux étaient placés individuellement dans une cage de test, et après d'une période d'acclimatation de 20 min, 10 "stimuli" en ordre aléatoire étaient présentés dans des intervalles de 3 min: 5 stimulus audio brusque et 5 moments contrôles de silence. Les sujets étaient filmés et, dans le cadre d'un double aveugle, la fréquence de leur comportement (changement de la direction du regard et de la locomotion) était enregistrée de 0 à 6s avant la présentation du stimulus et avant les contrôles.

A 18 ± 1 h LST, la tendance était la même que durant la période 13.5 ± 1 h, bien qu'il y ait une différence entre les essais en préstimulation et les essais contrôle sur le plan de la direction du regard, différence légère et non-significative, et sur le plan de la locomotion, différence alors marginalement significative.

Spanish

RESPUESTA ANTICIPATORIA DE ALTA MAGNITUD DURANTE TIEMPO SIDERAL LOCAL EN 13.5 ± 1 H EN MANDARIN LISTADO

RESUMEN: La habilidad de precognición fue explorada en relación al tiempo sideral local (TSL) con 25 mandarines listados adultos de sexo femenino, *Taeniopygia guttata*. Su respuesta anticipatoria a un sonido repentino fue estudiada en segmentos de 2 horas a 13.5 ± 1 h TSL, un período que Spottiswoode encontró que estaba correlacionado con el mayor éxito en respuestas anómalas con seres humanos, y en 18 ± 1 h TSL, un período de bajo éxito. Los pájaros fueron colocados individualmente en la jaula experimental y después de un período de tiempo de 20 minutos para acostumbrarse, se les presentaron 10 "estímulos" seleccionados al azar en intervalos de 3 minutos: 5 estímulos repentinos auditivos y 5 momentos de silencio control. Los sujetos fueron filmados y la frecuencia de su comportamiento (cambio en la dirección de su mirada y locomoción) fue anotado a doble ciego de 0–6 segundos inmediatamente antes de la presentación del estímulo y antes de los controles. Los resultados mostraron que en 13.5 ± 1 h TSL, durante la presentación del período de preestimulación, la frecuencia de cambios de dirección de la mirada fue significativamente mayor y de locomoción fueron significativamente menores que las frecuencias durante los controles. Durante 18 ± 1 h TSL la tendencia fue la misma que durante 13.5 ± 1 h, aunque la diferencia entre prestimulación versus control de la dirección de la mirada fue leve y no-significativa, y la de locomoción sólo fue marginalmente significativa.