

Efficacy of a Cochlear Implant Simultaneous Analog Stimulation Strategy Coupled With a Monopolar Electrode Configuration

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Objectives: The present study was performed to evaluate the efficacy and clinical feasibility of using monopolar stimulation with the Clarion Simultaneous Analog Stimulation (SAS) strategy in patients with cochlear implants.

Methods: Speech recognition by 10 Clarion cochlear implant users was evaluated by means of 4 different speech processing strategy/electrode configuration combinations; ie, SAS and Continuous Interleaved Sampling (CIS) strategies were each used with monopolar (MP) and bipolar (BP) electrode configurations. The test measures included consonants, vowels, consonant-nucleus-consonant words, and Hearing in Noise Test sentences with a +10 dB signal-to-noise ratio. Additionally, subjective judgments of sound quality were obtained for each strategy/configuration combination.

Results: All subjects but 1 demonstrated open-set speech recognition with the SAS/MP combination. The group mean Hearing in Noise Test sentence score for the SAS/MP combination was 31.6% (range, 0% to 92%) correct, as compared to 25.0%, 46.7%, and 37.8% correct for the CIS/BP, CIS/MP, and SAS/BP combinations, respectively. Intersubject variability was high, and there were no significant differences in mean speech recognition scores or mean preference ratings among the 4 strategy/configuration combinations tested. Individually, the best speech recognition performance was with the subject's everyday strategy/configuration combination in 72% of the applicable cases. If the everyday strategy was excluded from the analysis, the subjects performed best with the SAS/MP combination in 37.5% of the remaining cases.

Conclusions: The SAS processing strategy with an MP electrode configuration gave reasonable speech recognition in most subjects, even though subjects had minimal previous experience with this strategy/configuration combination. The SAS/MP combination might be particularly appropriate for patients for whom a full dynamic range of electrical hearing could not be achieved with a BP configuration.

Key Words: cochlear implant, electrode configuration, simultaneous analog stimulation, speech processing strategy, speech recognition.

INTRODUCTION

It has long been assumed that for speech perception with a cochlear implant, the optimal electrode configuration is one that restricts the spread of current and maximizes channel independence, such as a narrow bipolar (BP) configuration. However, in the past decade, a few studies have found that patients often prefer the sound quality of speech when the device is programmed to use a broader configuration, such as a monopolar (MP) configuration.¹⁻⁶ In those studies, speech recognition with the broader configurations was often equal to or better than that achieved with the narrower configurations.

Both the Clarion (Advanced Bionics Corporation) and Nucleus (Cochlear Corporation) multichannel

cochlear implant devices have the option of using either MP or BP stimulation, whereas the MED-EL device uses only MP stimulation. With MP stimulation, an intracochlear electrode acts as the current source, while an extracochlear electrode serves as the reference. With BP stimulation, both the source and reference electrodes are intracochlear and in close proximity. In theory, MP configurations produce more diffuse current fields and therefore stimulate larger numbers of nerve fibers than BP configurations at a given level of loudness. This idea is supported by a number of animal studies of neural response patterns for various electrode configurations.^{7,8} Therefore, MP stimulation is likely to have a larger overlap of current fields generated by nearby stimulation sites than does BP stimulation.

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The above-mentioned studies comparing broad and narrow configurations in implanted human subjects all used various versions of Nucleus prostheses that employed sequential (nonsimultaneous) pulsatile speech encoding strategies. In the early 1980s, a compressed analog (CA) strategy that used simultaneous stimulation was employed in the University of California at San Francisco/Storz and Ineraid multichannel cochlear implant systems.^{9,10} In the CA strategy, the signal was first compressed with a fast-acting automatic gain control, passed through 4 band-pass filters, and then fed to corresponding electrodes. The CA strategy used MP stimulation. Patients achieved limited speech recognition with CA, but the performance for open-set speech recognition was not satisfactory. A potential problem with simultaneous stimulation strategies is current interactions, which can lead to distortions in the electrical waveforms. An alternative strategy was developed by Wilson et al¹¹ to avoid this problem. This strategy, called Continuous Interleaved Sampling (CIS), utilizes trains of interleaved pulses so that no 2 channels are stimulated simultaneously and the temporal envelopes of the CA signals from the processor's bandpass filters are used to amplitude modulate pulse trains on electrodes selected on the basis of the center frequencies of the filters. This strategy reduced some of the temporal information being delivered to the cochlea, but effectively avoided the problem of current interaction and the resulting waveform distortion. Interleaved pulsatile stimulation strategies have also been in long-term use by Cochlear Corporation in various forms,^{12,13} and these also lack the ability to transmit temporal fine structure.

In order to regain some of the temporal information sacrificed by the CIS and other pulsatile stimulation strategies, Advanced Bionics Corporation reintroduced, in 1999, a simultaneous stimulation strategy as one option for its users. This strategy, called the Simultaneous Analog Stimulation (SAS) strategy, differed from the earlier CA strategy in that the number of channels was increased to 8 and the "front-end" compression in CA was changed to "back-end" compression (see Wilson¹⁴ for details). To reduce current interaction, the manufacturer recommended a narrow BP configuration for the SAS strategy.¹⁵

The SAS strategy appears to be the strategy preferred by a remarkable proportion of implant users. A few studies have investigated the preference for the CIS strategy versus the SAS strategy in Clarion cochlear implant patients. Battmer et al¹⁶ found that approximately half of their 22 CI implant patients preferred CIS and the other half preferred SAS. Osberger and Fisher¹⁷ and Stollwerck et al¹⁸ found that

approximately three quarters of the patients preferred CIS and the remaining one quarter of patients preferred SAS. In a study of clinical trial data,¹⁹ we evaluated speech processing strategy preference among CIS, MPS (Multiple Pulsatile Sampler), and SAS in Clarion CI and CII implant patients. Of the 56 CI implant patients, 50% preferred CIS and 39% preferred SAS. On the other hand, only 15% of the 56 CII implant patients with the HiFocus electrode array preferred the CIS strategy, whereas 52% preferred the SAS strategy. All of the above studies used the BP configuration in the SAS strategy.

With a simultaneous stimulation strategy such as SAS, the effects of electrode configuration are expected to be different from those observed when nonsimultaneous strategies are used. As noted above, when current is delivered simultaneously to multiple stimulation sites, current interactions can occur, and these interactions can distort the waveforms of the signals on the individual channels. For this reason, the diffuse current fields generated by MP stimulation are assumed to be less desirable than the more restricted fields generated by BP stimulation when the SAS strategy is used. On the other hand, any advantages of MP over BP stimulation obtained with nonsimultaneous strategies, such as activation of a larger population of information-bearing neural channels, might also apply to the SAS strategy. Thus, we might expect a mixture of benefits and detriments from combining the SAS strategy with an MP electrode configuration.

Clinically, some early Clarion patients who used the radial BP configuration could not be fitted with the SAS strategy, because adequate dynamic range could not be achieved because of limitations in current output level.²⁰ We have also observed that some patients who use the SAS strategy experience an increase in most comfortable loudness (M) levels over time. When such patients reach an upper limit of the stimulator output when using BP stimulation, they are faced with the difficulty of either converting to a different strategy or converting to an MP configuration that requires a much lower current.²¹ Because no data on SAS programmed with the MP configuration are available to date, the present study was conducted to determine the feasibility of using this strategy and configuration in combination and to compare the results with those obtained with other strategies and configurations. For these comparisons, a nonsimultaneous pulsatile strategy, CIS, was also tested with both MP and BP configurations. To assess the efficacy of these various combinations of strategy and configuration, we used speech recognition tests and subjective judgments of the sound quality.

DEMOGRAPHIC INFORMATION ON ALL SUBJECTS

Subject No.	Electrode Array	Everyday Strategy and Electrode Configuration	Duration of Implant Use From Activation to Testing (mo)	Age at Onset of Profound Deafness (y)	Age at Implantation (y)	Cause	Preoperative PTA Unaided (dB HL)*	
							Right	Left
1	Enhanced BP/EPS	SAS/BP	59	37	42	Alport's syndrome	107	110
2	Enhanced BP	SAS/BP	29	45	46	Unknown	95	92
3	Enhanced BP/EPS	SAS/BP	36	73	74	Unknown	NR	107
4	HiFocus	SAS/BP	9	35	35	Unknown	107	117
5	HiFocus/EPS	SAS/BP	46	3	19	Meningitis	117	103
6	HiFocus	SAS/BP	9	72	73	Ototoxicity	108	118
7	HiFocus	CIS/BP	11	54	55	Ototoxicity	95	113
8	Enhanced BP/EPS	CIS/MP	35	53	53	Unknown	NR	97
9	HiFocus/EPS	MPS/MP	41	5	40	Enlarged vestibular aqueduct	103	107
10	HiFocus	MPS/MP	8	50	55	Unknown	92	97

PTA — pure tone average of 500, 1,000, and 2,000 Hz; HL — hearing level; BP — bipolar; EPS — electrode positioning system; SAS — Simultaneous Analog Stimulation; NR — no responses; CIS — Continuous Interleaved Sampling; MP — monopolar; MPS — Multiple Pulsatile Sampler.

*Bold type indicates implanted ear.

METHODS

Subjects and Implants. The subjects were 10 post-lingually deafened adults implanted with either a Clarion 1.2 enhanced BP array or a Clarion HiFocus electrode array. In the enhanced BP array, the electrodes are arranged so that 8 are located medially and 8 are located laterally along the electrode carrier and offset longitudinally with respect to the medial electrodes. With the BP configuration of this array, current flows from the medial electrode to the neighboring lateral electrode, resulting in a total of 7 off-radial BP channels. The distance between the electrodes in each enhanced BP pair is about 1.7 mm. In the HiFocus array, the electrode contacts are arranged linearly along the carrier, and the distance between the adjacent electrodes is 0.9 to 1.1 mm. Eight channels are formed between the odd- and even-numbered electrodes in the BP configuration.

All subjects had a minimum of 8 months' experience with their cochlear implant, and all obtained a score of at least 20% correct on HINT (Hearing in Noise Test) sentences²² (+10 dB signal-to-noise ratio) when tested using their everyday program. In this group of subjects, 6 used SAS/BP (subjects 1 through 6), 1 used CIS/BP (subject 7), 1 used CIS/MP (subject 8), and 2 used MPS/MP (subjects 9 and 10) as their everyday strategy/configuration combination. The MPS strategy is similar to CIS except that pairs of channels (eg, channels 1 and 5, 2 and 6, etc) are stimulated simultaneously. Demographic information for the subjects is shown in the Table. Total participation for each subject lasted approximately 6 hours. The use of human subjects in this study was reviewed and approved by the University of Michigan Medical School Institutional Review Board.

Programming Procedures. Four sets of threshold (T) and most comfortable loudness (M) levels were obtained for each subject in order to create 4 different programs: SAS/MP, SAS/BP, CIS/MP, and CIS/BP. Default settings in the clinical programming software (SCLIN 2000, Advanced Bionics Corporation, Valencia, California) were used for all other parameters in the programs, which were implemented on a laboratory-owned Clarion Platinum Speech Processor (PSP).

The following procedures, used for creating programs, were the same as those used in the clinic. First, T levels were obtained for all stimulation sites by means of an ascending method-of-limits procedure. The threshold stimuli for both the analog and the pulsatile strategies were 200 ms in duration with a 1,000-ms interval between stimuli. Stimulation began at a subthreshold level, and the subjects were asked to press the arrow key on the computer keyboard until a stimulus was just perceptible. Second, M levels were obtained for all stimulation sites by a similar ascending method-of-limits procedure. The stimuli for the analog and pulsatile strategies were 50 ms in duration and had an interstimulus interval of 1,000 ms. The subjects were instructed to adjust the stimulus level using the up and down arrow keys on the computer keyboard until the stimulus reached "the loudness level where you hear sound at a normal level — where you could listen to the sound for a long time without any discomfort." The stimuli at the initially selected M levels were then presented to all stimulation sites in a basal-to-apical "sweep" to test for equal loudness across all of the stimulation sites in the array. Adjustments were made to individual M levels until the subject reported equal loudness for

all of the stimulation sites. Third, the volume of the subject's program was adjusted in SCLIN 2000 software so that the most comfortable listening level for calibrated speech was achieved with the volume control of the PSP set at the 12 o'clock position. The sensitivity dial was fixed at the 10 o'clock position.

After the levels were set for the 4 programs, the subjects participated in testing using each of the 4 programs in a randomized order. When a program was tested for the first time, the subjects listened with the new program for a few minutes and then took a practice speech recognition test that lasted about 15 minutes before data collection began.

Speech Recognition Tests. Four speech recognition tests were administered in the following order: consonant test, vowel test, consonant-nucleus-consonant (CNC) word test, and HINT sentence test. The speech stimuli were presented through a loudspeaker mounted 1 m away from the subject at 0° azimuth inside a double-walled sound-attenuating booth. The stimulus level was 70 dB sound pressure level. Each sequence of 4 tests was administered 3 times for each of the 4 programs (CIS/BP, CIS/MP, SAS/BP, and SAS/MP). The order of the 12 test conditions (4 programs times 3 repetitions) was randomized. The stimuli were presented a single time, and no feedback was provided. The subjects were instructed to guess if they were not sure.

The consonant tests used 20 syllables in a consonant-/a/ context (ba, cha, da, fa, ga, ja, ka, la, ma, na, pa, ra, sa, sha, ta, tha, va, wa, ya, za).²³ One male talker (No. 3) and 1 female talker (No. 3) were used of the multiple talkers available for this test, so that there were a total of 40 stimuli per test. For the vowel test, 12 different vowel stimuli were presented in an hVd context (had, hayed, hawed, head, heard, heed, hid, hod, hoed, hood, hud, who'd).²⁴ Two male talkers (Nos. 48 and 49) and 2 female talkers (Nos. 39 and 44) were used of the multiple talkers available in these test materials, so that there were a total of 48 stimuli per test. For both the consonant and vowel tests, a stimulus token was chosen randomly (without replacement) from the 40 tokens in the consonant test or from the 48 tokens in the vowel test. Alphabetic representations of the 20 consonant or the 12 vowel stimuli were presented in a grid on a computer screen. The subject responded by pointing the cursor to the appropriate symbol using a computer mouse and depressing the mouse button. For the CNC word test,²⁵ 1 list containing 50 items was presented. Last, 1 list of the HINT sentences²² (10 sentences, about 50 words) was presented at a +10-dB signal-to-noise ratio. For both the CNC word and the HINT sentence tests, the subjects were required to report

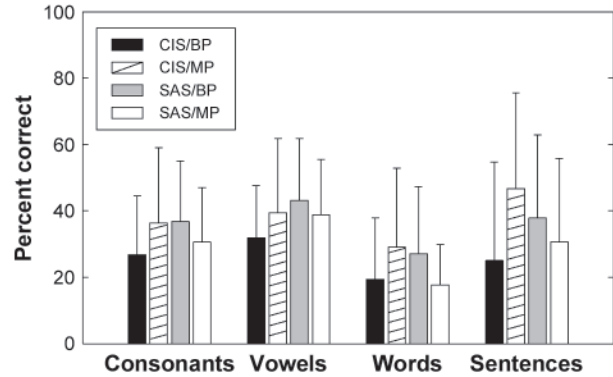


Fig 1. Means and standard deviations of speech recognition scores across all 10 subjects. Strategy/configuration combinations are indicated by key. CIS — Continuous Interleaved Sampling; BP — bipolar; MP — monopolar; SAS — Simultaneous Analog Stimulation.

verbally what they had heard after each presentation of a word or a sentence. The experimenter then wrote down the responses. The scores for the HINT sentences were based on the number of correct words reported.

Subjective Judgments. Subjective judgments of the sound quality were obtained immediately after each test with the HINT sentences. The subjects rated the sound quality of the program using a graphic user interface (a sliding bar) controlled with the computer mouse. The possible ratings ranged from *very poor* (0) to *excellent* (100). Three ratings were obtained for each strategy/configuration condition and then averaged.

RESULTS

Figure 1 shows the group mean data of speech recognition tests across all subjects. The scores obtained with SAS/MP were comparable with those obtained with the other strategy/configuration combinations. In fact, the mean speech recognition scores among the 4 different strategy/configuration combinations were not significantly different from each other (analysis of variance, $p > .05$). More importantly, this Figure demonstrates a high intersubject variability, as indicated by the large SD values.

Figure 2 shows the individual speech recognition scores. Each bar represents the mean of the scores obtained by each subject for the 3 presentations of each test. Using the SAS/MP strategy/configuration combination, all subjects with the exception of subject 3 demonstrated performance in consonant and vowel recognition that was markedly above the chance performance. The chance performance was 5% and 8.3% correct for consonants and vowels, respectively. For open-set speech recognition (CNC words and HINT sentences), performance with SAS/MP ranged from 8% to 49% correct for CNC words and from

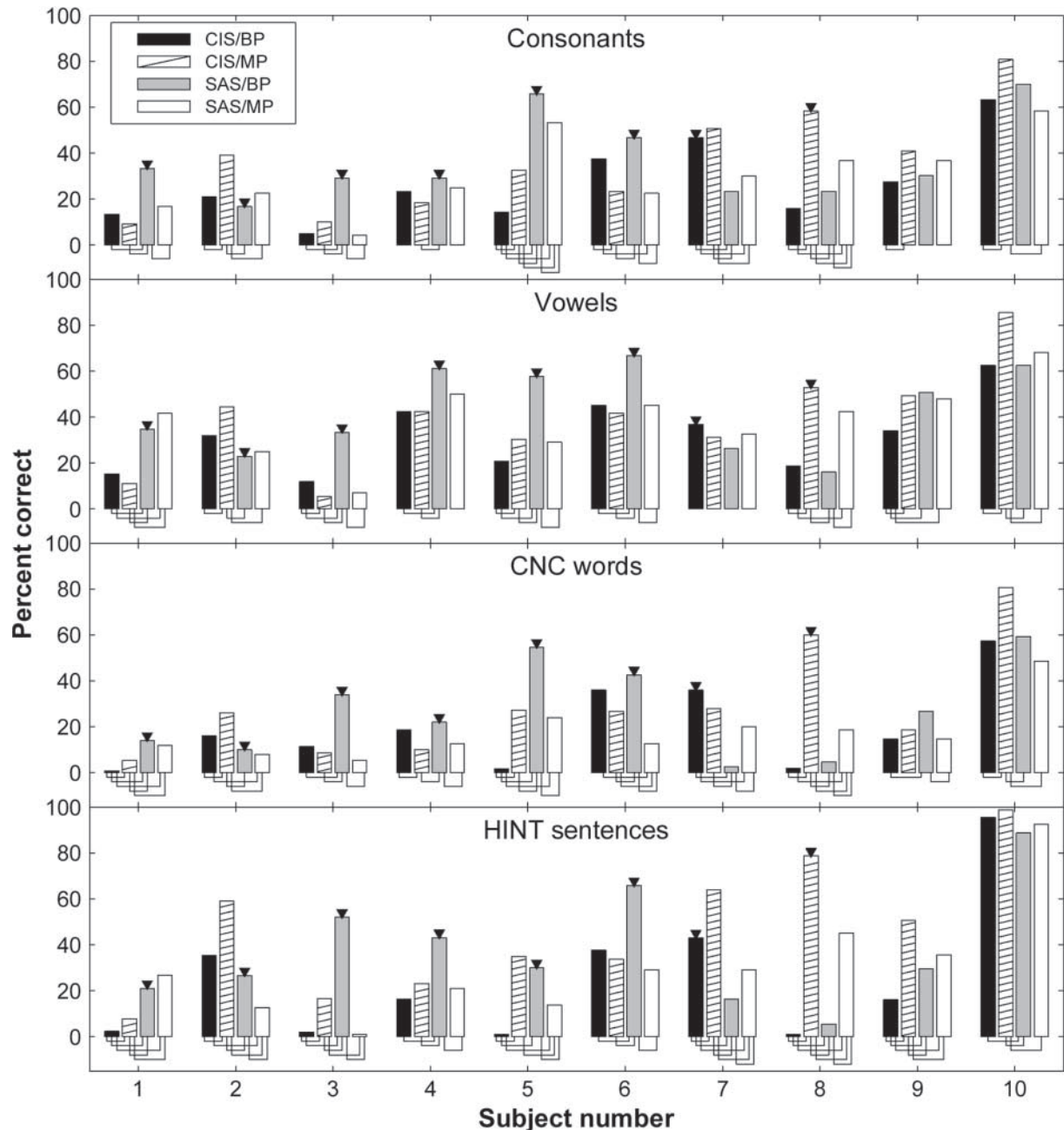


Fig 2. Individual speech recognition scores. Four panels show data from consonant tests, vowel tests, consonant-nucleus-consonant (CNC) word tests, and Hearing in Noise Test (HINT) sentence tests (+10 dB signal-to-noise ratio). Each group of 4 bars shows data from 1 subject using 4 different strategy/configuration combinations as indicated by key. Each bar represents mean speech recognition score from 3 tests. Arrowheads indicate subjects' everyday strategy/configuration combination prior to study. Subjects 9 and 10 used MPS/MP combination, which was not tested in study. Brackets beneath bars represent significant differences of scores between 2 bars (binomial-variable analysis, $p < .05$).

12% to 92% correct across all subjects excluding subject 3.

In Fig 2, arrowheads indicate the subject's everyday strategy. For 6 (subjects 2, 3, 4, 6, 8, and 10) of the 10 subjects, the performance was the best with 1 strategy/configuration combination on all 4 tests. In these 6 subjects, 5 used SAS or CIS as their everyday strategy. Subject 10 used the MPS/MP combina-

tion, which was not tested in the study. Of the 5 of these subjects whose everyday strategy was either SAS or CIS, 4 (subjects 3, 4, 6, and 8) showed the best performance with their everyday strategy/configuration combinations on all tests. It is noteworthy that for the 8 subjects (subjects 1 through 8) whose everyday strategies were either SAS or CIS, the performance with their everyday strategy/configuration combination was the highest in 23 (72%) of the 32

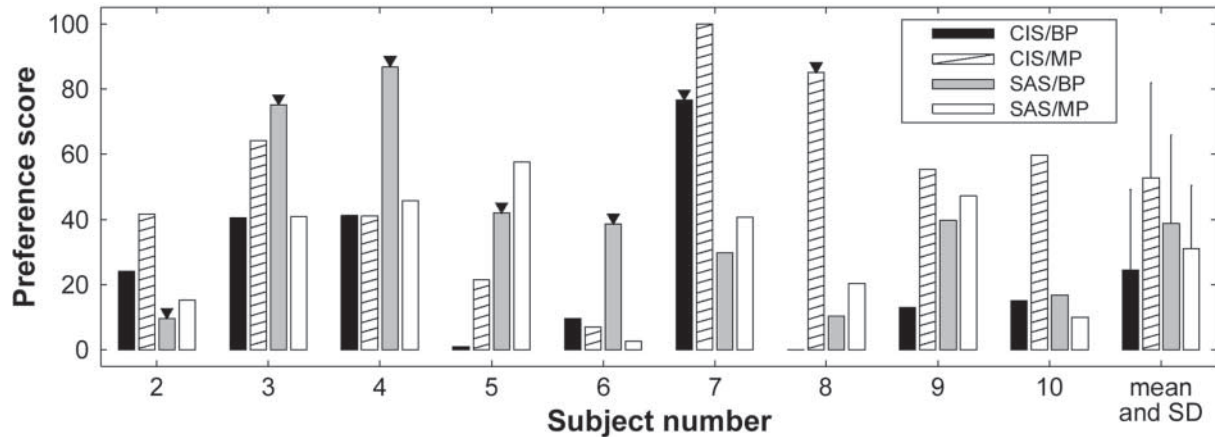


Fig 3. Preference ratings. First 9 groups of 4 bars show data from 9 subjects (subjects 2 through 10) using 4 different strategy/configuration combinations as indicated by key. Each bar represents mean from 3 ratings. Arrowheads indicate subjects' everyday strategy/configuration combination prior to study. Subjects 9 and 10 used MPS/MP combination, which was not tested in study. Preference rating data were not available for subject 1. Rightmost group of 4 bars shows group mean and SD for 4 different strategy/configuration combinations.

cases (ie, 8 subjects times 4 speech tests). If we removed the results for the everyday strategy/configuration combination from the data set of all 10 subjects, performance with SAS/MP was better than that with any of the remaining strategy/configuration combinations in 12 (37.5%) of the 32 cases.

The binomial-variable analysis developed by Thornton and Raffin²⁶ was used to determine the statistical significance of the individual speech recognition scores obtained with different strategy/configuration combinations. The results of these analyses are represented by the brackets under the bars in Fig 2. When 2 bars are connected by the brackets, it indicates that the differences of scores between the 2 bars are statistically significant (binomial-variable analysis, $p < .05$).

Individually, the SAS/BP users (subjects 1 through 6) tended to show a reduced level of performance when tested with SAS/MP. In 16 (67%) of the 24 cases (ie, 6 subjects times 4 speech tests), the speech recognition scores with SAS/BP were statistically significantly higher than those with SAS/MP. For the CIS users (subjects 7 and 8), the speech recognition scores with SAS were lower than those obtained with CIS, as was shown in a study by Loizou et al.²⁷ More interestingly, in those CIS users, the speech recognition scores with SAS/MP were always higher than those with SAS/BP. They were significantly better in 6 (75%) of the 8 cases (ie, 2 subjects times 4 speech tests). For the MPS users (subjects 9 and 10), the speech recognition scores with SAS/MP were comparable to those with SAS/BP; only in 1 case was the score with SAS/BP significantly higher than that with SAS/MP (subject 9, CNC words).

The preference ratings provided by each subject

for each of the 4 strategy/configuration combinations and the mean and SD across all subjects are summarized in Fig 3. Each bar in Fig 3 represents the mean of 3 ratings. The possible ratings for each strategy/configuration combination ranged from 0 (very poor) to 100 (excellent). No preference rating data were obtained from subject 1. Of the 5 SAS/BP subjects (subjects 2 through 6), 3 (subjects 3, 4, and 6) preferred SAS/BP to SAS/MP, whereas the reverse was true for the other 2 subjects (subjects 2 and 5). In subjects 2 through 8, whose everyday strategies were either SAS or CIS, 4 showed higher preference ratings with their everyday strategy/configuration conditions (subjects 3, 4, 6, and 8). For the group (mean and SD shown by the rightmost group of bars of Fig 3), the intersubject variation was large, and a 1-way analysis of variance revealed no statistically significant differences in the means for the 4 different strategy/configuration combinations ($p > .05$).

DISCUSSION

In this study we evaluated speech perception using the SAS strategy with an MP electrode configuration. The performance of the SAS/MP combination was compared with the performance of SAS coupled with a BP electrode configuration and a CIS nonsimultaneous pulsatile strategy coupled with MP or BP configurations. Subjects achieved open-set speech perception with both the SAS and CIS strategies programmed with either an MP or a BP electrode configuration (Figs 1 and 2). Sixty percent of the subjects performed best on all tests when using 1 particular strategy/configuration combination, and the best performance was most often with the strategy/configuration combination that the subjects had used in their everyday processors. Some subjects demon-

strated a tendency to perform best with a particular strategy, regardless of electrode configuration (eg, subjects 2 and 7), whereas others demonstrated a tendency to perform better with a particular electrode configuration (eg, subjects 6 and 8).

The fact that subjects tend to do better with their everyday strategy/configuration combination could be attributed to 2 factors. First, the choice of the everyday strategy/configuration in the clinic was based on some preliminary testing with various options. Thus, some initial preference was found for the strategy/configuration that the subjects were given by the clinician for everyday use. However, not all of the 4 strategies/electrode configuration combinations tested in this study were tested in the initial clinical screening. In particular, the SAS/MP combination was never tested, because of the assumption that channel interaction would be a serious problem with this combination.

A second factor that almost certainly played a role in the typically better performance with the everyday strategy/configuration combination was the effect of experience with that combination. Previous studies have shown that speech recognition performance with the everyday strategy improves as a function of use over a period of 1 to 2 years²⁸⁻³⁰ and that the effect of experience with a particular strategy/configuration on performance with novel processor maps increases as a function of duration of use of the everyday map.⁴ If we exclude the subjects' everyday strategy/configuration from the analysis of the data in this experiment, we find that performance with the SAS/MP combination was better than that with any of the remaining combinations in 37.5% of the cases (12/32). On the basis of previous studies on the effects of training, we would expect considerable improvement in speech recognition with the SAS/MP combination if the subject used it daily.

The speech recognition performance with SAS/MP was usually not the best among the strategies that were tested. The relatively poor speech recognition with this strategy/configuration combination, as well as the low preference ratings, was probably due in part to the fact that none of the subjects had listened to speech with the SAS/MP combination before their participation in this study. However, even without previous experience with SAS/MP, subject 8 performed significantly better with the SAS/MP combination than with either CIS/BP or SAS/BP, and subject 10 showed 92% correct open-set speech recognition with SAS/MP on the HINT sentences (Fig 2). As discussed above, it is well known that speech recognition performance increases as a function of time after subjects with cochlear implants begin using a new pro-

cessing strategy.²⁸⁻³⁰ It is likely that performance with SAS/MP would improve if subjects were provided with additional experience in using such a program.

The finding that most patients were able to demonstrate some open-set speech recognition when using the SAS/MP combination is encouraging. In our clinic, some patients have experienced an increase in their M levels over time when using an SAS/BP program. These increases can eventually make some of the stimulation sites unusable. For some patients, it has been necessary to change to a different speech processing strategy, and some have experienced difficulty adjusting to an unfamiliar strategy, particularly when it also uses an unfamiliar electrode configuration, such as when switching from SAS/BP to CIS/MP. Such patients might adapt better to a change that entails use of a new electrode configuration only, such as SAS/MP. However, as in all instances in which a new or different strategy/configuration combination is used, the patient's speech recognition should be monitored closely to ensure his or her optimal performance.

The SAS strategy was designed in conjunction with electrode array designs that aimed at producing restricted current fields, either through an off-radial enhanced BP configuration or through a longitudinal BP configuration in a precurved, modiolus-hugging electrode array. It was an attempt to overcome the drawbacks of the large, interacting current fields produced by the MP stimulation of the CA (Compressed Analog) strategy. The present study showed that our subjects achieved open-set speech recognition with the SAS strategy coupled with MP stimulation. In some cases, the performance with SAS/MP was actually significantly better than that with SAS/BP (subjects 7 and 8; Fig 2). The mechanisms behind these findings are not clear. One possibility is that in those subjects, the channel interaction caused by MP stimulation is not greater than that caused by BP stimulation and that the auditory system can take advantage of broadly stimulated and yet distinct populations of neurons. Another possibility is that the SAS strategy may better convey temporal information and that some subjects can perceive changes in frequency over a relatively wide range. The ability to utilize the temporal information across a broad array of neurons in MP configuration might offset some of the detrimental effects of spectral smearing due to channel interactions. It has been demonstrated that there is a tradeoff relationship between the temporal and spectral cues for tone perception³¹ and to a lesser extent for phoneme perception.³²

In sum, SAS coupled with MP configuration does not clearly stand out as a superior strategy/configu-

ration combination, but it is certainly a usable strategy/configuration combination and could be recommended in certain cases, such as when SAS/BP fails

because of elevated M levels. The benefit of the SAS/MP combination after long-term use remains to be investigated.

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