Ideal Time of Day for Decision-Making (Applying Decision Effectiveness)

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Decision Effectiveness in Nature: Canada geese flying in V formation for effective energy conservation (Picture: BLFootage)

Are we larks, owls or something else when it comes to decision making?

In nature we can observe that Circadian rhythms are ubiquitous in many organisms. These rhythms are fairly stable and appear to control many behavioral and biological variables. Animals that are experimentally subjected to schedules differing profoundly from a normal day or that have their clocks continuously shifted typically show reduced performance, increased illness and lower survival (Martino, T. et al., Bloch et al.). While in general **stability** of circadian rhythms in constant environments can be observed, some species show a fairly high degree of **plasticity,** in **cases 1)** When it comes to performing particular tasks like: division of labor (e.g. insects), reproductive or maternal behavior (e.g. with offspring with no apparent circadian rhythms), feeding patterns (e.g. voles) and finally migration (e.g. birds that also travel at night) or in **cases 2)** When adapting to extreme and changing environments (e.g. polar animals during continuous light or darkness) (Bloch et al.).

In contrast, **humans show a fairly low plasticity**, as might surprise the reader. Humans, like many other animals, opt in large for a persistent and robust daily rhythmicity and the benefits that come along with it (Erkert).

How can the circadian rhythm help to find the ideal time of day for decision making?

In the article on optimal time of day for sports performance and decision making I introduced the link between most alert times of day and best performance. The data in this article focused on peaks of daily fitness, or to be more precise on cardiovascular peek performance (Facer-Childs & Brandstaetter).

Today I like to introduce a new study by a team of researchers from the University of Buenos Aires (Leone et al., publication 2017). The team led by Maria Juliana Leone looked at decision-making behavior of around 100 very experienced blitz chess players, with more than 2000 games, who use the Free Internet Chess Server (FICS) to discover at what time of day the players made their best decisions.

After the players had submitted their Morningness-Eveningness questionnaire (MEQ), the players were divided in three roughly equal groups of **1. Larks** (n= 32, early circadian phenotype, ECT), **2. Intermediates** (n=30, intermediate circadian phenotype, ICT) and **3. Owls** (n=32, late circadian phenotype, LCT) and the 3 minute games that they had played between **November 2008 and June 2015** were analyzed with respect to "Decision Time taken" and "Quality of Move".

The most important findings and conclusions of the study ("Chess Perspective", Leone et al.):

- Larks play more games in the morning and owls in the evening.
- Decision time varied robustly during the day, with subjects taking more time for each decision during the morning.
- Early types have a greater difference in Decision time between day and night.
- Accuracy is high in the morning and decreases in the evening.
- Players decide faster and less accurately as the day progresses, reaching a plateau in the afternoon.
- The increase in speed throughout the day has costs in accuracy, as it was observed in classical speed-accuracy tradeoffs in a broad class of problems in decision-making (Bogacz, Hu, Holmes, & Cohen, 2010; Gold & Shadlen, 2002; Wickelgren,1977).
- The major finding: "**There is a change in decision making policy: in the morning, players adopt a policy where decisions are slower and more accurate than in the evening, when decisions became faster but less accurate.**"

This **excellent and innovative study by Leone et al.** provides a very useful data base which I believe can **offer even more interesting insights** if a slightly different perspective is taken and the findings are applied to a wider decision context.

Introduction

As it turns out Leone et al. were particularly interested in decision making in the "blitz chess context" where a limited time-budget is a major factor influencing the decision maker and his/her decision making policy.

If on the other hand the data is applied to a wider decision making context, where time is not a major limiting factor, it is possible to **change the perspective** from **decision efficiency** ("faster and more accurately**",** Leone et al.) to **decision effectiveness** (see definition below).

I believe this change of perspective is permissible as Leone et al. took particular care to analyze only data that was taken in parts of the game where stress due to time limitation was fairly small: "One concern with rapid chess is that it can lead to situations of extreme time pressure where a player has to make many moves in a few seconds. To avoid this very particular situation, for all analyses, we only considered moves where the available time was higher than 60 s. We also excluded the first 30 s of the game, in the opening stage, where many players play from memory."

Method

Effectiveness is a concept, that according to my observation, many people rarely apply. Using the Wikipedia definition, something is "deemed effective, it means it has an intended or expected outcome ...". In a context of "rule based decision making", as in a game of chess, the concept is, I suggest, particularly applicable, as every move/every decision can be analyzed with respect to the stated rules and possibilities of the game.

I need to stress that the concept of decision effectiveness should strictly only be applied to decision making under certainty and to rules & processes that offer a high degree of repeatability & reproducibility.

For a better understanding, we can also find examples of decision effectiveness in nature, a very graphic illustration can be seen in the picture above where Canada geese are flying in V formation for effective energy conservation.

For decision making in general I therefore like to offer and use the following definition for decision effectiveness:

Decision Effectiveness (for a given skill or in a given context) = **The Results** (of a normalized application of the given process) **relative to a** (normalized) **benchmark**

In the concrete example using the data "Decision Time" and "Error Rate" from the chess study of Leone et al., I define:

Decision Effectiveness = Log (Decision Time) - (Error Rate - 1)

The values for decision effectiveness have been computed using the formula above and have been plotted in Figure 1, 2 & 3 (see below).

Results

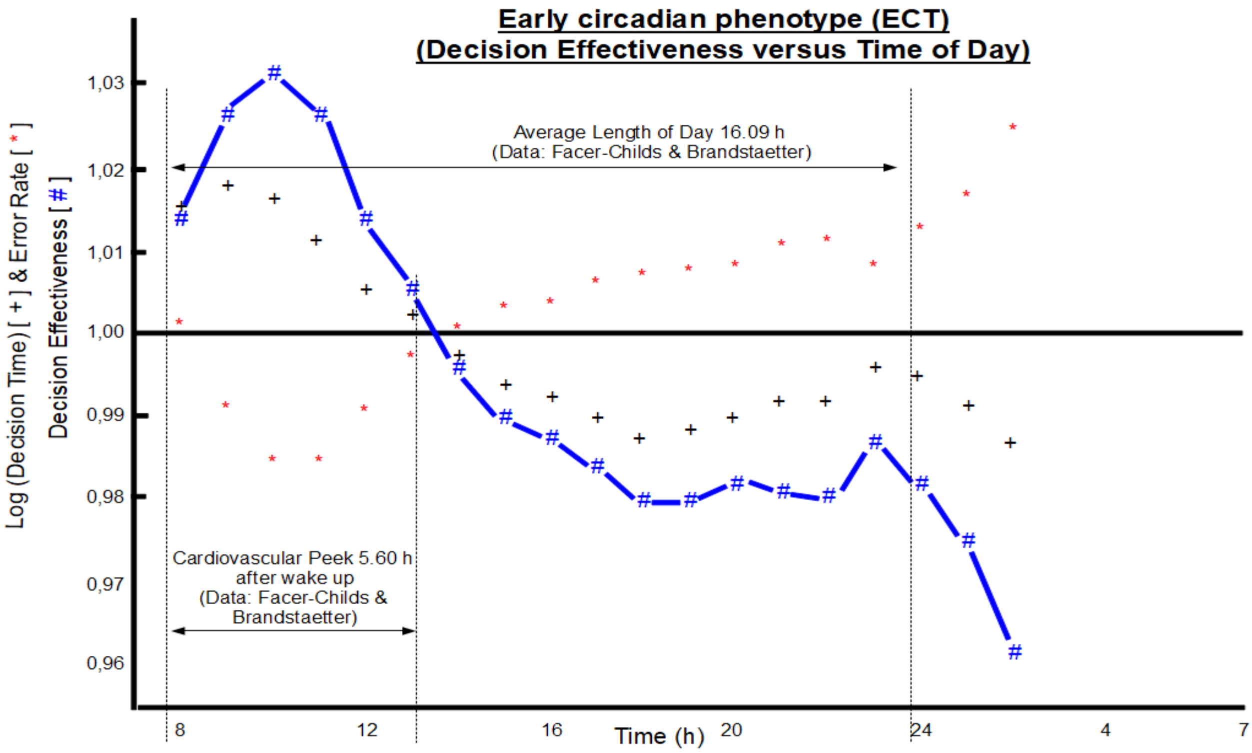

Figure 1

Data: Decision Effectiveness by Felix Schürholz
(Raw data „Decision Time“ & „Error Rate“ based on estimate of Figures from M.J. Leone et al. / Cognition 158 (2017) 44-55

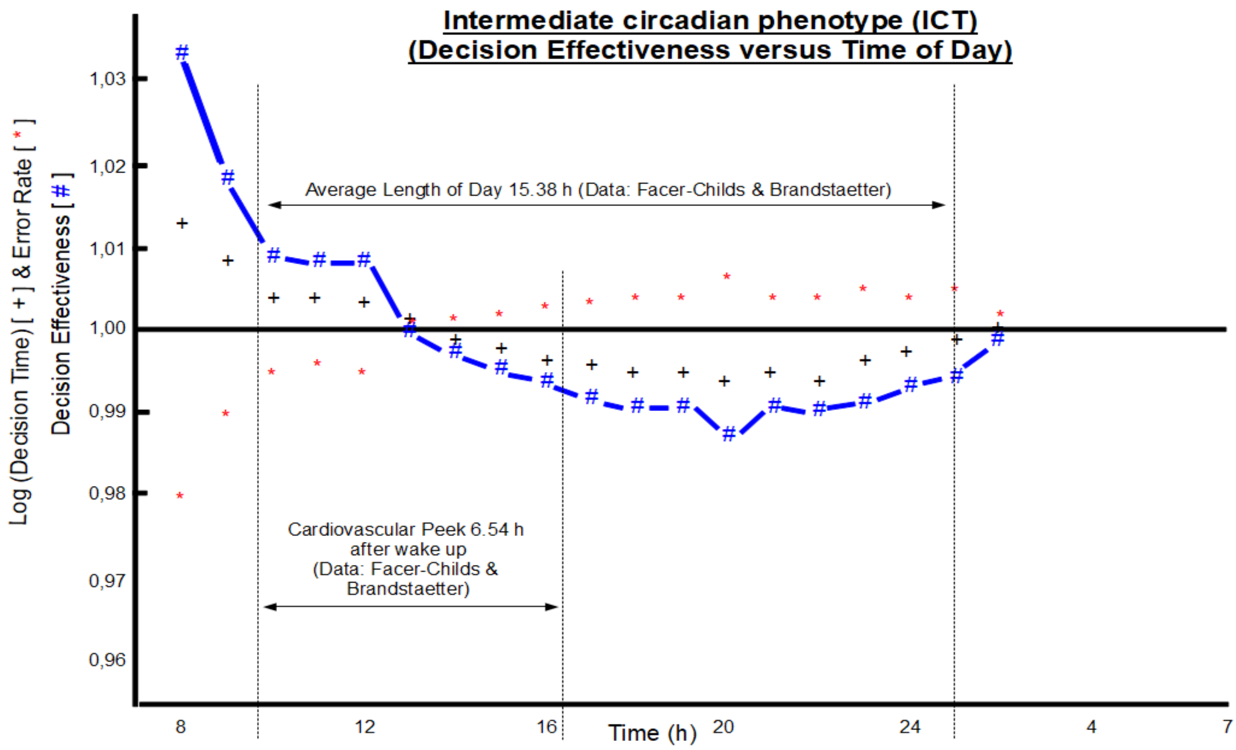

Figure 2

Data: Decision Effectiveness by Felix Schürholz
(Raw data „Decision Time“ & „Error Rate“ based on estimate of Figures from M.J. Leone et al. / Cognition 158 (2017) 44-55

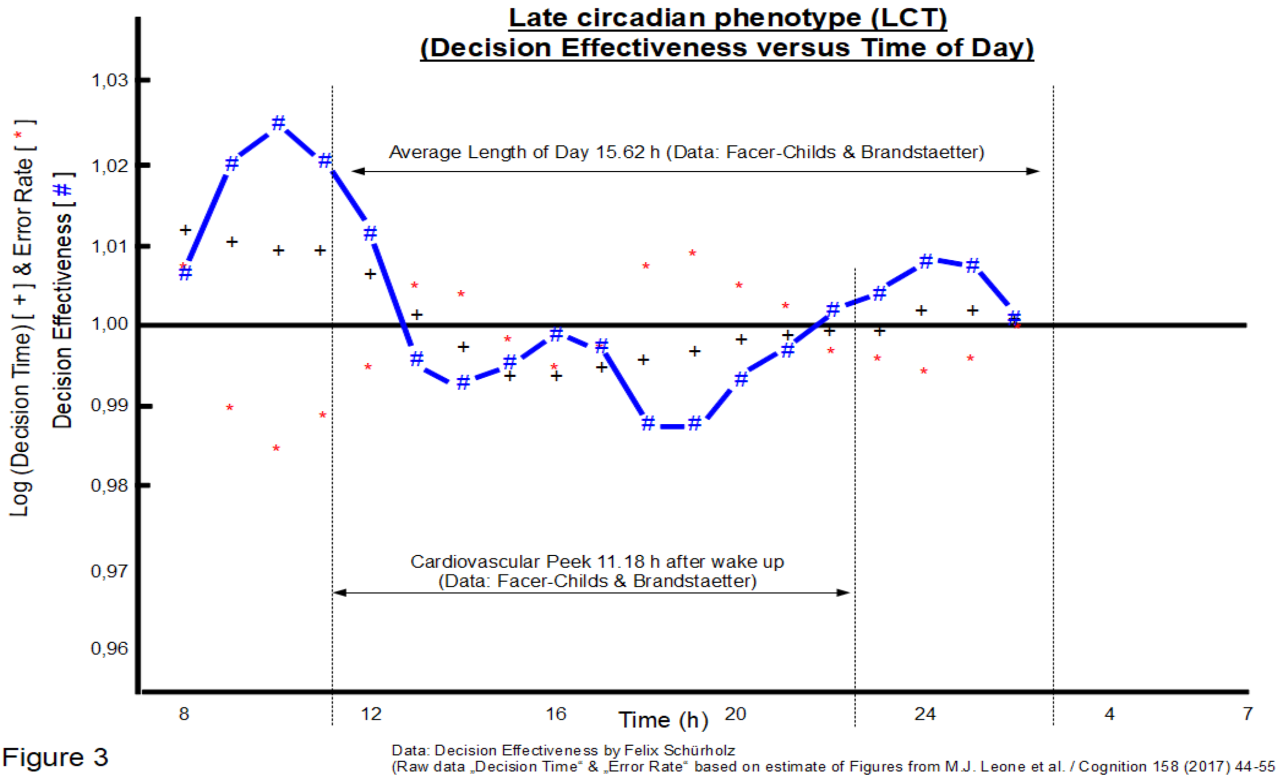

Figure 3

Using the above Figures 1, 2 & 3, the following conclusions can be drawn:

Data of "Chess Study" applied to "Wider Context" ("General Decision Effectiveness") also using Data by Facer-Childs & Brandstaetter:

● Larks (early circadian phenotype, ECT), **Figure 1**, is the phenotype with the highest decision effectiveness

● ECT´s highest decision effectiveness is on average between 8 a.m. and 12 p.m., and peaks at around 10 a.m.

● Intermediate circadian phenotype (ICT), **Figure 2**, tends to miss its morning peak due to a later wake up time at around 9.40 a.m..

● ICT´s highest decision effectiveness is in practice between 10 a.m. and 12 p.m.

● ICT´s afternoon and evening decision effectiveness is, in comparison to ECT, higher and more stable.

● Owls (late circadian phenotype, LCT), **Figure 3**, have two major peaks of high decision effectiveness. The first, between wake up (around 11:15 a.m.) and about 1 p.m., and the second, from around 10 p.m. to 2 a.m..

● The highest decision effectiveness for LCT will be in the morning provided that waking up takes place before 12 p.m.

● In comparison to ECT and ICT, LCT is the only circadian phenotype that has a high decision effectiveness after about 10 p.m.

Discussion

While most of the above conclusions are in line with the findings of Leone et al. like:"...we observed a consistent diurnal fluctuation in Decision time which is modulated by chronotypes. The pattern observed is that players use more time (with higher variability) during the morning, and less time (and lower variability) during the evening. This effect has higher amplitude in Early types than in Late types.", there are though also marked differences in conclusion between Leone et al. and the findings presented here, particularly when it comes to **performance** and **performance perspective**.

Leone et al. state using their "efficiency" and "performance" perspective:"... there are not diurnal fluctuations in performance... neither performance (as determined by rating) nor the choice/the distribution of opponents change along the day. ..."

I think it is important to note that Leone et al. are defining performance in terms of the overall outcome of the chess game which is of course only a **relative measure** i.e. which player is better than the other, and not an absolute one like an athlete jumping a certain distance or running a race in an **absolute time**. I therefore suggest in this article to focus especially on **decision time and individual accuracy of play** which I suggest is a much better indicator of performance i.e. individual decision effectiveness of a player than the evaluation of the whole game as this perspective is probably too strongly dependent on the strength of the opponent and probably too biased because of the limited time budget and the efficiency focus in blitz chess.

Recommendation and Application of Results

Using the basic data of Leone et al. and applying the concept of decision effectiveness to it, individual and distinct patterns of ideal time of day for decision making for each chronotype can be determined.

Knowing their individual chronotype which can be found for example using the Morningness-Eveningness questionnaire (MEQ) (page 6 and 7 of that document can be ignored), allows each decider, using their individual profile (see Figure 1 (MEQ 51.54 - 64.5, Mean 58) , Figure 2 (MEQ 41-51.54, Mean 46.1) and Figure 3 (MEQ 26.1-41, Mean 33.59) to **identify** their **ideal time of day for decision making**.

Please note: The three maps presented here are already distinctly different and for completeness it might well be necessary that further maps for types, like the "definitely morning type" (for MEQ higher than 64.5 respectively 69) and "definitely evening type" (for MEQ lower than 26.1), still need to be generated (reference Horne & Ostberg).

In practice readers should be aware that **for a given age** their circadian rhythm is pretty much fixed displaying **little plasticity** as indicated at the beginning of this article. Of course to some extent you can entrain your circadian rhythm (Scheer et al.) but the changes one should consider, should in practice probably not exceed 30 to 60 minutes.

There is some **change in circadian rhythm with age**, particularly in adolescence, as the study by Fischer et al. shows:"... shifting later during adolescence, showing a peak in ‘lateness’ at ~19 years, and shifting earlier thereafter. ...The greatest differences are observed between 15 and 25 for both sexes...The variability in chronotype decreases with age, but is generally higher in males than females."

Taking this into account it makes a lot of sense to **re-evaluate the personal circadian rhythm** say using the Morningness-Eveningness questionnaire (MEQ) at least **once a**

year particularly when the user is in the **age range between 15 and 25**. After that, taking the test every 2 or 3 years should probably be sufficient.

Summary

This article has clearly identified ideal times of day for decision making. While these patterns were found in the context of playing chess, it is fair to assume that these patterns will also apply when it comes to important and irrevocable decisions that can be prepared, scheduled and optimized in advance, as in a process like decision timing (Schürholz). Applying the concept of decision effectiveness, to real life decision behavior and data (from Leone et al.) has generated for the first time three distinctly different decision profiles for the early, intermediate and late circadian phenotype. Using Figures 1, 2 & 3 (above), gives deciders (with an Morning-Eveningness Score (MEQ) in the range of about 26 and 65) a very good indication for their decision effectiveness for every hour between 8 a.m. and 2 a.m.. Scheduling and timing their decisions according to the given profile, i.e. **most important decisions during decision effectiveness peaks** and **least important and routine decisions during the troughs,** should produce overall the **best and most appropriate decisions with the least effort** for the decider.

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