RECOMMENDATIONS FOR IMPROVING ON-DEMAND CONTENT, POST-BROADCAST DERIVED FROM AN ANALYSIS OF MINUTE BY MINUTE CONSUMPTION PATTERNS.

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ABSTRACT

As more content created for television and radio is consumed on-demand, audiences have become selective about which parts of a programme they consume, seeking out items of interest or scrolling past parts they find less relevant. Identifying patterns of audience behaviour with on-demand content has provided us with insights into audience needs and how their experience can be improved for post-broadcast viewing and listening.

This paper outlines a survey of minute-by-minute audience consumption of radio and television programmes for 3-4 days post-broadcast, spanning a period of twelve months. It describes the four main patterns of consumption and the way in which these can be characterised through mathematical modelling. This modelling in turn enables the automatic identification of programmes where the audience are being selective about which parts of the programme they consume.

These results are examined in the context of previous studies of audience behaviour and immersion using concepts from behavioural economics. The specific patterns of selective consumption are also described within the user experience framework of *desire lines* and suggests ways of better meeting the audience's needs using object-based production techniques to provide improved navigation as well as alternative versions of the content.

INTRODUCTION

Unlike dedicated streaming services the on-demand services provided by public-service broadcasters mostly consist of content which has been commissioned to fit within a broadcasting paradigm. In the case of television this content is commissioned, created and scheduled to fit within a continuous flow of output and work well within a specified time slot [1, p86-87]. The programmes will often be scheduled to corral the audience from programme to programme and discourage them from changing channels [2, p250]. In the case of radio a high proportion of the output is presented live with a significant amount of contemporaneous time related content such as news, weather, travel news and time checks [3, p154-155]. The live speech content in radio is particularly of-the-moment with the presenter addressing the audience directly [4, p1-13]. This approach has developed over 100 years of broadcasting and has evolved along with the behaviour and needs of the audience [5, p17-20].

By contrast, when offered on-demand these radio and television programmes can be consumed at any time, removed from their temporal and broadcasting context. This is most significant for programmes which cover live events, because their consumption is no longer contemporaneous with the event. The audience can also be selective about which parts of a programme they consume, scrolling forwards through a programme to select items of interest and avoid less engaging parts.

This study of audience statistics and behaviour used data from the BBC's iPlayer and Sounds platforms. The aim was to reveal the usage patterns for the programmes on these platforms on a minute-by-minute basis to identify content which could be enhanced by improved navigation and object-based media techniques. The study also revealed a surprisingly consistent set of consumption patterns cutting across standard genre boundaries and so provides new insights into the relationship that audiences have with on-demand content. In addition this study provides baseline data for further research in the field of audience studies.

THE SURVEY

The data encompassed iPlayer and Sounds content broadcast on the BBC's main UK TV and radio services, plus national services in Scotland for the period from 04/07/2021 to 24/08/2022. These were Radio1, 1Xtra, Radio2, Radio3, Radio4, 5Live, 6Music, Asian Network, BBC One, BBC Two, BBC Three, BBC Four, BBC News, BBC Parliament, CBeebies, CBBC, BBC Scotland and BBC Alba. They cover iPlayer and Sounds requests for between 3 and 4 days after each broadcast. The length of time for scans was chosen in an attempt to control costs, running from midnight to midnight over 4 days. In total this provided data on 163,762 programme broadcast episodes, including repeats. In addition to the original programme there are often separate versions of an episode with sign language or audio description and other versions where a programme has been edited making a total of 193,023 programme versions. The data covered consumption across all platforms with the exception of native Apple apps. Whilst not representing the entire audience it reflects a broad range of devices including web, mobile and smart televisions. The total data set represents 487.162 million hours of user consumption.

The schedules for each day were taken from the BBC web pages for each channel and these were used to obtain the programme identifies (pids) for each episode (e-pid). From these the pids for each version could be determined (v-pid) and the v-pids could then be collected for each day and used to trigger a scan of the number of accesses across the specified period. The data came with anomalies at the start and end of each programme so the first and last minute of the programme were discarded before the visualisation and modelling were carried out. Initially the samples were taken on a day-by-day basis, automated using python scripts and charts were plotted using `matplotlib` for programmes with more than 10 data points, effectively programmes over 12 minutes in length. The excluded items had too few data points to spot trends reliably or run mathematical modelling. Whilst this excluded less than 1% of the user consumption it removed around 14% of the programmes, mostly short radio items like weather forecasts and many children's TV programmes.

Initial Findings

After several days' worth of data had been viewed it became clear that there was a surprising consistency to the results. Across both radio and television programmes viewed on-demand there emerged four basic patterns of consumption:-

1. **Constant** audience numbers - consuming the programme from start to finish.
2. A **linear decline** in audience numbers - people stop the playback at a random time.
3. A **concaved curve** declining steeply at first then levelling off.
4. **Selective consumption** - scrolling through to access or avoid parts of the content.

What was also clear was that across any programme series the plots were remarkably consistent, and any variation in the shape of the curve could be traced to a notable item in the programme such as an interview with a particularly interesting guest or unusual incident. Even in the case of selective consumption, the patterns were often very similar, reflecting the structure of the programme, especially in live sports coverage where the temporal characteristics of the sporting event could be seen.

Mathematical modelling

Because broadcast schedules are seasonal in nature it was decided to collect an entire year's worth of data. With such a large quantity of data, some way was needed of automatically identifying programmes which fall into the selective consumption category. A python curve fitting library, `numpy.polyfit` was used to characterise the data, allowing curve fitting from zeroth order (constant) upwards. This provides a best fit polynomial equation of the form $y=ax^n+bx^{n-1}...px^2+qx+r$ along with a residual value in the form of the "sum of squared residuals of the least squares fit". This residual, once converted into an overall percentage of the mean audience, could be used to determine how close the curve fit was to the data. After some initial trial and error the 3rd order or cubic curve fit was found to be the highest order to give useful characterisation of the non-selective curves. A threshold of a 5% residual on a cubic fit was then used to identify programmes which fell into the category of selective consumption. This was fit for purpose, giving only a few false positives. A residual of below 5% could still include a small amount of selective consumption, such as skipping news bulletins in radio programmes, and residuals below 1% could be used to identify programmes where there was almost no selective consumption.

This modelling was used to select items of interest and create a report for each day. Any programme with a mean audience of less than 1,000 was ignored as, amongst other considerations, low numbers increase the level of noise in the plots. This much smaller number of items could then be manually reviewed for each day and the charts examined to see what kind of selective consumption was involved. There were a number of regular entries in the report, programmes like the 3 hour long BBC Radio 4 Today programme where a significant proportion of the on-demand audience skip two hours from the start to reach the 8am news or the 8:10 interview slot that follows. There were also a number of tightly formatted daytime TV programmes that regularly appeared, so the focus became looking for less common items of interest. These were picked out manually and clustered to look for common patterns.

THE RESULTS

We shall now explore the four characteristics noted above in more detail, beginning with the three non-selective forms of consumption.

Constant Audience

In these cases the audience is clearly putting time aside to consume the whole programme. Whilst some people may have paused playback during the programme they almost all play it right the way through to the end. This mode of consumption is most pronounced in ongoing drama series, known as "soaps" on both radio and television, such as BBC One's *Eastenders*, Figure 1. This trend is also seen in quiz and challenge programmes such as *The Apprentice,* along with some long-running drama

Figure 1 – Constant audience

series and makeover programmes where a narrative arc is maintained all the way to the end. Examination of the Barb overnight TV audience data for some of these programmes indicates a similarly level trend [6]. These are also usually the programmes which attract the largest audience numbers both on-line and when broadcast.
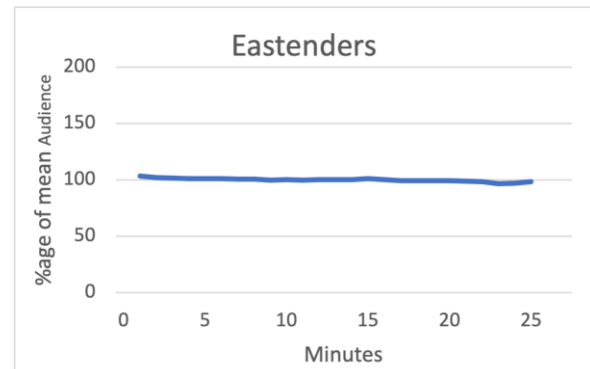
Linearly Declining Audience

The next category of programmes are the ones where the linear decline indicates that the audience is abandoning playback at essentially random points in the programme. The straightness of the plots is remarkably consistent and the slope is often similar between episodes of the same series. Even in the case of long radio programmes where a proportion of the audience will skip the out-of-date news bulletin, the slope is consistent throughout the rest of the programme.
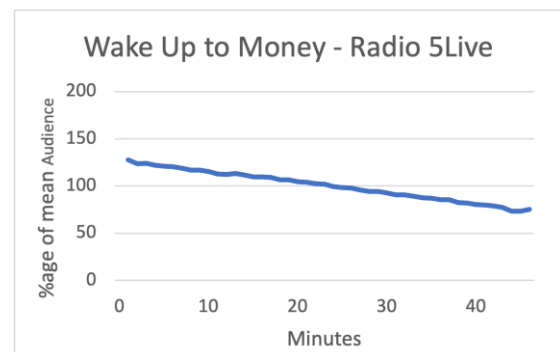

Figure 2 – Linear decline of audience

This characteristic is usually seen in factual TV programmes such as documentary series, wildlife programmes and most music and speech radio shows. When looking at TV overnight data, this type of content often shows the opposite trend with the audience numbers rising through the programme as people tune in. This would appear to indicate that this content can be enjoyed without consuming the entire programme. Clearly this is a more casual form of consumption, either as a time filler or as background to other activities. What should be noted here is that ending playback does not appear to be related to the items within the programme but more likely related to external events.

A Concaved Curve

These programmes are all ones where the audience numbers fall off steeply at first and then straighten out to a linear slope or constant level. These are characteristically one-off programmes. This suggests that the audience is sampling the content, trying it out and then abandoning it if they don't think it is worth watching any further, whilst most people who get over half way through will usually stay to the end. In this case abandonment of playback is related to the appeal of the content, but not to any specific moment in it. This characteristic is consistent across one-off dramas, films and one-off factual programmes, indicating that the behaviour is not genre related, but due to the lack of familiarity with the programme.
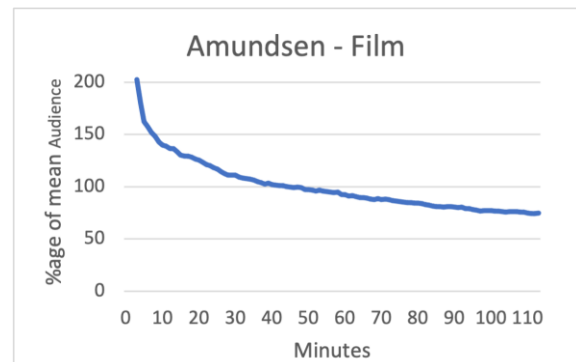

Figure 3 – Concaved curve

SELECTIVE CONSUMPTION

The ways in which audiences selectively consume some on-demand, broadcast content is more varied than the three characteristics above, but fall into a number of rough groupings.

Skipping past items

These are the programmes where a proportion of the audience is interested in consuming only part of the programme or is actively avoiding other parts. The key characteristic that emerged from the data was that these programmes either have one-off items of interest such as interviews or a quiz or had different types of content within the one programme, such as music and speech or sports action and speech. It was also observed in live cookery or magazine programmes where part of the audience skipped the non-live, archive content. There were many lifestyle programmes in this category where parts of the audience are skipping to the "reveal" moments such as the result of a makeover, a valuation or an auction.
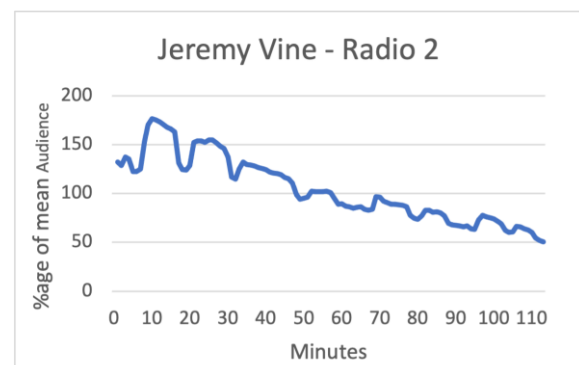

Figure 4 – Skipping music tracks

Regular, individual items of interest

The largest residuals from the curve fit came from a radio programme featuring a popular music quiz on BBC Radio 2, Figure 5. In this case the audience for the quiz was over three times that of the rest of the programme. This quiz occurred at the same time each day so the audience were skipping to a known point in the programme to join the first part of the
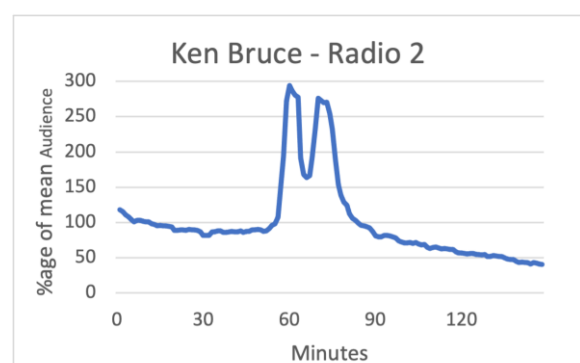

Figure 5 – Music quiz in a radio programme

quiz, then skipping the news bulletin and consuming the second part, stopping playback once the quiz ended. While this is an extreme example, other TV and radio programmes also showed uplifts in audience numbers for regular, stand-alone items of interest.

One-off, individual items of interest

Some programmes episodes attracted additional audiences for individual one-off items, particularly interviews with people of interest or notoriety. What is striking is that the audience must have learned about the item through social media or news reports and so it has drawn in a new audience to the episode.

Highlights programmes - sport and music

Music and sports highlights programmes characteristically show skipping behaviour. In the case of sport, a proportion of the audience will skip though the speech sections and just consume the sports action, producing a trend similar to Figure 4 above. With music festival highlights there is similar behaviour except that the audience tends to be selective about which music acts they consume.

Live coverage on catchup programmes - sport and music

Live coverage of sport and music events that are consumed on-demand show the most striking patterns because the coverage contains long periods filled with speech, such as the run-up to a match, half time and post-match analysis. Similar issues can be seen with classical music concerts and music festivals. In these cases the on-demand figures can show the majority of the audience skipping through to the action. In the case of sport the charts show the structure of the match very clearly, Figure 6.
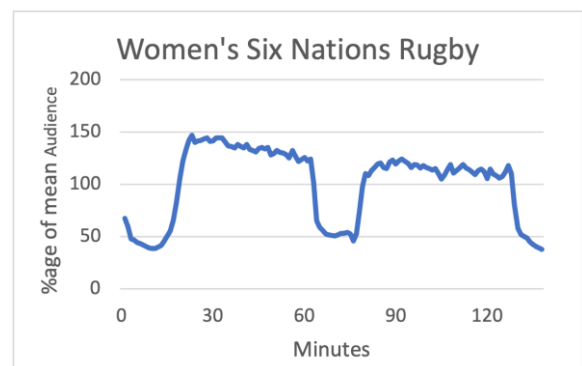

Figure 6 – Live sports coverage

In the case of coverage of live events such as the Olympic games or the Eurovision Song Contest, lasting for several hours and containing a mix of different sports or musical styles, the audience scrolls through large parts of the programme looking for individual items of interest.

DISCUSSION

At this point it is worth emphasising that on-demand content consumption can have very different characteristics to the same programme when broadcast. This can be seen from a comparison of the on-demand one minute sampled data for a programme with the five minute television overnight statistics from Barb [6]. While on-demand consumption inevitably begins at the start of the programme, even if the audience then skip though to some point later, radio and television audiences may switch on or select the channel part way through a programme. Thus while on-demand audience levels usually fall across a programme, broadcast audiences often rise as people switch on or tune in.

Academic studies of the audience's responses to streamed media have used the concept of *risk of viewership loss* and *survival function* to model how people decide to stop viewing [7]. Under this model, if the risk of viewership loss is constant, then the audience numbers fall exponentially as the number of people leaving at any one time is proportional to the remaining number of viewers. This model contains the implicit assumption that the attention of the audience is fully engaged with the content. In the case of laboratory testing where participants are studied whilst watching selected items with no additional distractions this model is likely to be a good fit. In our studies of dynamic behavioural and physiological measures of audience immersion such constraints are unavoidable [8].

However, radio does not require the audience's visual attention and can be consumed whilst carrying out visually demanding tasks such as cooking, ironing or driving. Indeed the challenges faced in the early days of radio was that, unlike theatre, film or the pulpit, it was a medium which entered uncontrolled environments and extensive research went into making content work for this new context [9]. For similar reasons, the narrative in television is carried mainly by the soundtrack with the sound directing the audience's attention towards the action on screen at important moments [10]. This is unlike cinema where far more of the narrative can be carried by the images and also unlike cinema, broadcast content often follows repeating patterns so the audience can anticipate key moments.

Because consumption of broadcast material is often secondary to other activities we should expect to see the time spent consuming content on-demand to include factors other than the media itself. Where people are highly engaged with the media we expect them to consume the content in its entirety or select individual items of interest. Where people are engaging with unfamiliar content we expect to see trends similar to an exponential decay. The four main trends in the audience data reflect these different types of consumption.

- The **constant audience** numbers show a highly engaged audience for popular ongoing series watch from beginning to end. There is no significant fall off in audience for these programmes.
- The **linearly declining audience** numbers are evidence for programmes being used as background or as time fillers. This is content which can be enjoyed without consuming it in its entirety or as background to other activities. The fact that the decline is linear with time and not proportional to the audience size means that the decision to stop viewing is related to time and not the content.
- The programmes where the audience numbers show a **concaved curve** is consistent with an attempt to engage with the content and a decision when to stop. The one-off nature of these programmes would appear to be driving this behaviour.
- Finally in the case of programmes that shows **selective consumption** in the audience data, the audience is moving into a lean-forwards mode, picking out items of interest or avoiding material not relevant to them, investing effort and attention as well as time to satisfy their interests.

Constant Audience and the Endowment effect

The endowment effect is the name given to a phenomena whereby people place extra value in a thing simply by virtue of their ownership [11]. There is an association between ownership of an object and both a personal sense of identity and projecting identity to others through these items. With the changes in technology, particularly around media you no longer have to own an item you can stream it and share your experience of it online. In the same way the phenomena we see in many ongoing programme series with large audiences consuming programmes on-demand from beginning to end suggests that these audiences have a strong relationship with these programmes, giving them a sense of ownership and identity with the wider audience [12]. As with live audiences who watch the programme when it is broadcast, the on-demand audience appear to be setting aside time to consume the content.

Linear Decline and Narrative Structure

There is a different relationship between the audience and the media for these programmes, suggesting that they have less of a sense of ownership and investment. The trend is also affected by the structure. These programmes tend to have a magazine format, consisting of series of short items which do not combine to make an overall narrative arc. Even in the case of presenter lead factual programmes, the way in which each section, such as an interview or reconstruction has a self-contained narrative, means that the audience can feel satisfied without consuming the whole programme. This can also be seen in television viewing figures where there is a rising trend as audiences join part way through and stay to the end. It also explains why this kind of programming can be consumed as background to other tasks, only paying attention from time to time.

The Convex Curve and the Sunk Cost Fallacy

The sunk cost fallacy describes the way people tend to continue to commit time and money into something even when abandoning it would give a better outcome. It reflects a psychological feeing that they have invested too much time or effort in an activity to abandon it. It is likely that, in the exponential decay we see this behaviour with longer, one-off programmes. The audience numbers fall steeply at first but tend to level out after around half an hour. This suggests that either the remaining audience are enjoying the programme or have spent enough time that they feel committed to watching to the end even if they are no longer that interested in it [13].

Selective Consumption - Desire Lines/The Worn Path

In any park or public garden with paved walkways it is common to see worn paths running across the grass indicating the routes people take, rather than the paved routes chosen by the designer [14]. These desire lines can be seen in this audience data where people are skipping past parts of programmes to reach the items of interest. These desire lines are created by an audience that is familiar with the narrative of the programme series or the structure of the event [15]. By paying attention to the desire lines in this data it is possible to design navigational enhancements that enable the audience to find the items of interest and/or provide alternative versions of this content which better meets the audience's needs. This would improve their experience of the content and hopefully, as a result, attract more people to that content [16, p76].

IMPROVING ON-DEMAND BROADCAST CONTENT

Clearly in the case of several hours of live coverage of events like the Olympics or long breakfast-time magazine style programmes, scrolling through several hours of unlabelled content to find an item of interest is an unsatisfactory user experience. On-demand content that contains out of date news bulletins, travel news and time checks is also less than ideal. This study, along with previous work on object-based media [17] has highlighted the audience's selective appetite for parts of programmes along with ways of making their listening and viewing experience more engaging and convenient. However, two different modes of consumption have to be taken into account; **lean-back** where the audience is being provided with a broadcast/podcast type experience and **lean-forwards** where the audience can make active choices along the way.

Lean-back consumption

This approach gives the audience the items of interest without having to search for them, removing items that are less interesting or relevant.

- Replacement versions of live programmes are already being offered by the BBC in a few cases. For example, some radio programmes are edited post-broadcast to add new idents and/or remove unrelated items such as news bulletins. These are often characterised as "podcast" versions. Some automation has also been piloted; where news bulletins in radio programmes are automatically replaced with idents.
- A choice of versions could also be offered where the audience could select between the full length programme and the main items of interest, for example offering versions of live sports and music coverage without the speech sections.
- Personalised versions could also be offered where the user selects what parts of a programme they are interested in up-front to create their own lean back version. Alternatively, personalisation could be attempted by the broadcaster based on the person's previous consumption patterns.

Lean-forward consumption

This is about providing improved navigation within the content. This can also improve the searchability and shareability of individual items within programmes.

- Chapterisation is the most basic navigation aid, providing semantic labelling of each section of content. This helps people easily find the items of interest in a programme. If these chapters can also be accessed with a unique URL, then not only can they be easily accessed and bookmarked, they can also be shared with others driving new audiences to the content [17].
- Event markers, which enable navigation to a key moment, such as a goal in a football match can supplement chapterisation to give finer grained navigation.
- Skip functionality can help in some cases. It is often provided with streaming services to enable people to jump past the intro and recap sections in drama series.
- Interactive choices can also be provided, as with experiences like Click 1000 and Discover Your Daemon where the audience can make navigation choices throughout the programme [18].

CONCLUSIONS

There is further research to be done with this data set. Some small pieces of work have already been carried out for individual programme series to identify any items in their episodes that were particularly popular or conversely any items that people have skipped over. In the case of BBC Springwatch programmes it was noticeable that some people scrolled past an item about spiders. There is also the more complex task of understanding the usage patterns of the different programme versions, particularly in relation to those carrying sign language and audio description. Beyond this data, there is the question of the relationship between the patterns of consumption we see in this data and the way in which audiences consume content that is not commissioned for broadcast. For example, is there a difference between the way people consume radio programmes on-demand and the way they listen to podcasts? Are there also different patterns in the consumption of different types of podcast?

This work so far has revealed clear, reoccurring patterns in audience usage of broadcast content that is made available on-demand. It has not only given us insight into the way that audiences are selective in the way they consume some content, it has also revealed different relationships between the audience and various types of content. Laboratory testing and other controlled experiments tend to focus on the audience's engagement with novel content in controlled conditions. From our data we can see that this corresponds to the viewing behaviour for one-off programmes. However, this represents only a small proportion of on-demand consumption of broadcast content. Audience familiarity with programme series and the uncontrolled environment for viewing and listening means that we see a wider range of patterns of engagement, from using content as background to other tasks, to searching through content for specific items or parts of programmes. These active patterns of consumption are only enabled by the audience's familiarity with the programmes or the structure of the content such as sports matches.

For a broadcaster looking to attract a wider audience into their on-demand and live streamed offerings, it is important to provide new audiences with the ability to understand and navigate the unfamiliar content. Long programmes, with no information about their content or structure create a barrier to new audiences, effectively excluding them [17]. By providing good quality information about programme content using techniques like chapterisation, event markers and sharable links, a broadcaster can engage new audiences through social media and improve the experience for existing audiences. Further information on each item can give credit to the people who created it, moving the emphasis away from the programme as a whole and towards the individual stories and events. The BBC provides information about the music played in most of the programmes on the web pages because of the ongoing demand for this information from the audience. This work shows there is a similar need for information about the other items within programmes. Such information, if time-accurate, can also be used to automate re-versioning and personalisation of programmes to create both lean-back and lean-forwards experiences. Work is now ongoing at the BBC under the title of Flexible Media to turn these ideas into a set of systems to achieve this goal.

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