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Whitaker, Simon

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Case record analysis

By

Simon Whitaker PhD

Consultant Clinical Psychologist/Senior Visiting Research Fellow
The Learning Disability Research Unit
Room HW G/16
The University of Huddersfield
Huddersfield
HD1 3DU
UK
s.whitaker@hud.ac.uk

Abstract

It is argued that the determinates of low frequency (less than once an hour) challenging behavior are likely to be more complex than those of high frequency behavior involving setting events that may not be present when the behavior occurs. The analysis of case records is then examined as a method of identifying possible setting events to low frequency behaviours. It is suggested that time series analysis, correlational analysis and time lag sequential analysis may all be useful methods in the examination of case records.

Although the literature on behavioral analysis has always acknowledged the inference of private events and those distant in time and place (c.f. Skinner 1953, 1974), the bulk of the literature seeks to explain behavior in terms of observable antecedents and consequences present when the behavior occurs. This has produced some notable successes in understanding some of the challenging behavior shown by people with intellectual disabilities. Iwata and colleges (for example Iwata et al 1982, 1990, 1994) have used experimental methods to demonstrate that many challenging behaviors shown by people with intellectual disabilities occur under identifiable antecedent conditions and are reinforced by immediately occurring consequences. The identification of these antecedents and consequences has led to the development of effective treatment for challenging behavior (Iwata et al 1994). However, much of this work has involved high frequency (greater than once an hour) target behaviors (Whitaker 2000). However, it has been noted by Whitaker (1993, 1996, 2000) that epidemiological studies (Harris 1993; Kessler et al 1984) have found that the majority of people with intellectual disabilities who have challenging behavior show them at a relatively low rate (less than once a day).

Examination of the behavioral literature suggests that the determinants of low frequency behavior may be more complex than those of high frequency behaviors. Behaviorally orientated authors working in a clinical field have pointed out that it can be difficult to understand the behaviors shown by referred clients in terms of the three term contingency (Dougher and Hackbert 2000, Wahler and Foxx 1981) and have suggested extending this basic analysis. Wahler and Foxx (1981) highlighted the importance of "setting events", events that affect the probability of future behavior in some way. Although setting events could be concurrent with the behavior, this need not be the case. For example, a temper outburst may be made more likely in the afternoon if the client was reprimanded by staff in the morning. A more theoretically developed concept is that of establishing operations (Michael 1982, 1993); environmental events that result in a stimulus becoming an effective reinforcer. Dougher and Hackbert (2000) have further extended this theoretical analysis to show that a full understanding of clinically disturbed behavior needs to take into account an individual's emotions and cognitions. It is not difficult to think of examples of events occurring one time that could cause a stimulus to become a reinforcer and thus increasing the probability of behaviors reinforced by that stimulus in the future. For example, missing breakfast due to not getting up on time would increase hunger and therefore act as an establishing operator for food to become a reinforcer. This could then increase the likelihood that the individual would steal food from a shop later in the day. A more clinical example is provided by Dicesare et al (2005) of an 18-year-old man with Attention Deficit Hyperactive Disorder (ADHD) and a moderate degree of intellectual disability. A formal experimentally based analogue functional analysis (c.f. Iwata et al 1982) showed that his disruptive behavior was maintained by attention, however, only when he was not taking medication (methylphenidate) for his ADHD. When he had taken the medication the difficult behaviors were at a much lower rate. The medication could therefore be said to have stopped attention action as a reinforcer. These examples show that past events can have an influence on current behavior. However, whether this is always due to them functioning as establishing operations has not been demonstrated; because of this the less theoretically constrictive term of setting events will be used in the rest of this paper.

Although it is possible to envisage low frequency challenging behaviors that are at the same time highly predictable with antecedents present at the time of the challenging behaviour, for example, if a client had a severe emotional reaction when the saw a spider, it is the author's experience that most low frequency challenging behavior will occur unpredictably in apparently different antecedent conditions. It therefore seems likely that at least some of the events influencing whether the behavior occurs are not present. Therefore, in order for a clinician to understand why a particular low frequency challenging behavior occurs, he/she must be able to identify the setting events to that behavior.

The identification of setting events will involve looking for relationships between observable events and the target behavior. However, it is perfectly possible that some events that seem to be systematically related to the behavior are not actually having an effect on the behavior. For example, aggression shown by an individual living in a group home may be found to be far more probable when a particular member of staff was on duty. It therefore would be a reasonable hypothesis that the presence of this member of staff is a setting event for the aggression, though this may not be the case. It could be that the presence of the member of staff was purely coincidental or that it coincided with other events that did influence the behavior such as the meals that are provided or a change in the routine in the home. The key point is that these methods are not experimental and can only identify events that may possibly be setting events. Once they have been identified it may be possible to experimentally test the hypothesis that they are setting events, though this may not always be practical, in which case it should the event's influence on the target behavior should be regarded as working hypothesis only.

To date there are only a few examples of studies in the literature in which setting events or establishing operators have been identified. Kennedy and Itkonen (1993) found that setting events occurring before school had a strong influence on the challenging behavior shown by two young women in school. In one case this was staying in bed too long and in the other it was the bus stopping too many times on the way to school. Touchette, MacDonald and Langer (1985) report a case study of a young man for whom the presence of a particular member of staff was a setting event for self-injurious behavior. In each of these studies the setting events were identified by directly observing the client, for example Touchette et al (1985) used a scatter plot in which was recorded when the behaviors had occurred thought out the whole day. One possible reason why there are so few studies is that this observation is too costly in time and resources. If, for example, one is trying to understand the aggressive behavior of a client who is aggressive on average once every two weeks in apparently different circumstances it may be necessary to observe him/her for several months in order to observe sufficient incidents to start to hypothesise what events are having a significant effect on the probability of aggression. Also, in addition to the time constraints in doing sufficient observations, there is the ethical consideration of allowing the behavior to continue while the information is gathered.

If the client is in a residential or day care setting then an alternative to direct observation is to use information in the records kept by staff on the client over the years. It is the aim of this paper to consider how these records could be analysed by those working clinically with clients to generate hypothesis as to potential setting events. These analyses are not experimental and do not demonstrate a clear causal relationship between events and behavior, however, they can generate clinically useful data that can be used to produce a working hypothesis as to why the behaviour is occurring which might be testable empirically. In order to clarify the various analyses used I will give examples using simulated data to demonstrate the ease with which this analyses can be done. All the figures can be drawn simply using Excel chart drawing.

Case record analysis

The reliability of the data in case files
One immediate problem with the use of information in a client's case records is that there usually will be no way of telling how reliable they are. Not all incidents of the challenging behavior may be recorded, and different staff may have a different understanding of which behaviors and other information should be recorded. However, although this data may not be reliable in the scientific sense, it has been argued (Whitaker and Lamb 2001, Whitaker and Hirst 2002, Whitaker, Walker and McNally 2004), that uncertain reliability need not prevent data from being used to obtain clinically useful information. They justify this for the following reasons. First, records of low frequency and high intensity challenging behavior are more likely to be accurate than those of high frequency low intensity behaviors, as it will involve less recording

and be less ambiguous to carers that the behavior has occurred. Secondly, although data may not be accurate in absolute terms, it may be accurate in ordinal terms, which means it could be analysed using nonparametric statistics. Thirdly, if tests of statistical significance were used, then chance errors in the data would decrease the chances of getting a statistically significant result, so if a statistically significant result is found, in spite of these errors, one could have confidence in it. Whitaker and Lamb (2001) and Whitaker and Hirst (2002) both provide examples of such analysis being used clinically. Nonetheless the chances of a significant lack of reliability of the data should not be forgotten and this should be taken into account when interpreting the results of any analysis.

Time series
The frequency of the target behavior occurring is plotted against time, either over the full time for which data is available, for example the number of incidents per month or in terms of frequency at particular times, for example days of the week or hours of the day. This data can be analysed in various ways. Morry and Adams (1989, 1991) have suggested ways of looking at trends in short time services that can be used to detect trends or fluctuations in the data. Kahng et al (1998) has suggested the use of statistical process control (SPC) on time series data to identify times when the behavior is statistically more likely than other times. It may be helpful to illustrate this by considering a case which, although fictional, is typical of many of the cases the author has worked with.

The following graphs are based on simulated data of incidents of agitated/aggressive behavior shown by a female client. They cover a three year (36 months) period in which 99 incidents have been recorded.

-------------------- Put figure 1 about here ---------------------

Change over time. Fig 1 shows the number of incidents that occurred in each of the 36 months. It is produced by counting the number of incidents that occur on each calendar month during the period of observations, and plotting this against the number of the month in sequence. There was a mean of 2.75 incidents per month with a Standard Deviation (SD) of 1.23. The frequency of incidents fluctuates from month to month; however, there appears to be a negative trend in the data. Whether this is a real trend can be assessed by correlating the number of incidents per month with the number of the month in sequential order (c.f. Morley and Adams 1989), which is significant ($r=.63$, $p<.01$ Kendall's tau). This could be taken as suggesting that the behavioral problems are improving. However, given the data is based on staff recordings without a reliability check there is also the possibility that the trend is due to reliability drift, the gradual decrease in the probability of staff recording incidents that occur. Staff may become less reliable for a number of reasons; they may have got used to the behavior and so no longer see it as noteworthy, they have been devoting more time to dealing with other residents and so would be distracted from recording incidents, staff may have changed and new staff may be less reliable. So any conclusions as to whether the problem behaviors are improving can only be tentative.

-------------------- Put figure 2 about here ---------------------

Change over the week. Fig 2 shows the frequency of incidents over the week. The figure is generated by counting all the incidents that occur on each individual day of the week. The average number of incidents per day was 14.14 (SD 9.56). This analysis may identify if there are any particular days when the behavior is either significantly more or significantly less likely to occur. Kahng et al (1998) have suggested that SPC procedures can be used to identify times when data falls out of the normal expected fluctuations. They give

the following criteria for data being outside normal fluctuations based on Wheeler and Chambers (1992). Data are said to be outside statistical control if they meet one of the following criteria:

1. At least 8 consecutive points or 12 of 14 successive points fall on the same side of the centre line.
2. At least 4 of 5 successive points fall on the same side of and more than one sigma unit away from the central line (-+ 1 SD).
3. At least 2 of 3 successive points fall on the same side of and more than two sigma units away from the central line (+- 2 SD).
4. A single point falls outside the three-sigma control line.

None of the criteria for being outside statistical control are reached, though with only seven data points it would be very difficult to reach these criteria. Therefore less stringent criteria of deviation from the norm may need to be used, for example, deviating from the mean by one SD. However, as in a normal distribution 32% of points differ from the mean by more than one SD with seven points it would be very likely that some would be greater of less than one SD. Therefore a deviation of one SD is clearly not statistically significant and can only be taken as suggestions that the frequency is unusual. The number of incidents on two of the days is greater that one SD from the mean: Thursday, when there are only four incidents reported and Sunday where there are 27. It may therefore be appropriate to examine if anything happens or is more likely to happen on a Thursday that could be responsible for a reduced rate and if there is anything that is more likely to happen on a Sunday that may be responsible for an increased rate.

-------------------- Put figure 3 about here ---------------------

Change over the day. Fig 3 shows the frequency of incidents for each hour of the day from 6 a.m. to midnight. It is generated by simply counting the number of incidents that are recorded as occurring each hour. The average frequency for an hour was 5.5 (SD 3.95).

As with analysis of days of the week, none of the SPC criteria are met, though there are two times during the day (13:00 to 14:00 and 21:00 to 22:00) that are greater than two SDs above the average. There is also one hour during the day when there are no incidents recorded. As in a normal distribution 5% of observations would fall outside two SDs and this plot has 18 points, it would be expected that at least one point would fall outside two SDs. Therefore to have two points fall outside two SDs is not statistically indicative. Nonetheless it may well be worth investigating further if there are any events that could be affecting the challenging behaviors that occur during these times.

The analysis of time series can therefore produce useful information with regard to trends in the data. It may point to particular times in the day or week when the behavior is more or less likely to occur, which can be investigated further to see if any potential setting events can be identified. However, the illustrations above show that, given the small number of data points the analysis generates, it would be unlikely that any of the SPC criteria will be met, so this analysis will probably only lead to suggestions that a particular time is associated with a higher or lower probability. Also, even if particular times are identified, it does not mean that a clear setting event can be identified. In fig 3 above there is a higher rate between 13:00 and 14:00, a time that usually corresponds to staff handover, when the staff on one shift are meeting the staff on the next shift. This is therefore a time when there is less direct supervision of residents and less staff attention available, which in the author's experience is a time when challenging behaviors are more likely. So in this case the analysis may have identified the lack of staff in the client's immediate environment as a setting event. However this is not always the case. Kahng et al (1998) made detailed

observations of 20 individuals using a scatter plot method in which it was recorded if the target behaviour had occurred every half hour during the day. The data was then checked for reliability and subject to SPC. They found that for five of the individuals the data was not sufficiently reliable. Of the other 15, twelve reached the SPC criteria; however, they were still not able to identify what factors were controlling the behavior.

A major limitation with the analysis of time series to identify setting events is that it will only be able to point to those events that occur regularly in time. For example, if challenging behavior was made more likely by not having day care available, then there would be a high rate at the weekends when there was no day care. However, if the challenging behavior was made more likely by the presence of a particular member of staff who worked irregular shifts then a time series analysis would not detect it. Therefore other methods will often have to be used to identify setting events, such as questioning staff as to what they feel causes the behavior, looking in the client medial records to see if there is any condition such as epilepsy that may have an effect on the behavior, or examine if there are any events that may be thought to result in stress and anxiety.

If on the basis of these investigations a particular event or events that may be influencing the behavior are identified then the data can be analysed further to bring further support to the hypothesis that the predicted setting event is influential. Wahler and Fox (1981) have suggested the use of correlational analysis where significant correlations are looked for between the frequency of challenging behavior and the occurrence of possible setting events, for example, the frequency of incidents per month and the frequency of epileptic seizures per month.

Correlational Analysis

This form of analysis may well lend itself to case record analysis if other events that may potentially be acting as setting events have also been recorded. There are very few examples of correlational analysis being used in the literature. One is a case study by Whitaker and Hirst (2001) of a man with moderate intellectual disabilities and autism. It was hypothesised that his aggressive behavior may in part have been the result of him being under-stimulated. This was tested by looking back in his case records for the previous six months and finding when he went out for a walk and when he was aggressive. The frequency of walks and the frequency of aggression was then correlated and found to be negatively related (Kendall's tau= -0.30 P< .05) supporting the hypothesis that his aggression was in part due to under stimulation. On the basis of this staff were encouraged to ensure that he had regular walks. Following this there was a very low rate of aggression over the next four months.

Although correlational analysis is useful in giving support to hypotheses, correlations are limited in what they can show. Whitaker and Hirst (2001) point to the following limitations: First, there may be considerable error in the data gleaned from the client's case records, both in terms of the occurrences of his/her challenging behaviors and in the environmental events that they are correlated with. Secondly, a correlation between two variables simply shows that they vary systematically in the same or opposite directions and not that one causes the other to vary. It is therefore possible that a third variable could have affected both the variables that were correlated. For example, in the case study they present, both the increase in going out and the reduction in his outbursts could have been due to better management of staff on the unit, ensuring that they were both able to manage his behavior better and were organised so that he was able to be taken out. Thirdly, even

`if there is a` causal relationship the direction of the causation is not know. For example, in the case they present the man could have gone out more because his behavior had improved, rather than going out causing his behavior to improve. Fourthly, even if there was a causal relationship in the direction hypothesised, it still does not indicate the mechanism by which the environmental variable affects behavior, though ideas about setting events and establishing operations may be a useful way to theorise about what is happening. They therefore suggest that correlational analysis should be used but that the results are interpreted with caution.

Time lag sequential analysis

A method that has been used that may give insight into the nature of the relationship between behavior and environmental events is "time base lag sequential analysis" (Bakeman 1978; Bakeman and Gottman 1978; Emerson et al 1995; 1996; Forman et al 2002). This procedure involves comparing the conditional probability of a particular "target" event at specific times before, during or after another "given" event, with the average unconditional probability of that target event occurring. Emerson et al (1995; 1996) and Forman et al (2002) have used this method in order to do a functional assessment of the challenging behavior of children by looking at the probability of challenging behaviors in the seconds before, during and after a given event. However, the method could also be used with much longer time scales to investigate the relationship between low frequency challenging behavior and hypothesized setting events.

-------------------- Put figure 4 about here ---------------------

Fig 4 shows a time lag sequential analysis for the simulated data used in the earlier examples to test the hypothesis that the woman's challenging behavior was related to the menstrual cycle, information that is likely to be recorded by staff.

The graph was generated as follows: Over the three years she had 39 menstrual periods. For the sake of simplification I will assume that they all lasted exactly four days. The probability of having an incident on the days she is having a period is calculated by counting the number of days on which an incident occurred on each of the four days of her period separately for each day and then dividing this by 39. The same procedure is then followed for the six days before her period and the six days after. The probability of an incident occurring on the days following, during and after a period can be compared to the average or base probability of an incident occurring on any one day which is .09 (99 days on which incidents occurred divided by the total 1095 of days of observation).

It can be seen that four, five and six days prior to her starting her period the probability of having an incident is below the base rate of .09. However, on the three days just prior to her starting her period the probability of an incident increased to well above the base rate. The probability then remains above base rate for the four days of her period and then goes down to near or below base rate for the six days following the end of her period. There therefore seems to be a systematic relationship between the probability of an incident and having a period. It is difficult to envisage any realistic way in which errors in recording could have resulted in this relationship; the only way would have been for staff to be systematically more vigilant in recording incidents on the days before and during her periods. The results therefore would seem to indicate a real relationship between her challenging behavior and menstrual periods. Also, as in this case it is far more likely that the menstrual periods cause the increase in the likelihood of an incident rather than the other way round causality is also indicated. This therefore could lead to

treatment of her challenging behaviour by treating her pre-menstrual tension medically.

Whitaker, Walker and McNally (2004) used this method to investigate the relationship between low frequency challenging behavior and hypothesized setting events, presenting three case studies. The first was of a woman who was recorded as showing agitated and aggressive behaviors about twice a week. It was felt by the staff who worked with her that the behaviors were more likely before seeing her parents. The group home had records of both the agitated/aggressive behaviors and when she saw her parents. An initial correlation between the frequency per month of seeing her parents and the frequency of outbursts was very low and not significant. Nonetheless, in spite of this negative result a time lag sequential analysis was performed. This showed that there was indeed a relationship between the outbursts and seeing her parents, though it varied over the days before, during and after the parental visit. For the six days before and on the day of parental contact there was a slightly above average probability of agitation/aggression. However, on the two days following a visit there was a significant drop in the probability of the challenging behavior followed by an increase over the next for three days. The impression was one of a clear relationship between behavior and contact with parents, however, the average rate over the six days before, the day of the contact and the six days after was not very different from the overall unconditional probability of the behavior, hence the failure to find a positive correlation.

The second case was also of a woman who showed agitated aggression about one to two times a week, where it was felt that contact with her father was a factor in the behavior. In this case the woman had a mild degree of intellectual disability and had been diagnosed as having a borderline personality disorder. She was a resident in a forensic treatment unit for people with intellectual disabilities. Over the 153 days she had been on the unit she was recorded as showing disturbed behavior on 41 of these days and having had contact with her father on 28 days. It was found that the correlation between the number of days per month when she had contact with her father and the number of days when she was recorded as showing disturbed behaviour was significant (Pearson r = 0.576 significant at 0.01 level) giving support to the hypothesis that contact with her father was a setting event for her disturbed behavior. The relationship was further examined using a time base lag sequential analysis to see what the probability was of her showing disturbed behavior on the days she had contact with her father, and on the three days both before and after she had contact. It was found that the probability of her showing disturbed behavior on the three days before seeing her father was close to the unconditional probability of .27. On the day she saw her father it rose to .50, a significantly higher probability. In the three days after seeing him the probability again dropped to a near average rate. This analysis therefore gives further support to the simple correlation, and suggests that if there is a causal relationship between seeing her father and showing disturbed behavior, then the effect is mainly on the day on which she sees him.

In the third case time lag sequential analysis was used to investigate if there was evidence for a suggested relationship between seizures and hostile behavior. The client was a man who was a resident on the same unit as the second case. It had been suggested by staff that his hostile behavior was related to his seizures. Over the 157 days of records he was recorded as having had seizures on 28 days and having shown hostility on 30 days. The correlation between the number of days a month on which he was recorded as having had a seizure and the number of days when he was recorded as having shown hostility was non significant (Pearson r=-0.234) suggesting that there was no relationship between the two. Nonetheless the relationship between his hostility and epileptic seizures was further examined using a time base lag sequential analysis. This

showed that the probability of him showing hostility was not significantly higher or lower on days when he had a seizure, or the 3 days either before or after he had one. This finding is consistent with the correlation in again failing to find evidence of a relationship between his seizures and difficult behavior. Although this is a negative finding it is still important as it tests a clinical hypothesis as to why he was showing challenging behavior and demonstrates that it can be rejected (c.f. Popper 1972).

Discussion

Although experimental functional analysis has proved very successful in identifying the controlling environmental factors determining high frequency challenging behavior, there is a lack of evidence that it is a practical method of analysing low frequency behaviors. In part this may be due to the unreasonable amount of time such an analysis would take with low frequency behaviors, but also it is because it is likely that low frequency behaviors are affected by setting events that are not present at the time the challenging behavior occurs. Therefore in order that we are able to better understand why low frequency behavior occurs we need to develop technologies to identify potential setting events and to test if they are affecting behavior. This paper has focused on the analysis of case records, which, if they are available, is one technology that could be used.

The time series analysis of incidents can occasionally point to potential setting events and, as it can be done relatively easily, is well worth doing. Its key strength is that it can highlight times when the behavior is more or less likely, however, it requires a large sustained variation in rate to reach the SPC standards of statistical significance, which may not occur in the time series that can be constructed from case record material due to small number of data points. The analysis therefore will often need to be done with less rigorous criteria which may lead to false positives. Again one should be aware of this in interpreting this analysis.

Once potential setting events have been identified then correlational analysis and time lag sequential analysis can be used to lend further support to this hypothesized relationship. A significant correlation between behavior and events suggests that there may be a causal relationship between the two. However, the relationship will remain hypothetical unless it is possible to test it experimentally. Time lag sequential analysis can give more details as to the relationship between the setting events and behavior and, as was illustrated by the first case in the Whitaker et al (2004) study, can show relationships that were not apparent when a simple correlation was used. However, as with correlational analysis, time lag sequential analysis is not experimental and cannot confirm a causal relationship.

The method is, however, limited in many respects. The data that is being analysed may well not be reliable, which could result in both the analysis failing to show a significant relationship where such a relationship exists, or in suggesting a relationship exists that is in fact an artefact of change in reliability of recording. Therefore interpretation of the results of a case record analysis should be done with caution. However, provided one is aware of these limitations in a clinical context, these analytical methods can generate hypotheses that my not have been apparent without their use. These hypotheses may then point the way to an effective treatment.

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Figures

Figure 1. The frequency of incidents per month over a three year period, using simulated data.