Ancillary Aural Rehabilitation Services for Adult Cochlear Implant Recipients: A Review and Analysis of the Literature*

Services auxiliaires de réadaptation auditive pour les adultes receveurs d'implants cochléaires: revue et analyse des documents

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Abstract

This article provides a review and analysis of ancillary aural rehabilitation programs provided to adult postlingually deafened cochlear implant recipients. The benefits of cochlear implants that have been reported in the literature are summarized briefly. Then, the components of ancillary aural rehabilitation programs designed for adult cochlear implant recipients are described. Studies that investigated the effectiveness of post-implant ancillary aural rehabilitation programs are reviewed. The results of those investigations are critically analyzed. Finally, the need and direction for further research in this area is presented.

Résumé

L'article présente une revue et une analyse des programmes auxiliaires de réadaptation auditive pour les adultes avec surdité postlinguistique et qui ont un implant cochléaire. L'article décrit les advantages de l'implant cochléaire et en donne un bref résumé. Il décrit ensuite les composantes des programmes auxiliaires de réadaptation auditive conçus pour les adultes ayant un implant cochléaire. Des études sur l'efficacité des programmes auxiliaires de réadaptation auditive après implantation ont été examinées. Les résultats de ces études sont analysés d'une façon critique. Enfin, il est question de la nécessité d'effectuer des recherches ultérieures et de l'orientation de ces recherches.

Introduction

Over the last two decades there have been significant technological advancements in the development of cochlear implant prostheses (Clark, 1992; Clark, Tong, & Patrick, 1990; Hopkinson et al., 1986; Luxford & Brackmann, 1985; Millar, Blamey, Tong, Patrick, & Clark, 1990; Simmons, 1985). During this same period of time many investigations have been conducted that evaluate the effects of cochlear implants among individuals with profound hearing loss. The results of these investigations have revealed that cochlear implants may be quite beneficial for individuals with profound hearing loss who are not able to benefit from conventional hearing aids. Nowadays there is little doubt among most hearing health care professionals that cochlear implants constitute a viable treatment option for postlingually deafened adults (Bergeron, 1992; Clark, 1992; Haggard, 1991; Hopkinson et al., 1986; Tyler & Tye-Murray, 1991).

A comprehensive clinical cochlear implant program requires the participation of several health care professionals as well as the provision of specific services. (For a description of various clinical cochlear implant programs see: Cook, 1991; Fraser, 1991; Mecklenburg, Blamey, Busby, Dowell, Roberts, & Rickards, 1990; Tye-Murray, in press.) A major component of most cochlear implant programs consists of pre- and post-implant aural rehabilitation services. However, the effectiveness of these aural rehabilitation programs is not well documented (see Brown et al., 1990; Cooper, 1991; Tyler & Tye-Murray, 1991; Tye-Murray, in press). The main objective of the present article is to provide a critical analysis of the effectiveness of these programs for postlingually deafened adult cochlear implant recipients. First, some benefits of cochlear implants will be summarized briefly. Then, components of cochlear implant aural rehabilitation programs will be outlined. This will be followed by a review and an analysis of studies that have investigated the effectiveness of these programs. It should be noted that the article will deal exclusively with postlingually deafened adults who rely mainly on oral language to communicate. The situation may be very different for other populations, such as postlingually deafened children (Geers & Moog, 1992; Mecklenburg et al.,

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1990; Osberger, 1990) or individuals with congenital hearing loss (Bergeron, 1992; CHABA, 1991; Eisenberg, 1982; Hopkinson et al., 1986).

Benefits of Cochlear Implants

Most of the investigations that have evaluated the benefits of cochlear implants have focused on the perception of environmental sounds and speech stimuli. Several excellent reviews of post-implant improvements in speech perception have recently been published (CHABA, 1991; Faulkner & Read, 1991; Millar et al., 1990; Tyler & Tye-Murray, 1991). In summary, comparisons of pre- and post-implant performances reveal that most postlingually deafened adult cochlear implant recipients show improvements in the detection and identification of environmental sounds. Also, a significant number of multichannel cochlear implant recipients perform at levels that exceed chance on auditory-only vowel or consonant recognition tasks. Approximately 50% of postlingually deafened adults with multichannel cochlear implants are able to recognize words and sentences in an auditory-only sensory modality even when the stimuli are presented in an open set response format (Osberger, 1990). Almost all postlingually deafened adults exhibit a significant improvement in auditory-visual recognition and comprehension of speech (i.e., words, sentences, and continuous discourse) following cochlear implantation (Dorman, Dankowski, McCandless, Parkin, & Smith, 1990; Dorman, Hannley, Dankowski, Smith, & McCandless, 1989; Dowell, Mecklenburg, & Clark, 1986; Faulkner & Read, 1991; Millar et al., 1990; Tyler, Moore, & Kuk, 1989; Tyler & Tye-Murray, 1991).

In general, studies have failed to demonstrate systematic changes in intellectual abilities or personality traits following cochlear implantation (see McKenna, 1991). McKenna (1991) reports that short-term changes in psychological traits should not be expected because the standardized tests used to assess those traits are designed to be robust and unaffected by sudden changes in perceptual abilities. There have been reports that cochlear implant recipients perceive some changes in their emotional and psychological well being following implantation. McKenna's (1991) recent review of the literature suggests that the changes most often reported by cochlear implant recipients include: (1) a greater awareness of environmental sounds that results in an increased sense of safety and a reduced sense of isolation; (2) a reduced sense of depression and a perceived improvement in overall emotional well being; (3) more self-confidence during inter-personal interactions with family members, friends, and strangers; and, (4) an increase in the level of comfort at (and a greater level of independence in) social gatherings and in public places such as shops and restaurants.

Lansing and Seyfried (1990) administered a self-report questionnaire to a group of 21 postlingually deafened adults who were fitted with a multichannel cochlear implant. The authors analyzed the responses obtained for 30 items taken from the personal adjustment scale of the *Communication Profile for the Hearing-Impaired* (CPHI): (Demorest & Erdman, 1987). All of the questions addressed the subjects feelings and attitudes towards their hearing loss. The questionnaire was completed on four different occasions: preimplant and 1, 9, and 18 months post-implant. The results showed that those aspects of personal adjustment under investigation improved significantly following the cochlear implantation. These findings suggest that cochlear implants contribute to the reduction of some aspects of hearing handicap among postlingually deafened adults.

Other benefits that have been reported by cochlear implant recipients include: an improvement in family life (i.e., at home); better educational and vocational opportunities; advancements in work and professional careers; more diverse social and leisure activities (Cochlear Corporation, 1987; Horn, McMahon, McMahon, Lewis, Barker, & Gherini, 1991; McKenna, 1991; Tyler & Kelsay, 1990); the production of more intelligible speech (Leder & Spritzer, 1990; Read, 1991; Tartter, Chute, & Hellman, 1989; Tyler & Kelsay, 1990); and a reduction in tinnitus (Brackmann, 1981; Tyler & Kelsay, 1990). These benefits of cochlear implantation that are not directly related to speech perception abilities are not trivial and should be considered in assessing the effectiveness of cochlear implants.

Ancillary Aural Rehabilitation Programs for Cochlear Implant Recipients*

The importance of providing ancillary aural rehabilitation services to cochlear implant recipients has been advocated for many years (Alpiner, 1986; Eisenberg, 1985; Eisenberg & Berliner, 1983; Hopkinson et al., 1986; Osberger, 1990). Aural rehabilitation services continue to be considered a necessary and important component of cochlear implant programs (Brown et al., 1990; Cooper, 1991; Haggard, 1991). Many manufacturers of cochlear implant devices strongly

* Throughout the article the term ancillary aural rehabilitation services will refer to any audiological and rehabilitative services that may be provided to adult cochlear implant recipients. These services may include, but are not limited to: informational counselling; personal adjustment counselling; speech perception training; training in communication strategies; information, training, and practice with assistive devices including telephone communication; and speech-language pathology intervention.

encourage the provision of ancillary aural rehabilitation services, and some companies include modules on speech perception and communication training as part of the inservice program they provide to cochlear implant teams (e.g., Cochlear Corporation). Some manufacturers have developed aural rehabilitation manuals to guide clinicians in the provision of appropriate aural rehabilitation services for cochlear implant recipients (e.g., Eisenberg, House, & Zinder, 1985; Mecklenburg, Dowell, & Jenison, 1987; Norton, Eisenberg, Berliner, & Thielemeir, 1985). Also, several authors have described the aural rehabilitation services provided by specific cochlear implant centers (Brown et al., 1990; Cook, 1991; Cooper, 1991; Eisenwort, Brauneis, & Burian, 1985; Tye-Murray, in press).

Aural rehabilitation is an ongoing process that is initiated before the provision of the cochlear implant and may extend for a long period of time following the fitting and adjustment of the cochlear implant device (Brown et al., 1990; Tye-Murray, in press). Aural rehabilitation programs are often described as a series of sequential activities or events. Clinically, the order and the extent to which specific services are provided vary considerably across centers. Moreover, aural rehabilitation programs are modified to address the specific needs of individual cochlear implant recipients.

Informational counselling is an important component of an aural rehabilitation program for individuals who are candidates for (and/or recipients of) a cochlear implant. Informational counselling tends to be directed mainly to the cochlear implant recipient, however, some aspects of information counselling also may be provided to individuals who play a significant role in the life of the cochlear implant recipient, including family members, colleagues, and friends. Specific issues that may be discussed before the cochlear implant surgery include: (1) candidacy for a cochlear implant; (2) description of the device; (3) hospitalization and medical risks; (4) cost and insurance coverage; (5) post-surgery services and commitments (i.e., medical, audiological, and aural rehabilitation); and, (6) post-surgery expectations and performance (Brown et al., 1990; Cooper, 1991; Tye-Murray, in press). Post-surgery informational counselling includes topics such as: (1) information on the manipulation, adjustment, and troubleshooting of the cochlear implant device; (2) manipulation of the environment to optimize the clarity of the signal; and (3) discussions of specific communication strategies (Tye-Murray, in press). Other post-surgery aural rehabilitation services may include personal adjustment counselling and the provision of information and practice with assistive devices, including telephone communication, and training activities in communication therapy and speech production (Brown et al., 1990; Cook, 1991; Cooper, 1991; Lansing & Davis, 1988; Mecklenburg, Dowell, & Jenison, 1987; Read, 1991; Tye-Murray, in press).

Speech perception training is a major component of most cochlear implant aural rehabilitation programs (Gagné, Parnes, LaRocque, Hassan, & Vidas, 1991; Lansing & Davis, 1988). Most often the speech perception training activities are conducted in more than one sensory modality (i.e., visual-only, auditory-only (implant), and visual + implant). Some activities foster the development of analytic perceptual skills, while other activities are designed to practice the use of contextual and linguistic cues in speech perception. Most cochlear implant speech perception training programs rely on the stimulus-response speech perception training matrix described by Erber (1982), whereby the stimuli used range from single speech elements to continuous discourse materials and the responses are described in increasing order of complexity from detection to comprehension (Brown et al., 1990; Cook, 1991; Cooper, 1991; Mecklenburg et al., 1987; Tye-Murray, in press). The specific activities included in post-surgery speech perception training may vary considerably according to several factors such as: the philosophical approach of the cochlear implant center; the experience and expertise of the clinician; the type of cochlear implant device; the preimplant performance of the recipient; and the specific needs of the client. At the present time there are no universally accepted speech perception training programs for postlingually deafened adult cochlear implant recipients.

Evaluation of Aural Rehabilitation Programs

Based on their clinical experience as well as anecdotal evidence, many authors have suggested that aural rehabilitation programs accelerate post-implant improvements (Bergeron, Ferron, Gobeil, & Desgagné, 1990; Cook, 1991; Cooper, 1991). However, at the present time the specific effects of these programs on the attitudes and performances of cochlear implant recipients are not well known (Osberger, 1990; Tye-Murray, in press). It is very difficult to design studies that isolate the specific effects of aural rehabilitation from all the other factors that may also be contributing to the post-implant benefits and improvements observed among the cochlear implant recipients. These other factors may include: the quantity and quality of the additional sensory information provided by the cochlear implant device; the status of the recipient's cochlea and auditory nerve; cognitive factors such as intelligence and information processing strategies; and psychological factors such as motivation and personal adjustment (Gagné et al., 1991).

With one exception (Lansing & Seyfried, 1990) the studies that have examined the effectiveness of post-implant aural rehabilitation have limited their investigations to changes in speech perception. A comprehensive investigation of the effects of post-implant aural rehabilitation would require the

use of a battery of outcome measures that would make it possible to evaluate a wide range of skills (and attitudes) that may change following implantation. These variables may include: communication strategies; psychological and emotional well being; and the effects of cochlear implantation on the individual's personal, social, leisure, and professional activities. Also, information on the cost-effectiveness of the aural rehabilitation program would be valuable. Due to cost and methodological constraints, comprehensive investigations of this nature have not been completed satisfactorily at the present time. (In fact, there is a need for comprehensive studies of the effectiveness of all types of aural rehabilitation services, not only those related to cochlear implants).

To date few studies have investigated the specific effects of aural rehabilitation on post-implant performances. Spivak and Waltzman (1990) reported post-implant improvements in speech perception among a group of 15 adult multichannel cochlear implant recipients. All the subjects took part in a post-implant ancillary aural rehabilitation program that included vowel and consonant recognition training as well as speech tracking sessions. The investigators observed that the greatest improvement in speech perception performances occurred during the first 3 months post-surgery. However, for some subjects, auditory perception of segmental features of speech and open set speech recognition scores continued to improve well beyond the completion of the training program. Because all subjects completed the post-implant speech perception training program, it is not possible to separate the effects of the training program from the other variables (e.g., years of implant use and the type of speech processing strategies implemented in the cochlear implant device) that also may have contributed to the post-implant improvements in speech perception. However, the findings reported by Spivak and Waltzman (1990) do indicate that, at least for some individuals, long-term use of (and experience with) a cochlear implant can result in continued improvements in auditory speech recognition over an extended period of time.

Boothroyd, Hanin, and Waltzman (1987) measured the speech perception performances of five adult cochlear implant recipients for a period of six months post-implant. A battery of auditory and audiovisual speech perception tests was administered at one month intervals pre- and post-implant. This investigation revealed that the largest gains in speech perception were observed during a period of one month following the initial stimulation with the cochlear implant device, that is, before the subjects participated in any formal speech perception training. Only minimal additional improvements were observed after the speech perception training program was initiated. The authors concluded that the post-implant improvements in speech perception could not be attributed to the training program that the subjects completed.

Gagné et al., (1991) investigated the effectiveness of a post-implant speech perception training program on speech perception performances over a period of approximately one year post-implant. All subjects completed 36 hours of speech perception training during a 12 week period post-implant. The content of this training program was consistent with the aural rehabilitation activities recommended for Nucleus 22 channel cochlear implant recipients (Mecklenburg et al., 1987). Four postlingually deafened adults participated in the investigation. All the subjects completed a battery of speech perception tests before the cochlear implant surgery and at 3 month intervals post-surgery. To control for inter-subject variability in pre- and post-implant performances, the investigators used a single subject experimental design. Also, in an attempt to partial out the effects of the training program from other factors that may be contributing to post-implant improvements in speech perception as a function of time, the onset of the training program was staggered across subjects. Specifically, for one subject the speech perception training program was started approximately 8 weeks following the cochlear implant surgery, while the starting dates for the other subjects were 12, 16, and 20 weeks post-surgery, respectively. The results of this investigation revealed that all subjects displayed some post-implant improvement in auditory, visual, or auditory-visual speech perception performance. However, a within subject comparison of pre- and post-treatment performances failed to demonstrate that the improvements (or the rate of improvement) observed could be attributed unequivocally to the speech perception training program.

Lansing and Davis (1988) used a group experimental design to investigate the effects of an ancillary aural rehabilitation program for adult cochlear implant recipients. All the subjects completed an 40 hour intensive speech perception training program over a period of 10 days. One group of subjects (n=5) completed the training program one month after their initial hook-up to the cochlear implant device, while a second group of subjects (n=8) completed the training program nine months after their initial hook-up. An important finding that emerged from this study was that early training plus experience with the cochlear implant (for a period of nine months) resulted in more improvement than experience alone on four of the 10 tests included in their evaluation protocol. Moreover, the authors found that the subjects displayed additional improvements in after rehabilitation on some tests (i.e., auditory-only spondee recognition and auditory-only stress test) even when initiation of the training program was postponed for nine months after the initial hook-up. Recently, Lansing (1990) extended the results of this investigation. This latter report was limited to the auditory and audiovisual recognition of medial consonants. Results were obtained from a group of 33 adults over a period of 18 months post-implant. The data indicated that the group that completed their aural rehabilitation one month post-sur-

gery performed significantly better than the group for whom the aural rehabilitation program was delayed by 9 months. The results of these investigations provide some experimental evidence that post-implant training programs improve speech perception performance. However, these findings are limited to a small number of analytic tests (i.e., auditory-only and audiovisual consonant recognition; auditory-only closed set spondee recognition; and auditory-only primary stress test). The results do not make it possible to determine the extent to which these skills were generalized to everyday life interactions.

As mentioned previously, one interesting component of the work of Lansing and her colleagues involved the administration of subscales of the CPHI to cochlear implant recipients on several occasions covering a period of 18 months post-implant (Lansing & Seyfried, 1990). The subjects reported a significant improvement in feelings and attitudes towards their hearing loss and general communication skills after only one month of cochlear implant use. It is not possible to attribute the improvements in personal adjustment to the aural rehabilitation program per se because all of the subjects had worn their cochlear implant before they participated in the aural rehabilitation program. However, it was reported that one subject, for whom the aural rehabilitation program was delayed for nine months post-implant, displayed a significant improvement in self-reported personal adjustment after completing the aural rehabilitation program. These findings suggest that cochlear implantation may result in improvements not only in speech perception (auditory or audiovisual), but also in the reduction of hearing handicap.

Analysis of Previous Investigations

Except for the results of one noteworthy investigation (Lansing & Davis, 1988), there is little experimental evidence to indicate that ancillary aural rehabilitation programs contribute to the post-implant improvements observed among adult cochlear implant recipients. However, it is important to note that the studies that have failed to demonstrate the effectiveness of these programs do not provide unequivocal evidence that post-implant ancillary aural rehabilitation programs are ineffective. Scientific investigations are designed only to test the alternate hypothesis, in this case, that ancillary aural rehabilitation programs contribute to the post-implant improvements observed among cochlear implant recipients. Rejection of the alternate hypothesis does not defacto validate the null hypothesis. The results available reveal only that most of the studies reported thus far failed to demonstrate the effectiveness of post-implant ancillary aural rehabilitation programs. Perhaps the altemate hypothesis could be demonstrated under different experimental conditions.

Several factors could explain why it has not been possible to demonstrate unequivocally the effectiveness of ancillary aural rehabilitation services for cochlear implant recipients. One finding that consistently emerges from investigations of speech perception abilities among cochlear implant recipients is that there is a large amount of variability in performance across individuals (see, for example, Dorman et al., 1989; Tyler, Moore, & Kuk, 1989; Tyler & Tye-Murray, 1991). Large variability in the data makes it difficult to demonstrate statistically significant differences across groups (or experimental conditions). Two strategies that are often used to overcome the effects of large inter-subject variability in experimental research are to increase the number of subjects under investigation or to impose some restrictions in the selection of subjects in an attempt to control some of the sources of variability that may have a deleterious effect on the outcome of the investigation. Both of these strategies are difficult to incorporate into research projects related to cochlear implants because the number of homogeneous subjects who are available (and who consent) to participate in the evaluation of treatment programs is usually quite small (Gagné et al., 1991). One strategy that has been used to overcome the deleterious effects of inter-subject variability has been to use single subject experimental paradigms (McReynalds & Thompson, 1986; Waltzman, Boothroyd, & Levitt, 1987). However, a need for well controlled large scale studies that investigate the effects of ancillary aural rehabilitation programs remains.

Other experimental variables also may account for the findings that have been reported thus far. For example, only a limited number of different aural rehabilitation programs have been investigated. Longer (or alternative) programs may have yielded different results. Also, the attitudes and competency of the clinician(s) who provided the services may have played a role in the results obtained. Similarly the preimplant performance and motivation of subjects may have accounted for the findings reported in these investigations. Another factor that could have influenced results is the choice of measures (tests) used to evaluate the effectiveness of the ancillary aural rehabilitation program. Tests used may not have been sufficiently sensitive to measure accurately the changes in performance that did occur among the subjects as a result of the training program. Moreover, the results reported are restricted to the domain of performances (and attitudes) measured by the tests included in the evaluation protocols. For example, in the study conducted at The University of Western Ontario (Gagné et al., 1991), the post-implant aural rehabilitation program included activities intended to improve the use of the telephone and communication repair strategies. Informal interviews conducted with the individuals who participated in the study revealed that many of the subjects considered those two activities the most beneficial for them. Unfortunately, the investigators did not

include any measures of telephone communication or the use of communication repair strategies in their pre- and post-test protocol. Perhaps such measures would have revealed that those aspects of communication performance did improve significantly following completion of the post-implant aural rehabilitation program.

In addition to changes in speech perception, as noted previously, there are many facets of performance and attitudes that have been reported to improve following cochlear implantation. A comprehensive evaluation of the effectiveness of any ancillary aural rehabilitation program designed for cochlear implant recipients also would include measures of the psychological and emotional well being of the recipients, as well as changes in the social, leisure, economic, and vocational/professional activities of subjects. These measures should be obtained before the cochlear implant is provided to the subjects, as well as before and after the post-implant treatment program is completed. The results of such investigations would provide a more comprehensive description of the effectiveness of aural rehabilitation services provided to cochlear implant recipients.

Concluding Remarks

Previous investigations have demonstrated some of the benefits of cochlear implants. Individuals with multichannel cochlear implants demonstrate significant post-implant improvements in the perception of speech stimuli and environmental sounds. Also, many cochlear implant recipients experience improvements in their emotional, psychological, and psychosocial well being. In sum, there is little doubt that cochlear implants constitute a viable treatment option for postlingually deafened individuals with a profound hearing loss.

Ancillary aural rehabilitation services are an important component of cochlear implantation. These services may include the fitting and adjustment of the speech processing device, informational and personal adjustment counselling, and training in specific skills such as: speech perception, speech production, communication strategies, telephone communication, and the use of assistive devices. Thus far, few studies have investigated the effectiveness of post-implant aural rehabilitation programs. Moreover, the studies that have been done have focused on very specific components of such programs (e.g., speech perception training). In general, the results of those investigations have failed to demonstrate unequivocally that post-implant speech perception training programs contribute to the post-implant improvements in speech perception. However, these studies do not indicate that post-implant aural rehabilitation services are not effective. More importantly, the studies reported thus far have not evaluated the overall effectiveness of post-implant aural rehabilitative services.

There is a need for comprehensive investigations of the role of ancillary aural rehabilitation programs for cochlear implant recipients. Such investigations would make it possible to develop efficient and cost-effective post-implant rehabilitation services. The results of such investigations could have important repercussions on cochlear implant programs in Canada. They may provide answers to some of the following questions: What types of service should be provided to cochlear implant recipients (e.g., speech perception training, informational and personal adjustment counselling)? What effect does the candidate's preimplant performance and attitude have on the design of the post-implant aural rehabilitation program? Are short duration (e.g., 3 - 5 days) intensive post-implant training programs accompanied by regular follow-up visits to cochlear implant centers as effective (and more cost-efficient) than long-term (e.g., 12 weeks) programs? (How) can those services be provided to individuals who reside in remote communities in which there may be no hearing health care professional capable of providing post-implant rehabilitative services on location? Should cochlear implants be available only to those who reside in close proximity to cochlear implant centers? Answers to those questions would help in the development of hearing health service delivery models for cochlear implant recipients. Specifically, this information may influence service delivery models for cochlear implant programs in Canada.

The body of research available thus far does not make it possible to address those questions satisfactorily. Until more conclusive information on the effectiveness of specific types of aural rehabilitation services is available, all cochlear implant recipients should be provided with post-implant ancillary aural rehabilitation services. Not to do so may be unethical. In addition to the aural rehabilitation programs designed specifically for cochlear implant recipients (e.g., Brown et al., 1990; Cook, 1991; Cooper, 1991; Eisenwort, Brauneis, & Burian, 1985; Mecklenburg, Dowell, & Jenison, 1987; Tye-Murray, in press), the types of aural rehabilitation services that have been designed for all individuals with acquired hearing loss (e.g., Erber, 1988; Giolas, 1982; McCarthy & Culpepper, 1987; McKenna, 1987; Sanders, 1982) also may provide models for aural rehabilitation programs for cochlear implant recipients.

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