

3 Results and discussion

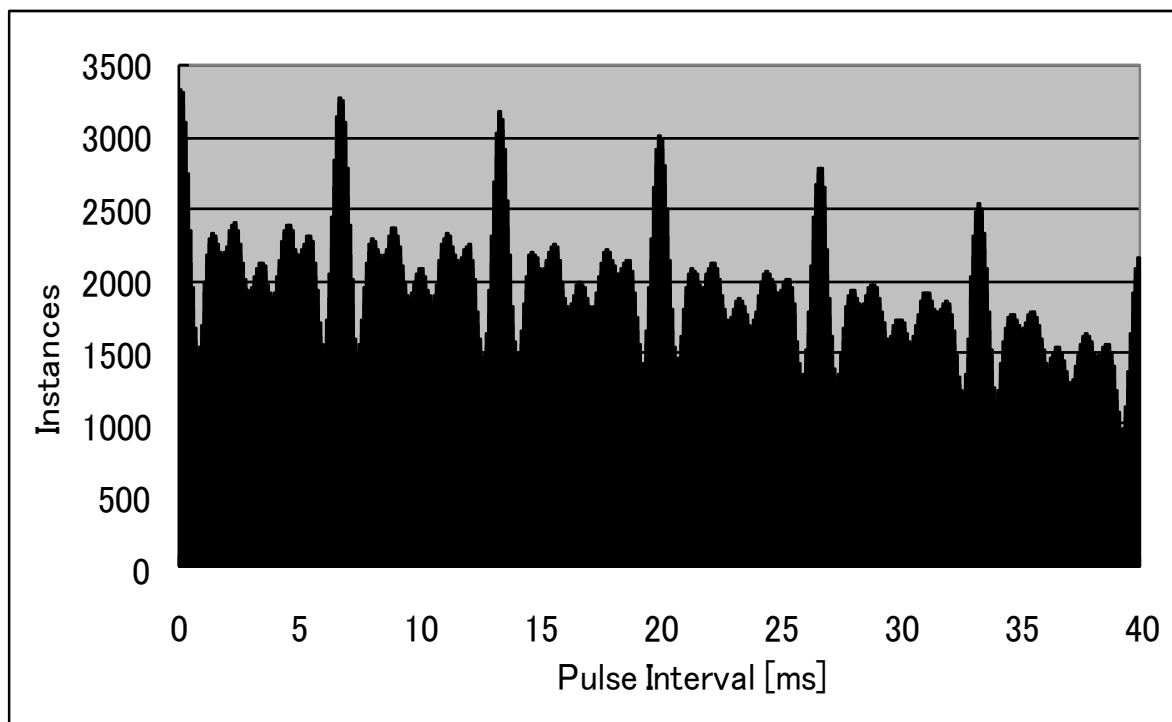
The psycho-acoustic experiments have showed that subjects perceived frequencies f_1 , f_2 , and f_0 . The subjects have perceived the missing fundamental f_0 more easily in the psycho-acoustic experiment for complex tones [experiment(2)] than in that for two pure tones [experiment(1)]. We have investigated what is the mechanism.

An interspike interval histogram for two complex tones is shown in Fig 5.

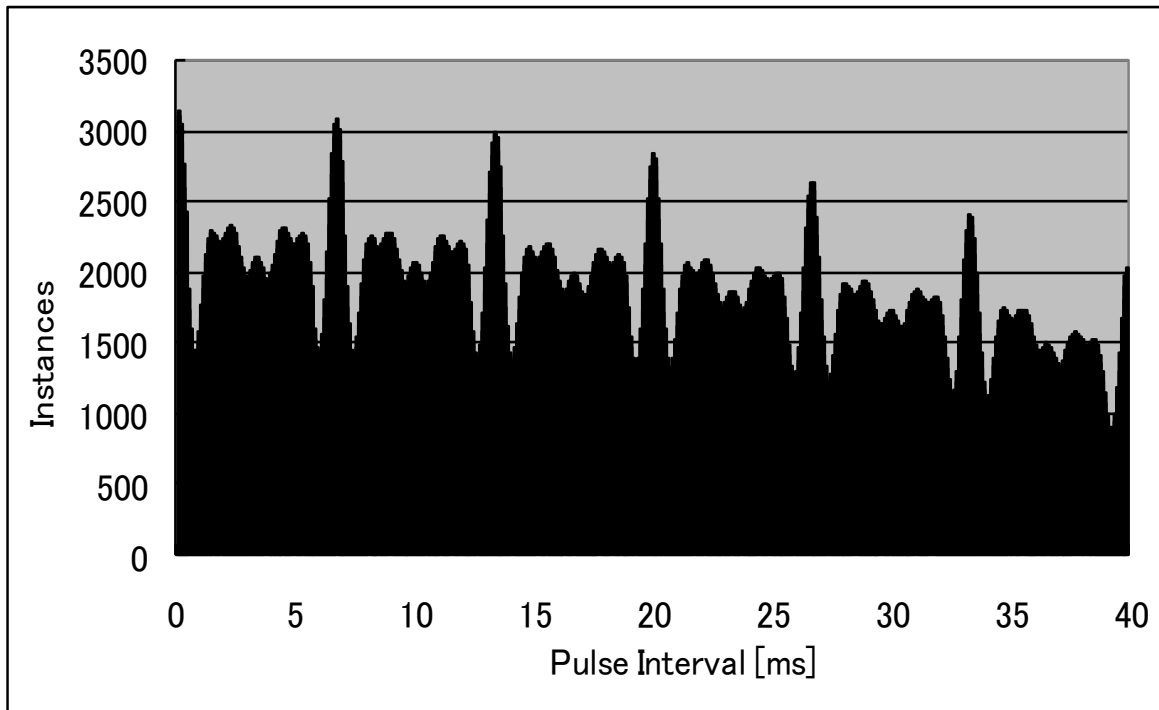
An interspike interval histogram for two pure tones is shown in Fig 6.

The subtraction of ‘the interspike interval histogram for two pure tones’ from ‘the interspike interval histogram for two complex tones’ is shown in Fig 7. The interspike interval histogram shown in Fig 7 has the information of f_0 . It means that two complex tones have more information of the missing fundamental than two pure tones have.

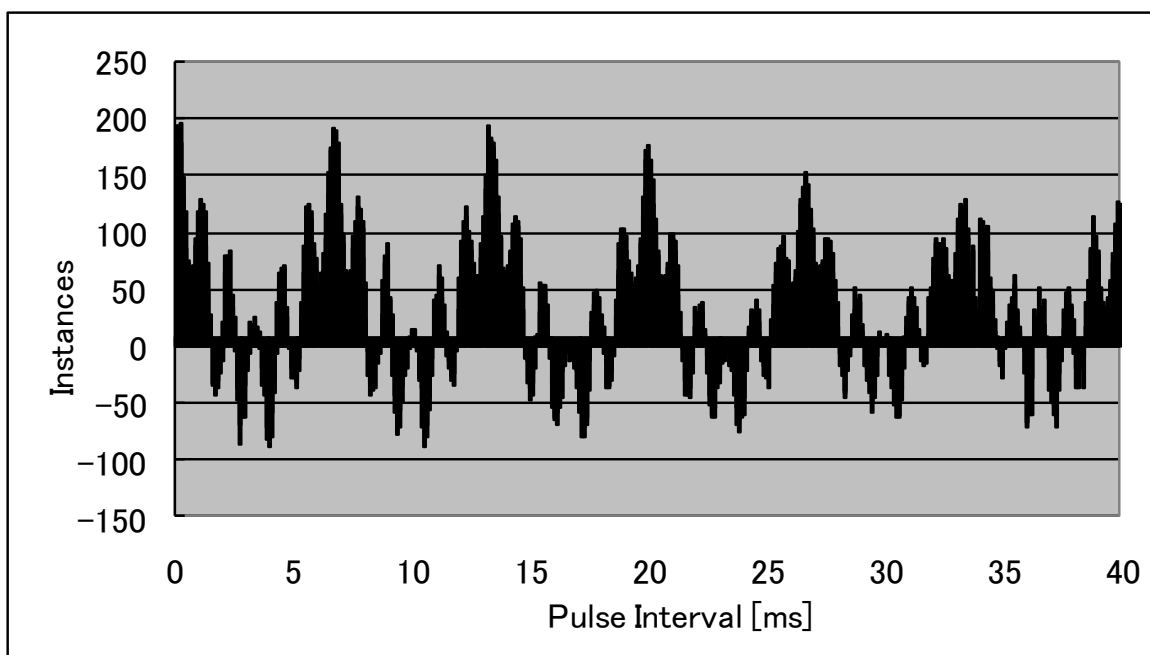
Two complex tones have the information of the missing fundamental and the information of combination tones $\{(f_2 - f_1), (2f_1 - f_2), \text{etc.}\}$. An example of the information of the fundamental from the combination tones is shown in Fig 7, where $(f_2 - f_1)$ equals f_0 , and $(2f_1 - f_2)$ equals f_0 . It has been made clear that subjects perceived the missing fundamental f_0 more easily in complex tones by the information from combination tones.



**Fig 5. The interspike interval histograms for two complex tones
[The experiments (2)]**



**Fig 6. The interspike interval histograms for two pure tones
[The experiments (1)]**



**Fig 7. The interspike interval histograms
[The results of the subtraction of Fig 6 from Fig 5]**

4 Conclusions

Subjects have perceived the missing fundamental f_0 more easily in the psycho-acoustic experiment for two complex tones than for two pure tones. The reason has been made clear by the consideration using cochlear models.

The research results of the mechanism generating the missing fundamental can be applied to the followings. They are the research of forming neural networks for perception in the auditory system, the improving cochlear implant, realizing electron water mark, etc..

Acknowledgement

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References

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- [2] Matsuoka T, Ono Y. Phase-locking by Integral Pulse Frequency Modulation and Information of Missing Fundamental in Pulse Trains. Proc 20th Annual Int Conf IEEE in MBS 1998; Vol 20 No 6: 3184-3187.