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論　文　要　旨

In this thesis, aiming at elucidating the functional basis of phoneme production and perception processes enabling inter-human speech communication, interdependence underlying speech motor control and auditory processing systems were studied based on physiological and psychophysical experiments. The dynamic behavior of speech organs during speech production has been found to be affected be self-produced auditory feedback signals. However, the functional characteristics of auditory feedback-based control of speech movements have not been fully elucidated. The involvement of speech motor control system in speech perception has also been evident. However, there have been controversial arguments regarding how incoming auditory information is processed and interpreted by the motor system and triggers a specific phoneme perception. From the above viewpoints, this thesis investigated the interaction mechanisms involved in the production and perception of speech phonemes, based on the following two experimental approaches: (1) as for speech production, evaluating changes in articulatory lip movement during speaking the bilabial plosive ([p]) repetitively, which occurred when a sudden alteration in timing and context of auditory feedback was introduced, and (2) as for speech perception, evaluating changes in phoneme intelligibility for bilabial, alveolar and velar plosives ([p], [t], and [k],

respectively), which occurred when hearing them simultaneously with whispering (silently articulating) incongruent phonemes, in comparison with viewing a mouth motion producing incongruent phonemes.

The critical result of the first experiment was that the articulatory lip movement quickened immediately when the auditory feedback virtually preceded the expected timing by 50ms. Such articulatory change was not observed when the feedback was presented more than 50ms earlier or later than the actual timing, or when the feedback syllable was replaced by other one. These results suggest that errors between the internally predicted and actually provided auditory information detected in a temporally asymmetric window contribute to the compensation for the inter-articulatory timing in the syllable repetition task.

The critical result of the second experiment was that the silent articulation affected the phoneme perception in a different way from the well-known visual effects (ex., McGurk effect). Viewing lip motion ([p]) degraded hearing of phonemes produced by the tongue ([t] and [k]), and viewing tongue motions degraded hearing of phoneme produced by the lips, replicating the previous studies. On the contrary, articulating phoneme with the lips ([p]) did not affect hearing of tongue-related phonemes ([t] and [k]), and articulating phonemes with the tongue did not affect hearing of phoneme produced by the lips. More interestingly, articulating phonemes with the tongue ([t] and [k]) degraded hearing of the other tongue-related phonemes ([k] and [t], respectively). These results suggest for the first time that motor interferential effect on speech perception is mediated by a different mechanism from the visual one: the auditory-visual integration occurs across different speech organs, whereas the auditory-articulatory integration occurs within the same organ.

審査結果の要旨

従来の研究成果と著者が行った新規部分とが明確に説明され，著者が提案する音声生成と聴覚フィードバックの相互作用を検証する実験方法，実験結果による新しい知見など明確にされている内容である．予備審査時に指摘された論文内容の充実もなされていることを確認している．さらに学術論文誌への投稿，国際会議での発表など，対外活動も活発に行われている事を確認した．委員全員が論文内容から合格と判定した．また外部委員の誉田雅彰教授．鏑木時彦准教授からも十分な内容の論文であるとの判定を得ている．以上から提出論文は，システム情報科学における学位論文として十分な内容と判断し，判定を「合」とする．