

## The 4–5 Cycles per Second Rhythm – Changes in Time

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**Summary.** The 4–5 cycles per second (c/s) rhythm is a relatively rare, individual EEG variant. Age distribution of subjects carrying this variant and longitudinal studies over many years have indicated that it may sometimes disappear during middle age. Observations on female monozygotic twins at 15, 23 and 45 years of age suggest that disappearance of this trait might also be under genetic control.

**Key words:** 4–5 c/s rhythm – Age – Genetics – EEG

The 4–5 c/s rhythm is an individual variant of the resting EEG that was found in ~0.025%–0.075% of the population examined in diagnostic EEG laboratories (Kuhlo et al. 1969), and in ~0.1% of normal males (Vogel and Fujiya 1969). This dominant 4–5 c/s rhythm shows the following characteristics: amplitudes between 20 and 120  $\mu$ V; no harmonic relationships to the alpha rhythm; blocking when eyes are opened. After closing the eyes, it does not return immediately; alpha waves are seen for a short time until the 4–5 c/s rhythm returns. This rhythm can easily be disturbed by mild stimuli, e.g. acoustic, and is then replaced by alpha waves. It disappears during drowsiness and sleep. The phenomena was observed over many years in the subjects.

Two monozygotic twin pairs were found to have concordant EEGs, and in some sibships, secondary cases were observed (Vogel and Götze 1959; Kuhlo et al. 1969; Vogel 1970). Therefore, at least for some of the cases a genetic basis was assumed. Family studies, however, have disproved the hypothesis of a monogenic mode of inheritance. Psychologically, many but not all of the trait carriers showed “neurotic” disturbances of various kinds (Müller-Küppers and Vogel 1965; Kuhlo et al. 1969; Heintel 1975; Fröscher 1979; Wolpert et al. 1979). The oldest trait carrier in our earlier study (Kuhlo et al. 1969) was 54 years old. But the average age of trait carriers was consistently found to be much lower than that of the population in which this EEG pattern was observed. Moreover, sibships without additional cases were older than those containing such cases. In two population samples of normal males – where average age was much lower – the trait was more common than in patient samples (Vogel and Fujiya 1969). Hence, there was some indirect evidence that the trait

might disappear in some individuals during middle or advanced age (Kuhlo et al. 1969).

In this report, we shall confirm this conjecture by some direct observations.

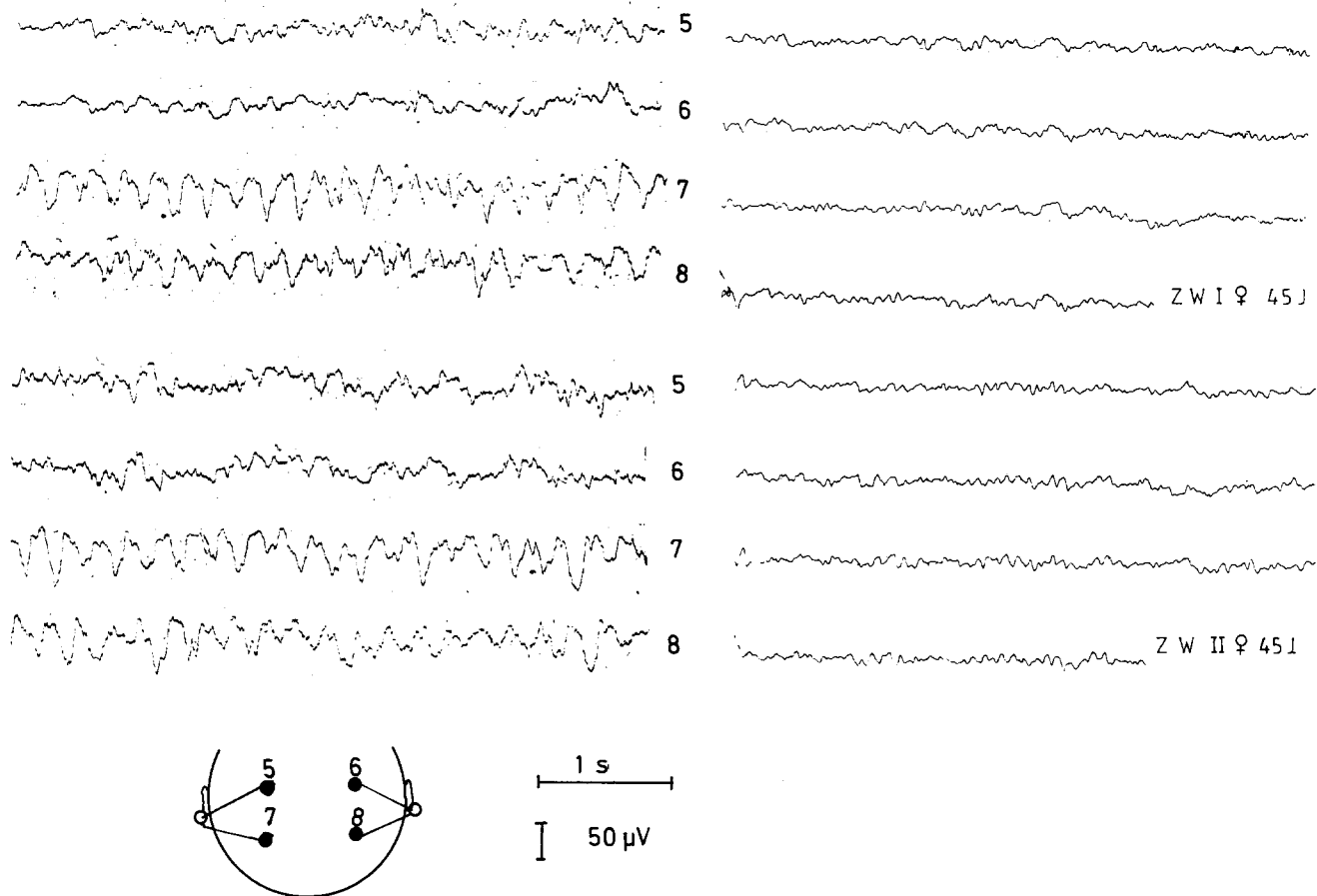
### Results and Discussion

In the EEG laboratory of the Stuttgart hospital, 54 trait carriers were observed between 1953 and 1984. The oldest was 84 years of age, the youngest 11. (Interestingly enough, the latter patient had already been examined at the age of 6.58 years; and at that time, the 4–5 c/s variant was not present.) The sex ratio was 1:1, hence, a predominance of females that had previously been observed (Kuhlo et al. 1969) was not confirmed ( $P > 0.05$ ). The average age was 38.24 years, compared with 52.46 years in the entire population studied; the difference being significant statistically ( $P < 0.05$ ). Dominant EEG frequencies varied between 3 c/s and 5 c/s; most individuals had a 4–5 c/s, a few a 3–4 c/s rhythm. There was no slowing with advancing age ( $P > 0.05$ ).

In two individuals disappearance of the variant was observed directly: P.B., a male, showed the variant at the ages of 11 and 17, but not at 27. In W.O., a male, it was seen at 15 and 25, but not at 42 years. Small groups of only 3–4 c/s waves were present instead. In two other individuals (K.G., E.Sch.), the variant had not disappeared after 27 and 8 years respectively; it was still visible at the ages of 51 and 72.

Female monozygotic twins were observed for the first time in 1954, at the age of 15, in a study of normal twins (Vogel 1958). The variant was still present in 1962. However, 22 years later, in 1984, the EEG of both twins had changed appreciably (Fig. 1). In occipital leads, where the maximum had been seen in earlier examinations, the 4–5 c/s waves had now disappeared completely; irregular and fast (~13 c/s) alpha activity predominated. A slightly irregular and flat 4–5 c/s rhythm was seen exclusively in central leads; here, activity had not changed very much during 30 years. As at the age of 15, EEGs were still completely concordant at 45, despite quite different life experiences (one twin was divorced and had one child; the other one was married and had 2 children).

In conclusion, the study confirmed earlier conjectures that the 4–5 c/s variant may sometimes disappear in middle age.



**Fig. 1.** 4–5 c/s rhythm in female monozygotic twins at the age of 15 (*left*) and 45 (*right*). Unipolar leads against the ipsilateral ear. Notice the difference in both twins between first and second examination

The observation of a monozygotic pair, in which the variant disappeared almost completely between the ages of 23 and 45, being replaced by a different but also concordant pattern points to a genetic determination.

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