

*INCREASING DRIVER YIELDING AND PEDESTRIAN
SIGNALING WITH PROMPTING, FEEDBACK,
AND ENFORCEMENT*

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The effects of an intervention package on drivers' yielding to pedestrians and on pedestrians' signaling their intention to cross the street were assessed using a multiple baseline design. The intervention, which consisted of publicly posted feedback on the percentage of motorists yielding to pedestrians, small signs prompting pedestrians to engage in appropriate crossing behavior, and an enforcement program involving the use of warning tickets and feedback fliers, was sequentially introduced on two streets. The intervention more than doubled the percentage of motorists yielding to pedestrians and increased the percentage of pedestrians signaling their intention to cross the street to over 13% from a baseline level of less than 1%. Near misses involving pedestrians decreased by more than 50% on the narrower of the two streets.

DESCRIPTORS: feedback, prompts, pedestrian safety, police, public posting

Each year in North America more than 2¼ million persons are injured or killed in motor vehicle accidents. Pedestrian injuries or fatalities account for approximately 140,000 or 6.3% of this number (*Accident Facts*, 1979; *Canadian Motor Vehicle 1980 Traffic Statistics*, 1981). Up to 40% of all pedestrians struck by vehicles are children under 10 years of age, and over 50,000 young children in the United States receive disabling injuries as a result of pedestrian accidents each year (Ross & Seefeldt, 1978).

One approach to reducing vehicle and pedestrian accidents at uncontrolled intersections has been to install marked crosswalks (*Urban Intersection Improvements*, 1977). However, it has been re-

ported that pedestrians frequently step off the curb into traffic at marked crosswalks without warning and without considering whether drivers have enough time to stop (Braaksma, 1976; Zegeer, Opiela, & Cynecki, 1982). In fact, safety engineers consider this the single most hazardous pedestrian behavior.

Although establishing pedestrian signaling behavior has received little scientific study, some research has addressed the general problem of changing other pedestrian behaviors. For example, Jackson, Mayville, and Cowart (1972) demonstrated that an instructional package combined with on-site observation and reinforcement was effective in teaching elementary school children to look both ways before crossing the street. Yeaton and Bailey (1978) successfully trained six street crossing skills to young children with a program consisting of an instructional package, modeling, social reinforcement, descriptive feedback, and prompts.

Each of the just-noted studies focused on directly changing the behavior of a specific group of individuals. However, to produce a change in the general population, more global interventions need to be developed that can influence large numbers of people at relatively low cost. One intervention

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that has proven effective in changing the behavior of large numbers of people is posting community feedback (Van Houten & Nau, 1981, 1983; Van Houten, Nau & Marini, 1980). In these studies, using a large highway sign to post the percentage of drivers not speeding reduced speeding behavior in the general population of motorists. Perhaps a similar feedback approach would be effective in increasing the percentage of motorists yielding to pedestrians.

Another approach to improving pedestrian safety is to enforce laws requiring motorists to yield the right-of-way to pedestrians at crosswalks. One way of increasing the efficacy of enforcement procedures is to make greater use of warnings. For example, Van Houten and Nau (1983) found that a warning program, which included the use of written warning tickets, and information fliers, was more effective in reducing speeding behavior than traditional police enforcement procedures. Further, Van Houten and Nau (1983) demonstrated that the combination of the highway feedback sign and the warning program was more effective than either program alone.

The purpose of this experiment was to determine whether an intervention package consisting of posted feedback, a warning enforcement program, and signs to prompt pedestrians to signal their intention to cross the street could increase the safety behaviors of pedestrians and motorists at crosswalks.

METHOD

Participants and Setting

Motorists and pedestrians using two main roads at selected crosswalks in the city of Dartmouth, Nova Scotia, during daylight hours on weekdays participated in the study. All but the follow-up data were collected before the first snowstorm of the season. The first street, Main Street, is a 4-km long, three-lane highway with three marked crosswalks, one of which is controlled by a traffic signal. The crosswalk with the greatest pedestrian use was selected for measurements. The second street, Port-

land Street, is a 10-km long highway, and four marked crosswalks on a 2-km, five-lane section of this street were selected. There were no traffic control devices at any of the experimental crosswalks. All data were collected at crosswalks that had the most pedestrian traffic.

These streets were selected because there were several pedestrian accidents on each of them during the previous 2 years, and many residents had expressed concern to the city council and the police. The speed limit on both streets was 50 km/hr. Vehicle traffic counts averaged 25,000 per day on Main Street and 26,000 per day on Portland Street. Neither street had a major parallel street that motorists could choose as an alternative route.

The crosswalk lines and advance marking on both streets were clearly painted prior to beginning the study. Advance markings were painted 50 m on each side of the crosswalks. An overhead light was already in place on Main Street. No overhead light was installed on Portland Street because of the high level of illumination on this street.

Apparatus

Four feedback signs were constructed to provide information on the percentage of motorists yielding to pedestrians during the preceding week, along with the highest reading. The signs read "DRIVERS YIELDING TO PEDESTRIANS LAST WEEK ____% RECORD ____%". These signs also contained a pictogram on the bottom left-hand corner showing a person with an extended arm and one foot in the road to indicate an intention to cross the street. The feedback signs measured 2.4 m wide and 1.2 m high, and were erected 2.3 m from the ground and approximately 0.5 m from the curb. All signs were made from reflective material and all numbers and letters were 15 cm high. The signs on Main Street were erected facing traffic approaching the crosswalk from each direction and were located approximately 50 m before the crosswalk on Main Street and approximately 50 m before the nearest of the four crosswalks on Portland Street.

In addition to the feedback signs, two types of smaller signs were constructed for the crosswalk on

Main Street and each of the four crosswalks on Portland Street. One of these signs was designed to prompt the motorist to watch for pedestrians approaching the street. These signs replaced the standard crosswalk signs on each end of the crosswalk and were the same dimensions as the standard sign (60 cm wide by 75 cm high). The pictogram described previously appeared on these signs.

The second set of signs erected at each crosswalk was designed to prompt pedestrians to engage in appropriate crossing behavior. These signs contained the following instructions: "TO CROSS THE STREET—1. EXTEND ARM—2. PLACE FOOT ON STREET—3. WAIT UNTIL CAR STOPS—4. THANK DRIVER WITH A WAVE AND SMILE." These signs measured 45 cm wide by 60 cm high. The pictogram also appeared at the top of these signs. These signs were erected at each end of the crosswalks so pedestrians waiting to cross the street could see them.

Measures

Two trained observers scored the behavior of motorists and pedestrians at the selected crosswalks for 1.5 hr per weekday at each crosswalk. Data were not collected on days with inclement weather (such as heavy rain), which would reduce pedestrian traffic. Measures were taken between 12:00 p.m. and 1:30 p.m. on Main Street and between 4:00 p.m. and 5:30 p.m. on Portland Street.

The observers sat in a car parked on a side street with a clear view of the crosswalk. As a pedestrian approached to within approximately 30 cm from the curb of a crosswalk, the observers began scoring the behavior of the motorists and the pedestrian. Motorist behavior continued to be scored until the pedestrian had cleared the crosswalk. Motorists were scored as yielding if they stopped before the crosswalk or slowed after passing the advanced markings and allowed the pedestrian to cross. Motorists were scored as not yielding if they proceeded through the crosswalk (provided they had not passed the advance marking, an X painted on the road 50 m before the crosswalk, before the pedestrian was within 30 cm from the curb).

Because the Nova Scotia Motor Vehicle Act requires drivers in all lanes facing the pedestrians to yield right-of-way, motorists traveling in either direction were scored as yielding or not yielding to pedestrians.

A near miss was scored when a motorist had to engage in abrupt audible braking or had to change lanes abruptly to avoid striking a pedestrian, or when a pedestrian had to jump to avoid being struck by a vehicle. In addition, the observers scored whether the pedestrian extended his or her arm to indicate an intention to cross the street while standing by the crosswalk and whether the pedestrian engaged in a waving or nodding thank you gesture to motorists who yielded right-of-way.

The observers estimated that roughly half of the pedestrians on Main Street and a third of the pedestrians on Portland Street used the crosswalks regularly. Approximately 151 and 104 vehicles were scored during each session on Main Street and Portland Street, respectively.

Measures of interobserver agreement were obtained by having a second independent observer, seated beside the primary observer, record the behaviors of drivers and pedestrians. Measures of interobserver agreement were collected during at least three entire sessions per condition. An agreement was scored for yielding behavior whenever both observers scored the same vehicle as yielding. A disagreement was scored whenever a motorist was scored as yielding by an observer and not yielding by another. Interobserver agreement was computed by dividing agreements by agreements plus disagreements. Similarly, interobserver agreement on pedestrians signaling (extending arm) and thanking motorists (waving or head nodding), was calculated by dividing the number of times both observers scored a particular pedestrian as signaling or thanking by agreements plus disagreements. Interobserver agreement on the occurrence of yielding behavior averaged 95% with a range of 89% to 100%. Interobserver agreement on the occurrence of thanking behavior averaged 97% with a range of 71% to 100%. Interobserver agreement on signaling and near misses was always 100%.

Experimental Design

A multiple baseline design across streets was used. After baseline data were collected on both streets, the feedback, prompting, and enforcement condition was introduced on Main Street; and when performance was stable there, the condition was then introduced on Portland Street. Next a "reward" condition was introduced on Main Street. Once performance had stabilized on Main Street, this condition was also introduced on Portland Street. Finally, follow-up data were collected on a weekly basis.

Baseline. During baseline, the feedback and prompting signs were absent and the police engaged in their usual level of enforcement, which was minimal. On one day in the middle of the baseline condition (between Session 35 and 36), probe data were collected on Portland Street on whether drivers were more likely to yield to a pedestrian signaling his or her intention to cross the street. Confederates crossed the street and extended their arm on one-half of the crossing trials and not during the other half. Motorists' yielding behavior was scored by observers. These data were not considered as part of the baseline condition.

Feedback, prompting, and enforcement. The feedback signs and prompting signs were erected. The percentage of drivers yielding to pedestrians was based on the data collected on one randomly selected day each week. The numbers were changed each Monday by city works crews. The instruction "EXTEND ARM TO CROSS," was also painted in the street on both ends of the crosswalk so a pedestrian looking down at the crosswalk could see it. The yellow letters were 30 cm high. In addition, a press conference was held the third day of the program on Main Street to publicize the program and to request the cooperation of the residents of Dartmouth. Four feature articles appeared in the local newspaper, and one television and two radio interviews were conducted during the first week of the program. No publicity accompanied the later introduction of the program on Portland Street.

During the first 7 days of this condition on each street, an enforcement program was also intro-

duced between 10:30 a.m. and 12:00 p.m. and between 1:30 p.m. and 3:30 p.m. Three people working for the police on a summer works program were assigned to cross the street at the selected crosswalks whenever a real pedestrian was not present, to increase the opportunity for police to apply consequences. These confederates always signaled their intention to cross the street by extending their arm and thanking drivers with a wave and a smile whenever they yielded. Once they had crossed the street, they usually waited for 1 minute before crossing again. One police officer was positioned on foot at each side of the crosswalk to pull over and warn motorists who failed to yield to pedestrians or confederates. When the police were busy with a nonyielding motorist, the confederates did not cross the street. All confederates were instructed not to put themselves at risk. They were further instructed to wait with their arm extended and one foot in the roadway until the cars in the first two lanes stopped before venturing to cross the street.

Whenever the police pulled over a vehicle that failed to yield to a pedestrian, the driver was informed that he or she had just failed to yield to a pedestrian at a crosswalk, was asked to produce a valid driver's license, and was given an information flier similar to that used by Van Houten and Nau (1983) to reduce speeding. The flier contained information on the number of children and adults using crosswalks and on the number of accidents and pedestrian injuries over the past 5 years in the city of Dartmouth. In addition, the flier mentioned that pedestrians were being encouraged to extend their arms to signal their intention to cross the street. Also appearing on the flier were the Dartmouth Police Force crest and the pictogram with the pedestrian with arm extended. The flier closed with a request to help make the streets safer for everyone concerned.

While a motorist read the flier, the police officer filled out the warning ticket. The police delivered between 50 and 87 warnings per day during this condition. Data were never collected while the police were present. Enforcement was only carried out

during the first 7 days of this condition on each street.

"Reward" condition. During this condition, one police officer standing on each side of the crosswalk stopped motorists who yielded to pedestrians, thanked each one for being a courteous driver, and gave each one a plastic bag containing a pen with the following sentence printed on it: "CAUGHT BEHAVING COURTEOUSLY—THANK YOU—DARTMOUTH POLICE FORCE"; a bumper sticker that read "I YIELD TO PEDESTRIANS," which was printed with white letters on a red background with the pictogram printed on the left in black; a plastic pin with the pictogram printed in black; a flier indicating why it was important to yield to pedestrians; and a certificate from the Police Chief thanking the motorist for contributing to the safety of the community by behaving in a courteous manner.

The motorist was allowed to proceed once the contents of the package were described. Typically, it took about a half minute per interaction. No more than two cars were pulled over at a time in either direction. This intervention was only carried out during the first 5 days of this condition on each street, starting at 1:30 p.m. and continuing until 150 packets had been given out (typically 1–2 hours) per day.

Follow-up. During follow-up, no police activity occurred at the crosswalks. Measures were only collected once per week on a randomly selected day. Data collection was missed on 2 days when snow covered the markings on the road. The feedback sign and prompting signs remained in effect throughout follow-up.

RESULTS

Motorists' Behavior

The percentage of motorists yielding to pedestrians at the Main Street and Portland Street sites is presented in Figure 1. During baseline, the percentage of motorists yielding averaged 22% on Main Street and 12.5% on Portland Street. The introduction of the feedback, prompting, and enforcement condition on Main Street led to an in-

crease in the percentage of motorists yielding to pedestrians to 51%. No change was noted on Portland Street over the same period of time. The introduction of the feedback, prompting, and enforcement condition on Portland Street led to an increase in the percentage of motorists yielding to pedestrians to 33.4%.

The introduction of the "reward" condition produced little change on either street, although it did generate a front-page story in the daily newspaper and numerous positive comments from motorists to police officers. The follow-up data indicated that the changes produced by the intervention package endured for a relatively long time in the absence of further enforcement.

Pedestrian Behavior

The percentage of pedestrians signaling their intention to cross at intersections is presented in Figure 2. During baseline, pedestrians rarely signaled at either the Main Street or the Portland Street sites (mean of 0.4% and 0.9%, respectively). The introduction of the feedback, prompting, and enforcement condition on Main Street led to an increase in the mean percentage of motorists signaling to 13%. No change was noted in the percentage of pedestrians signaling on Portland Street during this same period.

The introduction of the feedback, prompting, and enforcement condition on Portland Street produced an increase in the percentage of pedestrians signaling their intention to cross to a mean of 13.4%. The application of the "reward" condition produced no further increase in the percentage of pedestrians signaling their intention to cross the street. During follow-up, the percentage of pedestrian signaling had slowly increased to 19.6% and 21.9% on Main Street and Portland Street, respectively.

Observers noted whether pedestrians who signaled first looked at the sign or at the prompt in the street during the first 2 weeks of the study. These data revealed that approximately half of the pedestrians who signaled looked at the sign and half looked at the prompt in the street. The data collected during the middle of the baseline con-

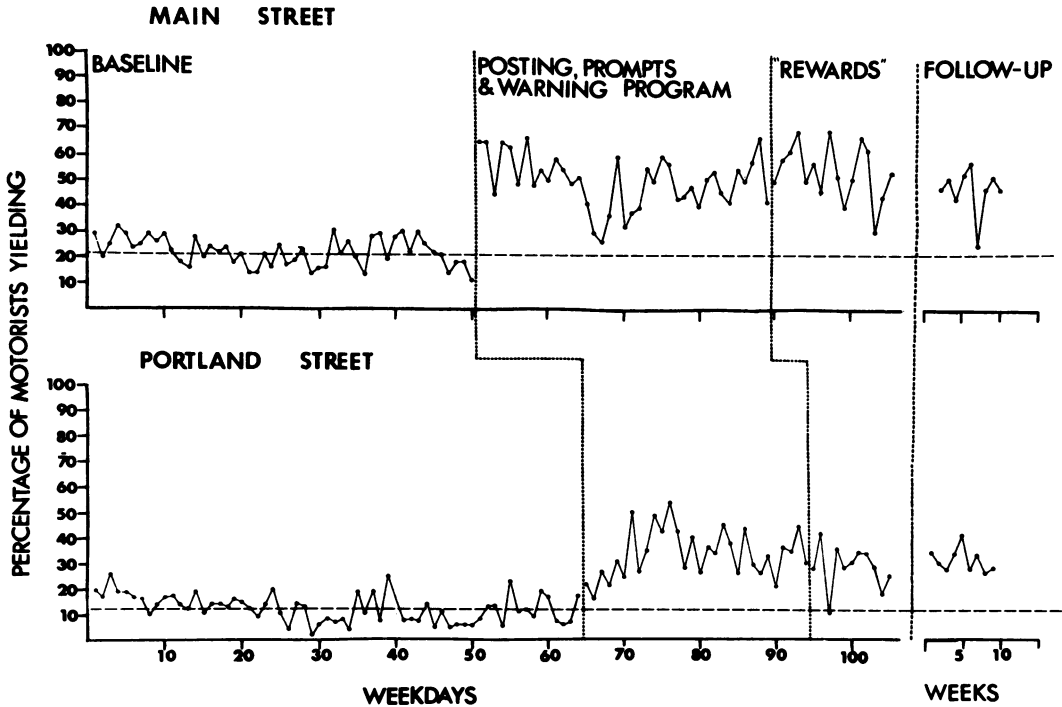


Figure 1. Percentage of motorists yielding to pedestrians on Main Street and Portland Street during each condition of the experiment. Dashed horizontal line indicates the mean percent yielding during the baseline condition.

dition on the percentage of motorists yielding to pedestrians who signaled versus ones who did not showed that motorists were approximately three times as likely to yield to pedestrians who signaled than to ones who did not signal (37% vs. 13%).

During baseline, the mean percentage of pedestrians who thanked motorists for yielding to them was 12% on Main Street and 15% on Portland Street. The introduction of the feedback, prompting, and enforcement program on both streets led to a small increase in the percentage of pedestrians thanking drivers, but the percentages returned to baseline levels after several weeks. The introduction of the "reward" condition did not appear to have any effect on the percentage of pedestrians thanking drivers.

Near Misses

The percentage of near misses per session was calculated by dividing the number of near misses by the number of times a pedestrian crossed while vehicles were present. The percentage of near misses for Main Street and Portland Street averaged

2.1% and 2.3%, respectively, during the baseline condition. The introduction of the feedback, prompts, and enforcement condition led to a decline to 1% on Main Street, whereas it increased to 2.8% on Portland Street. During the "reward" condition the number of near misses declined to 0% on Main Street and to 1.9% on Portland Street. The failure to produce a reduction in near misses on Portland Street may be related to the width of the road. Because Portland Street was five lanes wide, the likelihood of pedestrians being struck as they advanced from one lane to the next, even when a driver yielded, was somewhat greater.

DISCUSSION

The introduction of the feedback, prompting, and enforcement package produced clear increases in the percentage of motorists yielding to pedestrians and in the percentage of pedestrians signaling their intention to cross on both streets. The intervention package contained components that could influence one-time users of streets (feedback

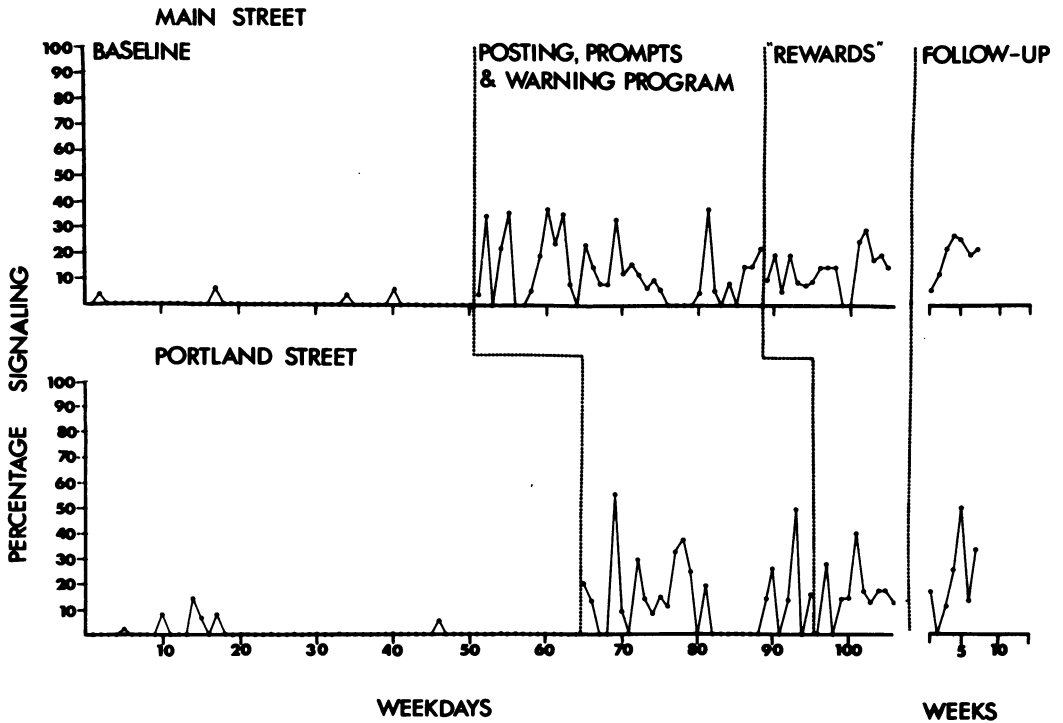


Figure 2. Percentage of pedestrians signaling their intention to cross the street on Main Street and Portland Street during all sessions of the experiment.

and prompting signs) as well as a component that could influence repeated users (the enforcement program).

One value of increasing signaling behavior is that it reduces the incidence of the single most hazardous pedestrian behavior—stepping into traffic without warning. Another value of signaling behavior is that it increases the likelihood that motorists will yield to pedestrians. The probe data collected on Portland Street indicated that motorists were nearly three times as likely to yield to pedestrians on this street when they signaled their intention to cross by extending their arm. There may be many reasons why signaling is an effective way to increase the likelihood of yielding behavior. First, it provides the motorist with a clear discriminative stimulus, making it easier to determine whether the pedestrian wishes to cross the street or is just standing on the side of the street. Second, signaling is an assertive request to cross the street. Not yielding in the face of an obvious request might be more difficult for most motorists. Because motorists are more likely to yield to pedes-

trians who signal by extending their arm, there is a potential natural reinforcer for this behavior or “behavior trap” (Stokes & Baer, 1977), given that pedestrians normally would have to wait longer for a reasonable gap in the traffic or for a motorist to yield.

The reduction in the number of near misses may have resulted from the increase in signaling behavior, the increase in yielding behavior, or both. Near misses on a street have been shown to be directly proportional to the number of accidents on that street (Older & Spicer, 1976). Hence, a reduction in the number of near misses provides some validation of the importance of the change produced in the target behavior.

One unexpected result was the failure of the “reward” condition to produce an increase in the percentage of motorists yielding to pedestrians. This condition may not have been effective because the drivers who were stopped for yielding may have usually engaged in this behavior anyway. In other studies, successful applications of incentives to increase seat belt use involved advertising the inter-

vention in advance (Geller, 1983; Geller & Bigelow, 1983; Geller, Paterson, & Talbott, 1982). Perhaps the application of a similar promotion would improve the effectiveness of a "reward" condition to increase driver yielding the right-of-way to pedestrians. It is also possible that being stopped and receiving the packet may not have functioned as a reinforcer. Perhaps the inconvenience associated with being stopped may have been important in this regard. However, it should be noted that this inconvenience was minimized because vehicles were stopped before they could accelerate to normal driving speed.

Overall, the intervention program was relatively inexpensive. The two prompting signs cost \$18 each and the two advance warning signs cost \$26 each, for a total cost of \$88 per crosswalk. Because the advance warning signs are usually replaced or rescreened every 8 years, these signs could be changed on a citywide basis at no extra cost. The four feedback signs cost \$250 each. The enforcement component was carried out by members of the traffic division, and there were no overtime costs. The 4,000 fliers cost \$78; and the 1,500 pens, bumper stickers, and pins cost \$750, \$450, and \$285, respectively.

The program was well received by the public, the media, and members of the municipal and provincial government. Many favorable newspaper articles about the program appeared locally and nationally. A year after the termination of the program, the special crosswalk signs and pedestrian prompts were still in effect, and the city is currently considering implementing the entire program on a citywide basis.

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