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Objective and self-report work performance measures: a comparative analysis

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Abstract

Purpose – The purpose of this paper is to assess the feasibility and comparability of daily self-report and objective measures of work performance in complex office tasks, and factors affecting the correlation between these measures.

Design/methodology/approach – Medical bill auditors provided daily information for 12 weeks through interactive voice response (IVR) on their speed, concentration and accuracy at work, compared to their best job performance.

Findings – The paper found that 124 of 142 recruited subjects (87 percent) completed > 50 percent of daily IVR reports. Concentration, speed and accuracy were highly inter-correlated ($R = 0.75$), and right-skewed (mean speed = 7.7, SD = 1.5). Mean adjusted daily productivity rate (MAP) was 34 bills/hour (range 4.7 to 111, SD12.6, 61 percent within-person variation). Subject-specific speed – MAP correlation varied from $R = -0.20$ to $+0.75$ (mean, 0.28). Health status, years on job, age, IVR completion rate, site, month of study, or total hours worked were not associated with these variations.

Originality/value – This paper provides an unprecedented level of detail in the comparison of self-reported and objective daily measures of work performance, demonstrates the feasibility of data collection and analysis, and identified significant inconsistencies among workers in the correlation between the two types of measures. Results demonstrated that daily self-reports cannot be used as a direct surrogate for objective performance measures.

Keywords Performance management, Measurement, Surveys

Paper type Research paper

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Introduction

A common belief is that the best indicators of individual worker performance would be objective measurements. However, such measurements have proven elusive in that they can be difficult both to conceptualize and to implement; few jobs in modern economies are designed in a way that facilitates easy collection and analysis of these data (Tangen, 2003).

Measures of work performance are especially important in order to understand the effects of various interventions on occupational functioning. For many health conditions, the majority of associated costs are due to effects on performance at work, rather than absenteeism or medical care. Therefore, when absenteeism and medical resource use are reported for these conditions, they understate the full economic impact of illness and potential benefits of treatment. Of the total, 12-17 billion dollars of lost productivity attributed to migraine headaches in the US, 60 to 70 percent may be due to impaired performance while at work (Schwartz *et al.*, 1997). The impact of seasonal allergies on productivity is estimated to cost US employers over $2.8 billion per year, but only 10 percent of this is due to lost workdays (Ross, 1996). Depressive illness is widely recognized to impact work-related function, with studies reporting substantial correlations between symptom severity and impairment in function at work (Lerner *et al.*, 2004).

Due to the unavailability of objective measurements of work function and performance, various self-reported measures have been employed in a wide range of studies. Several have demonstrated reliability and validity when compared to other self-reported measures. However, the relationship of these measures to actual at-work performance is not known, as extensive comparison studies have not been reported (Lerner *et al.*, 1999; Reilly *et al.*, 1993; Lerner *et al.*, 2001). Resolving this uncertainty is critical in order to fully understand and accurately report the impact of health and other factors, as well as interventions to improve performance, on business operations, and was one goal of this study (Blanc *et al.*, 2001). Improved understanding of the relationship between self-report and objective measures of work performance could provide essential information for employers seeking to better understand the factors associated with variations in productivity and the impact of health benefits policies, and for research to identify therapies that not only relieve symptoms, but also restore normal work performance.

We hypothesized that objective and self-reported daily performance measures would be positively correlated, and that the degree of association would be greatest among employees with the most experience on this job, highest level of education, highest level of daily participation in the study, and most experience with medical conditions likely to disrupt performance. The work setting studied here provided a unique opportunity to compare self-report and objective performance measures obtained on a daily basis for a stable group of experienced employees, working in an office-based setting, on tasks of relatively high complexity.

Methods

Study population

The study was conducted at three sites of a medical bill review and approval operation. Workers were responsible for reviewing and approving imaged medical bills, using specified criteria. Activities included processing of three different types of bills (medical, facility and pharmacy charges) for two different insurers. Bills were uploaded into the system by the employees, requiring an initial review of content, and

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comparison with prior utilization for the same patient and specific approval criteria. Certain bills required additional steps (adjustment and adjudication) depending on jurisdiction-specific rules and health care provider feedback. Once finished with the review and approval process, the reviewer forwarded the bill for finalization and payment; typically, bills were finalized one to four days after initial entry. Bill reviewers usually received large groups of bills early in the week, and spent a greater percentage of time later in the week adjusting or performing additional reviews on bills that required further evaluation. Workers were divided into teams of ten to 12 employees, each responsible for a specific geographic area. All employees were salaried; the rate was paid on an hourly basis, without direct incentives related to productivity.

Eligibility requirements included those employees who were working full-time as bill reviewers, had been on the job for at least three months, and expected to continue on the job full-time for at least another three months. Objective daily output and productivity data available for each employee included the number and types of bills processed, types of processing activities performed, and hours actually working on the bill processing system.

Study design

Employees were recruited through on-site meetings at each location, and volunteers were asked to provide written informed consent. All study procedures were approved by the associated Institutional Review Board. Subjects were asked to provide daily responses to questions administered by telephone interactive voice response (IVR). The IVR system was accessed by calling a toll-free number after the end of each workday, and responses were entered by pushing touch-tone buttons. Responses to all of the IVR questions could be completed in less than five minutes. If a subject missed one day, it was possible to provide responses for the missed day on the following day. A monetary incentive was given each month for successful completion of the required daily responses, and an additional incentive was offered to those who completed the entire three-month study.

Questionnaire development

Daily diary questions originated from detailed discussions with a group of 15 employees working in data entry positions, representative of those included in the study. They were asked to suggest brief self-report items that would capture the full range of day-to-day changes in work performance, in a format that would reference to the best and worst performance over the long-term at the current job. A second group of similar size was convened to pilot-test the questions developed with the first group, and independently validate the suggested approach. The final format of the daily questions about work performance used in the IVR system is listed in Table I. An additional daily question asked whether bills outside of the usual jurisdiction were processed. Questions at the end of the study ascertained demographic variables. Subjects were also asked by written questionnaire at the end of the study whether they currently had a headache disorder, depression, or other major illness requiring ongoing treatment by a doctor (yes/no).

In order to more accurately compare self-reported performance to objective measures, several assumptions were developed. Days out of work were excluded as the focus of the analysis was on self-report while at work. Most workers logged onto the system on arrival in the morning, and logged out only if they were planning to be away

Table I. Actual daily interactive voice response questions

1. Is today a workday for you? (y/n)	
2. Did your work today include responsibilities outside of your normal bill review activities, such as a different state or type of bill? (y/n)	
3. Compared to your best day at work, please rate the following on a scale from 0 to 10 with 0 being your worst and 10 being your best	
Concentration:	Enter now. Remember; use any number from 0 to 10, 0 being your worst and 10 being your best
Accuracy:	Enter now. Remember; use any number from 0 to 10, 0 being your worst and 10 being your best
Speed:	Enter now. Remember; use any number from 0 to 10, 0 being your worst and 10 being your best

from their desk for an hour or more, for lunch or meetings. Thus, time logged on the system was used as a surrogate measure of hours spent each day on bill review tasks.

Statistical analysis

Occasionally, workers were required to enter a large number of bills with minimal processing, or were present at work but temporarily re-assigned to a special project off the system; these exceptional periods of time at work could be identified by unusually large or small levels of activity in the system, manifested as an extremely high or low number of bills processed per hour. These observations were excluded by removing system measures that were greater or less than three standard deviations from each individual's 12-week mean. Exclusions for daily and weekly output and productivity were calculated separately.

After removal of these outlier observations, descriptive statistics were calculated for self-report and objective output and productivity measures. Site managers indicated that inter-team differences were partially due to variations in bill complexity by jurisdiction, and that workers often changed jurisdiction to assist others when their own team was ahead of schedule. There was also a range of bill types, with variations in complexity and length of time required for processing. Consequently, weights (relative difficulty) for each type of bill, type of activity, and jurisdiction were calculated, by computing average time required to process each type of bill using multiple linear regression, based on the mean weekly average time to process each type of bill. Simple linear regression analyses were used to determine weighting factors for each bill type and each type of activity, and relationships between self-report and objective measures. The primary objective performance measures used in the study were difficulty – adjusted bills processed per day (daily output), and difficulty – adjusted bills processed per hour on the system (daily productivity rate). Speed, concentration and accuracy responses were highly correlated ($R = 0.75$-0.77); because the focus of the study was on quantity of bills processed over time, the IVR measure for speed was chosen as the primary self-reported measure of performance for subsequent analysis. Analysis of variance was used to determine individual versus group contributions Correlation analyses and multiple linear regressions were used to examine relationships between self-reported performance (IVR speed), and the two measures of objective performance (daily output and productivity rate), and possible factors affecting differences in these relationships across subjects.

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Results

Participation

Of 220 employees at the bill processing centers, 207 attended an initial screening, and 142 enrolled in the study (64 percent). Of those who initially enrolled, seven dropped out soon after the start of IVR data collection. Another eight were subsequently excluded – because of withdrawal from employment, or changing jobs within the company. Additionally, a minimum of 30 days employment as a medical bill reviewer with participation in daily IVR data collection was required. As a result, of the 142 initially enrolled, 124 completed the study (87 percent).

Demographics

The average age of the subjects was 36 (+/− 10.6) years, and 97 percent were female. A total of 22 per cent had completed a college degree, another 39 percent had completed some college, and 38 percent had high school graduation as their highest level of educational attainment. On average, participants had been on the job for 2.6 +/− 2.4 years (range three months to 15 years) and had worked for this employer for 5.3 +/− 7.1 years (range three months to 33 years).

IVR data

For these 124 subjects, there was a 94 percent completion rate for the IVR on workdays. Examination of IVR responses revealed that responses to the questions about work performance (Table I) of zero or one on the 1-10 scale likely represented keying errors (the subject attempted to enter "10" using the telephone keypad, but the IVR system recorded only the "1" or the "0" keystrokes). These responses represented less than 0.5 percent of all IVR responses, and were recoded as missing values. Thus, the range of useful responses for analysis was from 2 to 10 (Table II). Analysis of variance demonstrated considerable intra personal, as well as inter-personal variation, for each performance dimension; results were right-skewed, to the high end of the range for responses.

Objective productivity data

A total of 5,856 daily observations from the 124 workers were available; 135 (2.3 percent) were excluded as outliers, resulting in exclusion of three subjects due to insufficient valid matched self-report-objective data days, reducing the analytical sample to 121 employees. Weights were calculated for type of bill, type of activity, team, location, and whether the employee was processing bills from their usual jurisdiction, using linear regression on mean values. For illustration purposes, Table III contains weights for type of bill and type of activity. Table IV describes the weighted objective output and productivity data available for each participant during the period of the study, for those days with a valid IVR response.

Table II. Daily work performance self-reports (scale from 2 = worst to 10 = best)

Variable	*N*	Mean	Median	Std dev.	Percent intrapersonal variation
Concentration	5,896	7.70	8.00	1.46	41
Accuracy	5,915	7.92	8.00	1.31	46
Speed	5,916	7.67	8.00	1.46	39

Correlations between daily self-reported performance (speed) and adjusted daily output and productivity were calculated for each subject over the 12-week study period (Table V) This analysis demonstrated a wide range of subject-specific correlations for both objective output and productivity measures (min and max, Table V).

Multivariate linear regression analyses were conducted to examine personal, workplace and job factors as possible explanatory variables for these variations in subject-specific correlations between self-report and each of the two measures of objective performance (the magnitude of correlation was the dependent variable). The factors assessed included employee age, educational attainment, years at the employer, years at this particular job, month of the study (first, second, or third), presence or absence of headache disorder, depression, or other significant illness, mean objective productivity level, average IVR speed response, variance in IVR speed responses across the study, number of days absent from work during the study, and number of workdays completing the IVR during the study. These analyses failed to demonstrate any statistically significant ($p < 0.05$) relationships. Workdays with and without IVR responses were compared; no differences were found with respect to average objective performance measures.

Table III. Relative weights for type of bill and type of activity; lower weights indicate easier bills (less processing time required)

Bill type	Activity type Enter	Adjust	Adjudicate
Provider charges	1.00	0.478	1.287
Facility charges	0.821	0.397	1.124
Pharmacy charges	0.806	0.437	0.905

Table IV. Adjusted objective productivity data, excluding outliers and observations without valid IVR data

Measure	*N*	Mean	Median	Std dev.	Min	Max	Percent intra-subject variation
Bills processed/day (all observations)	5,243	194.16	188.61	67.8	31.9	567	53
Bills processed/day (subject-specific means)	121	192.13	183.69	49.05	89	353	n/aq
Daily productivity (bills/hour-all observations)	5,243	31.03	30.13	10.07	5.6	91	58
Daily productivity (subject-specific means)	121	30.89	29.86	7.93	12	53	n/a

Table V. Correlation between adjusted objective and self-report (speed) daily measures

Subj. variable	Obj. variable	*N*	Mean *R*	Std dev.	Min	Max
Speed	Bills processed	121	0.294	0.222	0.201	0.750
Speed	Productivity/hour	121	0.276	0.227	0.226	0.684

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Discussion

Results have been presented from a study in which a sample of 121 workers, all in the same data entry occupation, at three different sites of the same firm were followed intensively over a 12-week period. Daily objective measures of their work output and productivity rate were analyzed, along with daily self-reported responses to questions about speed of their work. Daily self-reported and objective measures were weakly correlated, on average, but there was considerable variation in this correlation across subjects, with some subjects demonstrating a strong correlation between self-reported speed at work and objective measures of performance. Personal, workplace and job factors failed to explain the reasons for this inter-subject variance.

Few prior studies have offered the opportunity available in this investigation to examine possible correlations between self-report and objective metrics of daily work. Most prior comparison studies have used summary (over weeks or months), surrogate, or highly derivative objective measures that are distant from daily productivity (Wang *et al.*, 2004; Allen and Bunn, 2003). Lerner *et al.* (2003) demonstrated strong correlation between objective and self-reported monthly measures. A number of studies have however, examined the advantages of self-report metrics collected on a daily basis compared to recall by the study subject at various elapsed time intervals. Daily recall appeared to be more accurate than monthly measures. Stewart *et al.* found that days of more than 50 percent reduction in productivity based on three-month recall only moderately correlated with daily diary responses ($r = 0.42$). Recall tended to over-emphasize negative impacts: in his study, by recall, the number of days of > 50 percent decrease in work productivity due to headache was 3.77, compared to a mean of 2.22 based on daily diary measurement (Stewart *et al.*, 2000). Other studies have also demonstrated a tendency towards over-reporting in recall about disability compared with daily diary records, and only moderate correlations ($r = 0.4$-0.7) between the two measures (Peters *et al.*, 2000). In another study, recall of number of workdays missed due to headaches was considerably more accurate than self-reported average reduction in productivity over a three-month period (Stewart *et al.*, 1999). This could reflect selective recall – where more recent events, especially negative ones, are more influential in formulation of reported rates, or telescopic errors, where events in the past are placed more recently than they actually occurred (Fahrenberg, 1996). Use of an experience sampling method, where subjects are randomly contacted to provide an instantaneous report of current job performance, is one method to avoid recall bias without dramatically increasing the data collection burden (Wang *et al.*, 2004). Compared to most recent studies on self-reported and objective work productivity measurement reported in the scientific literature, the current study did not restrict self-reported responses to just those work performance limitations that were due to health problems, and thus may be of more general utility.

Although self-reported speed did not correlate strongly with objective measures of work performance, the low observed correlations do not imply that self-report is inaccurate. It is likely that self-report and objective measures provide information on distinct, different aspects of work performance. Objective measures, even in jobs that are apparently routine and straightforward, can present challenging levels of complexity, and may provide an estimation of only one dimension of actual job performance. Objective measures have also proven difficult to conceptualize. It has proven even more difficult to identify and access settings in which face-valid objective measures of work performance can be easily collected. Outliers encountered here may indicate that certain work functions were far from routine.

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Weighting difficulty based on an average obscures the considerable variation that may be present in time required to process a single type of bill. Weights may have varied considerably among subjects when performing similar activities. Shifting to another jurisdiction usually (but not always) was a transition to relatively easier bills. Thus, the inability to capture accurately and fully the relative difficulty of each bill type and procedure performed could have led to significant errors in estimating actual output and productivity, in terms of relative effort. The high levels of inter-subject variation in adjusted daily output and productivity argue for incomplete adjustment, as it is presumed that those at the extreme low end of the performance scale would have not continued employment for three months or more. Alternate analyses without weighting yielded substantially lower correlations of self-reported and objective performance data, and thus the adjusted measures were chosen as more likely to reflect an appropriate comparison (data not shown).

The significant inter-subject variation in subject-specific correlation levels suggests that idiosyncratic or inconsistent interpretation of the IVR questions may explain the low self-report-objective correlation observed here. The absence of a significant relationship between these subject-specific correlations and factors such as age, volume of bills processed, or years of experience argues against task familiarity or daily variation in job duties as possible explanations for these differences. Some subjects had IVR responses that varied little across the course of the study, despite significant daily variation in number of bills processed, suggesting hesitancy to admit having a relatively unproductive day. The positive skew of responses could also reflect a social desirability effect (Schwartz *et al.*, 1997). However, exit interviews conducted by physicians who had no relationship to the company failed to uncover concerns about reporting or desire to convey information to management through this process. Others may have not viewed any of the IVR responses as measures of number or rate of bills processed. Although difficulty-adjusted measures account for variations in average times required to process different types of bills, some respondents may have already taken this into account when providing ratings of their performance. However, the similarity of results using difficulty-adjusted and unadjusted output productivity measures (not shown) argues against this. Although employees indicated during questionnaire development that the scale anchors referred to best-ever and worst-ever productivity on the current job, some respondents may have alternatively interpreted this to refer to the current week or month. This would create a problem of shifting reference points within subjects, leading to very low overall correlation for a single subject with our analytic approach. At the exit interview, participants were asked about difficulties using the IVR system; no consistent problems were identified, other than forgetting to call in each day. Given the nature of the work, it was hypothesized that bills finalized per week might provide a measure more consistent with self-reported performance; however, these correlations were consistently lower than daily measures (not shown). The participant population may have been skewed towards those with good performance, thus limiting the variability in self-reported responses.

Daily self-report metrics of job performance have proven feasible to collect in the context of a prospective study. Given that the objective data may not be highly reliable or generalizable, self-report data may be preferable. Considerations include the extra effort required to collect daily self-report data, limited range of responses, multiple sources of possible bias, and lack of strong linkage to objective performance. However, self-report measures represent "perceptions" on the part of the individuals offering the assessments. As such, the magnitude of the self-reported metrics may be influenced by

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the respondent's "state". For example, if the respondent was depressed, a relatively "pessimistic" outlook and subsequently lower self-ratings might be expected, independent of actual performance. However, two observations argue against this effect. First, there was no association between self-report, objective measures and self-reported depression. Second, there was no association between depression and the correlation of self-report and objective performance (results not presented). The relationship between available self-reported metrics and unavailable objective counterparts has often been suggested as an important issue that merits further examination.

Several changes to the study might have led to a higher self-report-objective correlation. These include additional input from participants in the question development process, alternative formulation of questions and use of a designated mid-point in the "speed" scale to indicate average productivity, perhaps yielding a wider distribution of results. More complete data on relative complexity of each bill and task may have improved the accuracy of difficulty adjustment. Answers to a more specific question, such as the number of bills processed today vs average or best day, may have demonstrated higher correlations with objective data. More intensive training and reinforcement with feedback during a trial/training period could have led to higher within and across-subject consistency in relating IVR responses to the number or the rate of bills processed. Other studies with higher subjective-objective correlations may have benefited from tasks that were more routine, objective data of less complexity, and workplaces where individual performance metrics were more prominent, thus providing regular feedback to employees on their daily performance (Cockburn *et al.*, 1999; Kessler *et al.*, 2003).

Conclusion

A number of possible benefits could result from the ability to collect accurate data on daily work performance. In most instances, objective metrics of changes in work productivity are not feasible to collect, and are difficult to interpret. Under many circumstances, collection of self-reported or supervision-reported assessments, are relied upon. Decision makers facing these issues have asked whether subjective measures are a reasonable "barometer" for performance on the job. Our results, in the context of a particular occupation in one firm, suggest that self-report and objective assessments each appear to measure different aspects of work performance. Thus, both types of measures may be necessary. The wide variation in self-report-objective correlation and differences in response patterns across subjects raises concerns about the validity of daily self-reported performance, at least in relation to key objective business measures. Further studies are clearly needed to explore the factors that determine self-report responses, in order to better understand the relationship of these responses to objective measures of performance. Though results may appear to be highly specific to a single industry or type of operation, these types of complex operations are common throughout business financial services outside of the health care sector. As productivity measures continue to be a high priority for employers, continued exploration is warranted.

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