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CHANGING ORGANIZATIONAL ENERGY CONSUMPTION BEHAVIOUR THROUGH COMPARATIVE FEEDBACK

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Abstract

The differential effects of two forms of feedback on energy consumption behaviour were examined in two units of a metallurgical company. In one unit, employees received information about energy conservation, had to set goals and received feedback on their own conservation behaviour. The same procedure was followed with employees in a second unit, but they also received information about the performance of the first unit. In accordance with predictions from social identity theory and social comparison theory, the results clearly showed that employees in the comparative feedback condition saved more energy than employees who only received information about their own performance, even half a year after the intervention. A remarkable finding was that behavioural change took place with hardly any changes in attitudes or intentions. The discussion focuses on these findings and on their implications for organizational behaviour change in general.
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Introduction

The consumption of energy results in economic and environmental costs such as resource shortages, inflation, air pollution, and radioactive wastes (Cone & Hayes, 1980). Because of these costs, more and more Western industrial organizations are investing in innovative physical technologies to reduce energy consumption, for example, by insulating buildings, by purchasing or modifying equipment, and by using energy-saving devices. However, these energy consumption-reducing investments are not worth much unless employees handle apparatus and equipment in such a way that less energy is wasted. Hence, an important question is how energy-related organizational behaviour can be changed effectively.

Research on energy conservation in family households has shown that as a result of behavioural modifications, savings of up to 30 per cent can be realized (Seligman & Darley, 1977; Geller *et al.* 1982). However, generalization of these findings to the workplace is problematic because expenditures related to energy use are usually experienced more directly in a household, and, in the context of an organization, employees profit only indirectly from their extra efforts to save energy. Thus, the main question becomes: how can a company motivate its employees to behave in a more energy-saving way?

In the present study an attempt was made to encourage energy-saving behaviour by using comparative feedback. Employees in one unit of a metallurgical plant were provided with information about the performance of another unit to see whether this comparative feedback resulted in extra energy savings after both units had participated in a behavioural change programme containing educational information, task goal assignment, feedback, and supervision and control. Previous organizational research (Siero *et al.* 1989) has shown that such a behavioural change programme is an effective tool to motivate employees to reduce their energy-wasting behaviour. In the following section, we discuss the potential of comparative feedback for reducing energy-wasting behaviour. Subsequently, attention will be given to the elements of the behavioural change programme.

Comparative feedback

Receiving information about the performance of

other groups can lead to several group-dynamic consequences. First, comparative feedback emphasizes the existence of the own group. By making people conscious of the existence of another group with whom they may compare themselves, their own group is made more salient. According to social identity theory (Tajfel, 1978), people will in general strive for a positive self-image. Their membership in a group is itself perceived as part of their identity. Research in this area (Tajfel & Turner, 1979) has shown that emphasizing the social identity of individuals leads to a strong personal identification with one's own group which can have various psychological and behavioural consequences. For example, stronger identification manifests itself in a positive evaluation of fellow group members (Wilder, 1986). Wit and Wilke (1988) found that stressing the common group identity led to more cooperative behaviour, while there was no compensation in terms of individual benefits. In the context of organizational behaviour, this is an interesting outcome because employees are asked to change their behaviour to benefit the company.

Another consequence of comparative feedback could be that the information about the outcomes of other groups leads to competitive feelings and a striving for better performance. Such normative information can be given in several ways. For example Shalley *et al.* (1987) and Jackson and Zedeck (1982) allowed subjects to believe, among other things, that their performance would be compared with the performance of other subjects; the expectation that their performance would be compared was a sufficient condition to improve task performance. Additional empirical evidence was found by Mitchell *et al.* (1985) who demonstrated that presenting information about the performance of others on a wall chart resulted in better task performance. Comparative feedback appears to promote competitive feelings, increased attention to feedback information, and a striving to perform better than the other group. In the present study, this competitive orientation was expected to motivate employees to try to reduce the number of energy-wasting actions within their own group. Both elements of comparative feedback, emphasizing the common identity through comparative feedback and the competitive context, were expected to result in more energy-saving behaviour in the comparative feedback condition than in the condition in which only a standard behavioural change programme was provided.

However, there was a complicating factor in this field study: the direction of the comparative feedback could not be controlled beforehand. Generally, when subjects in a group perform better than the subjects in another (comparison) group, they may remain motivated to devote themselves to the group goal; in which case, subjects can derive a positive self-image from the feedback. If group members perform worse than subjects in a comparison group, they will try to improve their group performance in order to maintain a positive identity. However, in the case of a continuing bad performance, comparative feedback can also have negative effects. Under competitive conditions, people tend to avoid comparisons with others who perform better (Dakin & Arrowood, 1981; Van Knippenberg *et al.* 1981). When their own performance is worse than the performance of the comparison group for a long period of time, while members of the group are doing their utmost, they are confronted with unwanted information. The opportunity to attain a positive self-evaluation is lacking under those circumstances, which may result in demoralization and decreased performance. Thus, because of the indistinctness of the direction of the comparative feedback in the present study, it is not evident in advance what effect comparative feedback will have on group performance. In the case of chronically worse performance within the comparative feedback condition, dividing the employees in a better performance group and a worse performance group would be necessary to differentiate between the effects of prevailing upward comparison and the effects of prevailing downward comparison.

Behavioural change programme

In an attempt to change the driving behaviour of employees of a large transport organization, Siero *et al.* (1989) found that a programme containing educational information, task goal assignment, feedback, and supervision and control could significantly change employees' driving cognitions and behaviour in a positive, energy-saving direction. These four strategies will be explained below.

As the first step in the behavioural change process, an organization has to tell its employees that it wants different behaviour and why. By means of an educational campaign, the company can try to expand knowledge, to change incorrect beliefs and attitudes, and to motivate employees to behave in an energy-saving way (*cf.* Fishbein & Ajzen, 1975; McGuire, 1985). However, providing information is necessary but seldom sufficient for behavioural change to occur. Especially in the case of work-related behaviour, tasks and activities often have a

routine-like character and become habits which might impede behavioural change. In order to change this type of behaviour, at least a combination of goal-setting and regular feedback about goal achievement is necessary.

Second, when it comes to changing behaviour in an organizational context, one generally has to refer to collective rather than individual interests. By assigning a common performance goal, an organization can motivate individuals to work for the general organizational interest. A number of studies have shown that the higher the performance goal and the more precise this goal has been formulated, the better the performance will be (Locke *et al*. 1981; Locke & Latham, 1990; Smith *et al*. 1990; Siero & van Oudenhoven, 1995). A difficult goal supposedly challenges people to do their utmost, and precise goals give information about the direction people have to give to their efforts. For goals to be effective, a person has to accept the goals and consider the goals feasible.

In addition, goal-setting should be accompanied by feedback. Applied to the topic of the present research, employees can utilize concrete feedback about energy-saving results for 'temporal comparisons' (Wood, 1989): how well do I perform in comparison with earlier results, and how well do I perform in comparison with the task goal?

Finally, when members of an organization once show the desired energy conservation behaviour, this behaviour has to be retained and will eventually become more or less a habit. Initially, the organization will actively have to supervise and control the behaviour of its members until the behaviour is retained without the need for continued control.

Thus far we have discussed a set of four strategies a company can use for the promotion of energy-saving behaviour among its employees. We have defined this whole set of interventions as a behavioural change programme because the interventions cannot be seen in isolation. For example, task goal assignment will not be very effective without feedback. Moreover, a certain amount of supervision and control will always be needed.

In the present research, one unit of the company received all the elements of this behavioural change programme. This 'basic programme group' only received feedback about the performance of their own group. In the comparative feedback condition, employees also received information about the energy-saving performance of the other group. Our main hypothesis was that the addition of the comparative feedback to the four elements of the basic package would result in an extra reduction of energy-wasting behaviour, which is attended by an enhancement of competitive feelings and identification with their own group. By measuring attitudes, social norms and reported behaviour, it is possible to check the cognitive effects from the addition of comparative feedback to the basic programme. However, with the exception of reported behaviour, specific cognitive effects were not expected. It is obvious that the expected behavioural effects of comparative feedback should also be visible in reported energy-saving behaviour.

Method

Participants

The participants were employees of two units of a metallurgical company. The two units were located in different parts of the Netherlands (distance: 200 miles). Both units had a high degree of freedom of action and were principally self-supporting, which was formalized in an incorporated partnership. Furthermore, each unit had its own personnel department, technical department, and production department. Both units consisted of four hierarchical sections. The daily management was conducted by a unit manager. Middle managers, who were under the jurisdiction of the unit manager, were responsible for a part of the total production. The next hierarchical section consisted of first-line managers who gave guidance to one production department. The organizational structure and the educational background of the managers was identical within both units. In general, production employees had a low educational level. At the time the study was conducted, many employees had been employed in the same job for more than 20 years.

Design and procedure

A preliminary analysis showed that both units were highly comparable with respect to production processes, communication channels and structure, as well as personnel characteristics and organizational strategy. This comparability of units enabled us to apply a quasi-experimental design. The basic programme ('the campaign'), consisting of educational information, goal-setting and feedback, and supervision and control, was given to both units. In addition to this, the second unit received comparative feedback. Unit members were not told that there was a difference in intervention.

Besides the similarities between the two units, they differed in sample size; n=135 for the basic programme condition and n=50 for the comparative feedback condition. The potential confounding of this difference with the intended difference in feedback is dealt with in the 'Results' and 'Discussion' sections.

Because the company only utilized a rough measure of energy consumption, we recorded energy-wasting behaviour instead of actual energy consumption. The presence or absence of energy-wasting behaviour around a large number of objects (such as drilling, rolling and bending of steel, workstation lights, assembling) was measured during 10 weeks (September–November). Shortly before the campaign began, the employees filled out a questionnaire about their energy-saving behaviours, related attitudes (behavioural beliefs and outcome evaluations), and social norms (normative beliefs and motivation to comply). During the campaign, employees received information about energy savings and each week they were confronted with their energy-saving performance on the basis of observations of their energy-wasting behaviour (feedback).

The campaign lasted 20 weeks (November–March). Immediately after, a second questionnaire was administered to assess possible changes in reported behaviour, behavioural beliefs, and attitude. Questions about evaluations of behavioural consequences were left out because of the extremity and low standard deviation of the pretest responses. Questions about the elements of the basic programme and about comparative feedback were added to gain insight into the quality of the implementation. Observations of energy-wasting behaviour immediately after the end of the campaign (first post-test; April) and a half year later (second post-test: September) provided information about the short-term and long-term behavioural effects of the basic programme and the additional behavioural effects of comparative feedback. Time of measurement of pretest, post-test, and start and end of the campaign was identical for both conditions.

Independent variable

Both units received a basic programme. The addition of comparative feedback to one of the two units defined the independent variable.

Basic programme. General and specific educational information about energy-saving behaviour was given over a period of 12 weeks by means of energy bulletins and announcements in the company's magazine. During these weeks, employees successively received information about the social aspects and economical consequences of energy-saving behaviour, about the consequences of energy-saving behaviour related to workstation lights, heating, and compressed air and machine use. The selection of the consequences was based on pretest data related to perceived advantages and disadvantages of saving energy.

In order to set a feasible performance goal, an accurate estimate of the potential savings was needed. The potential savings were assessed by calculating the percentage of the total number of observations that could be classified as energy-wasting behaviour (see 'Dependent Variables'). To arrive at a compromise between the highest possible percentage of energy-saving behaviour and a feasible amount of savings, the performance goal was set among employees of another unit of the same company.[1] They considered 75 per cent of the total potential savings feasible. Thus, if, for example, the percentage potential savings was 60 per cent, the goal would have been achieved if only 15 per cent of the observations (0·25×60%) could be classified as energy-wasting behaviour.

The feedback consisted of weekly graphic displays of saving results for the whole unit over all behaviours which were updated weekly. Savings were expressed in percentages of the total potential of energy savings. One hundred per cent savings implied that there were no wasteful actions, 75 per cent savings indicated that the goal was realized, and zero per cent savings indicated that the behaviour was as wasteful as during the pretest. The graphic display also presented the task assignment line, from which it was easy to deduce the distance between actual behaviour and goal performance. To make the feedback more specific, they were also given precise digital information about two energy consumption behaviours, namely, turning off workstation lights and compressed air leakages. These data could be read beneath the graphic display. To avoid information overload, no specific feedback was given about shutting off machines, or about the remaining energy consumption behaviours.

At the start of the campaign, a number of agreements were made with the first-line managers to motivate energy-saving behaviour and to supervise and control the employees. They were responsible for the energy consumption behaviour within their department. Unit and middle managers were

responsible for their own units and workstations respectively.

Comparative feedback. To effectuate comparative feedback, the second unit received information about the saving results of both their own unit and two other units, namely, the unit in which the employees received only the basic programme and a third unit of the same company which was not involved in this study (see Note 1).

Because the feedback data were production- and season-independent and related to the saving potential per unit, the second unit was able to compare its own performance with the performance of the other units in a meaningful way. The information about the savings results of the two other units were added weekly to the graphic display, together with the savings results of their own unit.

Implementation variables

Basic programme. In order to check the implementation of the four strategies of the basic programme, employees were asked whether they agreed with a number of statements on a 5-point scale, ranging from (1) 'disagree' to (5) 'agree'. They were asked to what extent they knew about the reasons for the energy savings campaign (knowledge; one item), they talked with their colleagues about the saving results displayed on the charts (communication; one item), and they understood how to realize energy savings (insight; three items, Cronbach's α=0·87). In addition, they were asked to what extent there was contingency between their effort and the feedback about their energy savings (for example, 'Multi Moment Recording was a good measure of my contribution to energy saving'; four items, Cronbach's α=0·81), their acquaintance with (one item) and their perception of the attainability of the task goal (one item), and the level of supervision and control they experienced (with respect to energy saving in general and with respect to shutting off machines, turning off workstation lights, and reporting compressed air leakages; four items, Cronbach's α= 0·87).

Comparative feedback. The success of the comparative feedback manipulation was checked by the following questions (1 = disagree, 5 = agree): 'I am curious to know about the saving results of the other units' (curiosity), 'I was aware of the saving results of the other units' (feedback-awareness), and 'I think that my unit should save more energy than the other units' (competition).

Dependent variables

Energy-wasting behaviour. Energy-wasting behaviour was measured with a Multi Moment Recording (MMR) technique. Around the selected objects, the observations related to shutting off machines, turning off workstation lights, reporting compressed air leakages,[2] and a remaining set of energy consumption behaviours, such as disconnecting electrical equipment, turning off the general lights and preventing heat loss by closing doors and windows. Within the unit that only received the basic programme, 79 objects were observed: 35 objects for shutting off machines, 33 objects for turning off station lights, and 11 objects for the remaining set of energy-wasting behaviours. In the comparative feedback unit, 69 objects were observed: 23 objects for shutting off machines, 34 objects for turning off station lights, and 12 objects for the remaining set of energy-wasting behaviours.

Using the MMR technique, an observer registered, for each object on randomly chosen days and at randomly chosen moments, the presence or absence of an employee and the energy consumption (machines on or off, workstation lighting on or off, etc). By dividing the frequency of observed energy-wasting behaviour ('absent and on') by all observed behaviours ('absent and on' plus 'absent and off'), the percentage of energy-wasting behaviour could be assessed. The observations were made by the company itself.

Given sufficient observations and a random choice of days and moments, the MMR technique guarantees accurate estimates of the percentages of energy-wasting behaviour. In order to assess the reliability, we calculated the agreement between the observations of two independent observers during one day. The agreement between them was remarkably high: 96·3 per cent of the 1016 observations were identical.

Preceding the interventions, a baseline of energy-wasting behaviour was recorded in both units under study during a 10-week time period. All selected objects were observed at 10 random moments on 2 arbitrary days per week. During the intervention period (20 weeks) and post-tests, the same observations were made, but at that time on only 1 day a week. The first post-test lasted 4 weeks and took place immediately after the last intervention. A half year after the last intervention, the second post-test was conducted lasting 5 weeks.

Reported behaviour. Reported behaviour was assessed by three questions (1=never, 5=very often):

'Do you pay attention to energy savings within your company?', 'Do you immediately report a compressed air leakage to your supervisor, as soon as you detect it?', 'Do you turn off the workstation lights as soon as possible?', and 'Do you shut off machines as soon as possible?' These variables were also combined in one index for reported behaviour with a Cronbach's α of 0·69, reflecting a reasonable internal consistency (*cf*. Nunnally, 1978, p. 245).

Identification. Their identification with the colleagues and with their own unit was measured with the following statement: 'If I had the opportunity to choose, I would again cooperate with the same colleagues' (1=disagree, 5=agree).

Attitude. Attitude towards saving energy was measured by asking for the evaluations about shutting off machines, about turning off workstation lights, and about reporting compressed air leakages (three items: Cronbach's α=0·79). Behavioural beliefs (Ajzen & Fishbein, 1980) were measured by employees' perceived probability of consequences of energy-related (saving or energy wasting) activities (–2=very unlikely, 2=very likely). Four consequences were used for each of the three behaviours. Three consequences were identical for the three behaviours, namely 'yields energy savings', 'leads to a reduction in the waste of materials', and 'leads to appreciation of the supervisor'. For shutting off machines, the consequence 'leads to extra wear in switches' was added. For turning off workstation lights and for reporting compressed air leakages, the consequence 'yields less costs for the company' was added. To assess outcome evaluations (only pretest; see 'Design and Procedure'), employees were asked to evaluate the consequences on a 5-point scale ranging from (–2) 'very bad' to (+2) 'very good'.

Social norms. The social norm was measured for turning off workstation lights and for reporting compressed air leakages. The social norm was calculated by summing the products of normative beliefs and motivation to comply (Ajzen & Fishbein, 1980). Normative beliefs were assessed by asking employees, for each of the two behaviours, how positive two referents, namely, their supervisor and their colleagues, would evaluate their energy-saving behaviour (1=absolutely negative, 5=absolutely positive). Motivation to comply was measured by asking for each behaviour on a 5-point scale, to what extent employees cared about the opinion of the supervisor and of colleagues (1=not at all, 5= very strongly).

Results

Implementation checks

Basic programme. This manipulation was relatively straightforward. On the whole, the responses to the specific statements about the four elements of the programme indicated that the implementation was successful (mean scores above 3·0 points to agreement). Concerning the educational information, employees reported knowing about the reasons for the energy savings campaign (M=4·1), and understanding how to realize energy saving (M=3·8). In addition, they perceived the contingency between their effort and the feedback they received about their energy-saving behaviour (M=3·3). Employees knew about the task goal (M=3·8) and perceived the goal as attainable (M=3·6). They experienced a relatively moderate level of supervision and control (M=2·5), and they reported that they did not communicate intensively with their colleagues about the saving results on the charts (M= 3·0).

With the exception of the elements of performance goal and of supervision and control, the implementation of the basic programme was the same in the two experimental conditions. Acquaintance with and perceived attainability of the performance goal was higher in the comparative feedback condition than in the basic programme condition: for 'acquaintance' (M=4·3 vs M=3·4 (F(1, 69)=12·6, p<0·001)) and for 'perceived attainability' (M=4·0 vs M=3·2 (F(1, 69)=14·5, p<0·001)). In view of the possibility that extra attention was paid to the performance goal in the context of the comparative feedback manipulation, these differences are not surprising. Moreover, employees in the comparative feedback condition experienced less supervision and control than employees in the basic programme condition: (M=2·1 vs M=3·0; F(1, 78)=16·5, p<0·001).

Comparative feedback. Employees in the comparative feedback condition were more curious to know about (M=3·9) and better aware of the savings results of the other unit (M=3·6) than employees in the basic programme condition, (M=3·3 and M=2·3, respectively); for 'curiosity' (F(1, 71)=6·5, p<0·05) and for 'awareness' (F(1, 71)=24·0, p<0·001). In addition, the comparative feedback group (M=4·4) indicated they were more competitive than the basic programme group (M=3·8, F(1, 71)=6·0, p<0·05).

There was no indication for any nonequivalence between the two conditions at the start of the cam-

paign. The two conditions (the units) did not differ on the mean pretest scores on any of the cognitive variables (attitudes, social norms, and reported behavior).

Effects of comparative feedback

Cognitive effects. A comparison of the mean scores on behavioural beliefs, on attitude, and social norms about shutting off machines and switching off lightings between the two conditions before and after the campaign revealed only an effect of the intervention on the behavioural beliefs that these habits resulted in energy savings. As can be seen in Table 1, after the intervention, the mean scores within the comparative feedback condition differed from the means within the basic programme condition. After the campaign, employees who received comparative feedback (vs the basic programme condition) had a stronger belief that shutting off machines and turning off workstation lights resulted in energy savings. This contrast between the two conditions on the pretest is supported by a significant interaction for the behavioural belief about shutting off machines ($F(1, 168)=3{\cdot}9$, $p<0{\cdot}05$) and for the behavioural belief about turning off workstation lights ($F(1, 168)=3{\cdot}1$, $p<0{\cdot}08$). As predicted, inspection of the simple main effects revealed significant differences between the two experimental conditions after the campaign for both behavioural beliefs: for shutting off machines ($F(1, 168)=6{\cdot}7$, $p<0.01$), and for turning off workstation lights ($F(1, 168)=9{\cdot}5$, $p<0{\cdot}01$).

In addition, the mean scores in Table 1 show differences between the two conditions before and after the campaign on the combined index for reported behaviour: ($F(1, 180)=3{\cdot}7$, $p<0{\cdot}06$). Inspection of this interaction revealed that the employees within the comparative feedback condition, in contrast to the employees within the basic programme condition, differed in their reported behaviour from pretest to post-test (simple main effect: $F(1, 180)=10{\cdot}5$, $p<0{\cdot}001$). As predicted, they reported behaving in a more energy-saving manner after the campaign. Finally, as predicted, employees within the two conditions show a differential change from pretest to post-test in their identification with their own unit. As depicted in Table 1, this interaction ($F(1, 167)=5{\cdot}0$, $p<0.03$), particularly means that the identification with the own unit decreased from pretest to post-test for the employees within the basic programme condition (simple main effect: $F(1, 167)=7{\cdot}4$, $p<0{\cdot}01$).

Behavioural effects. The impact of both the basic programme and the addition of comparative feedback is remarkable with respect to each of the three types of energy-wasting behaviours, namely shutting off machines, switching off workstation lights, and the remaining set of energy-related behaviours. The assessment of energy-wasting behaviour was in contrast to the other measures, object-oriented and not individual-oriented. As mentioned above, it was based on the observation that, for example, workstation lights were unnecessarily turned on (lights on and employee absent); no record was made of who was absent. The percentages of energy-wasting behaviour for each object, observed weekly from the start of the intervention, were, for the sake of the analysis, aggregated into six periods, i.e. four intervention periods of 5 weeks each, the first post-test of 4 weeks, and the second post-test of 5 weeks. The energy-relevant behaviours before the campaign (pretest) and during these six periods are graphically presented in Figures 1 to 3. These figures show the percentage of energy-wasting behaviour with regard to shutting off machines, turning off workstation lights, and remaining energy consumption behaviours before, during, and after the inter-

TABLE 1
Effects of the basic programme and the comparative feedback interventions on identification with own unit, behavioural beliefs, and reported behaviour (mean scores)

Variable	Intervention			
	Basic programme		Comparative feedback	
	Pretest	Post-test	Pretest	Post-test
Identification with own unit	$4{\cdot}2^{a}$	$3{\cdot}6^{bc}$	$3{\cdot}8^{ab}$	$4{\cdot}0^{ab}$
Shutting off machines yields energy saving	$4{\cdot}2^{a}$	$4{\cdot}0^{a}$	$4{\cdot}2^{ab}$	$4{\cdot}6^{bc}$
Turning off light yields energy saving	$4{\cdot}4^{a}$	$4{\cdot}1^{a}$	$4{\cdot}5^{ab}$	$4{\cdot}6^{bc}$
Reported behaviour	$3{\cdot}4^{ab}$	$3{\cdot}5^{ab}$	$3{\cdot}1^{a}$	$3{\cdot}7^{bc}$

Means with the same superscript per row are not significantly different at $p<0{\cdot}05$.

ventions for the basic programme condition and for the comparative feedback condition.

The pretest data for shutting off machines showed that, when possible, employees did regularly shut off machines before the interventions. The percentage of energy-wasting behaviour was relative low: 16·1 per cent in the basic programme condition and 8·7 per cent in the comparative feedback condition. We expected that the addition of comparative feedback to the basic programme would lead to an extra reduction of energy-wasting behaviour. Indeed, in spite of the lower level of wasting energy before the start of the campaign, the comparative feedback unit showed a stronger decline in the percentage of energy-wasting behaviour than the basic programme unit. A multivariate analysis of variance on repeated measures with type of intervention as the independent variable and four times measures as dependent variables (pretest, mean score on the four intervention measures, and first and second post-test) revealed that intervention type had a highly significant multivariate effect on the percentage of energy-wasting behaviour related to shutting off machines from the pretest to the second post-test ($F(3, 54)=3{\cdot}54$, $p<0{\cdot}05$). Inspection of the univariate tests for the linear, quadratic, and cubic trend variables showed a significant effect for the linear trend ($F(1, 56)=6{\cdot}78$, $p<0{\cdot}05$). The mean percentages of energy-wasting behaviour related to shutting off machines for the two conditions are depicted in Table 2 and in Figure 1. Employees in the comparative feedback condition reduced their energy-wasting behaviour from pretest ($M=8{\cdot}7$) to the second post-test ($M=1{\cdot}5$) even more than their task goal (i.e. 75% of the percentage of wasteful behaviour during the pretest = 2·2%). The decline in energy-wasting behaviour within the basic programme condition is less dramatic and less permanent; employees even showed a rise in wasteful behaviour from the first to the second post-test. Six months after the campaign,

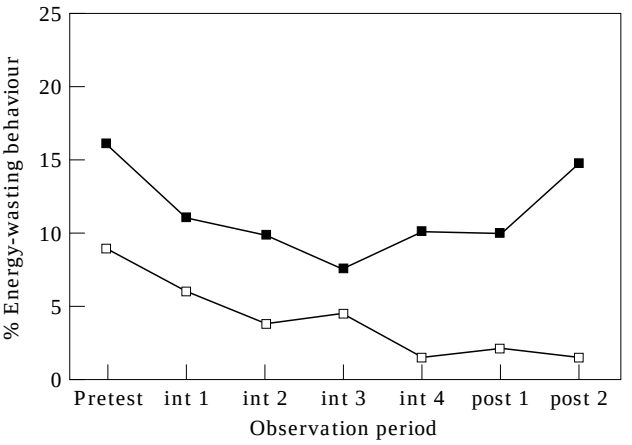

FIGURE 1. Energy-wasting behaviour with regard to shutting off machines before, during, and after the interventions (Int) with the programme (—■—) and with comparative feedback (—□—).

the percentage of energy-wasting behaviour in this condition turned out to approach the percentage of wasteful behaviour before the start of the campaign.

At the start of the campaign, the employees in both conditions showed a high level of energy-wasting behaviour related to turning off workstation lights: 68·9 per cent in the basic programme condition and 74·1 per cent in the comparative feedback condition. The multivariate test on the differences between the four time-measures (pretest, mean score on the four intervention measures, and first and second post-test) showed a dramatic difference in the decline of wasteful behaviour between the basic programme condition and the comparative feedback condition ($F(3, 63)=12{\cdot}55$, $p<0{\cdot}0001$). Inspection of the univariate test results indicated that these differences must be ascribed to a linear trend effect ($F(1, 65)=38{\cdot}5$, $p<0{\cdot}0001$). The mean percentages in Table 3 and Figure 2 show that employees in the comparative feedback condition were able to reduce their energy-wasting behaviour

TABLE 2

Percentage energy-wasting behaviour related to shutting off machines before, during, and after the interventions (Int) with the basic programme without (n=*35) and with comparative feedback* (n=*23)*

Intervention	Observation period						
	Pretest	Int1	Int2	Int3	Int4	Post1	Post2
Basic programme	16·1	11·0	9·9	7·5	10·1	9·9	14·7
Basic programme + comparative feedback	8·7	6·1	3·9	4·6	1·5	2·2	1·5

The task goal for the basic programme condition was a reduction to 4·0 per cent and for the comparative feedback condition, a reduction to 2·2 per cent energy-wasting behaviour.

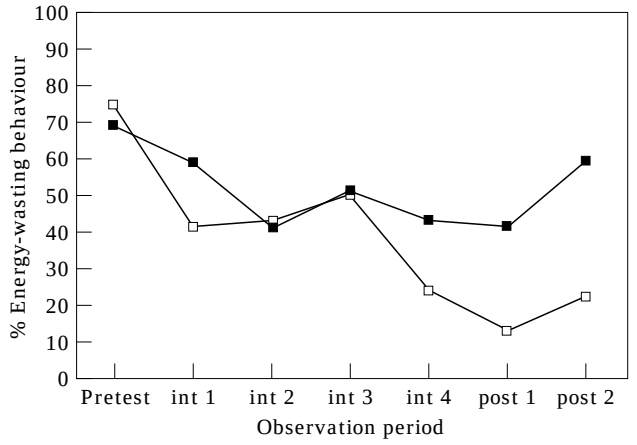

FIGURE 2. Energy-wasting behaviour with regard to switching off lights before, during and after the interventions (Int) with the programme (—■—) and with comparative feedback (—□—).

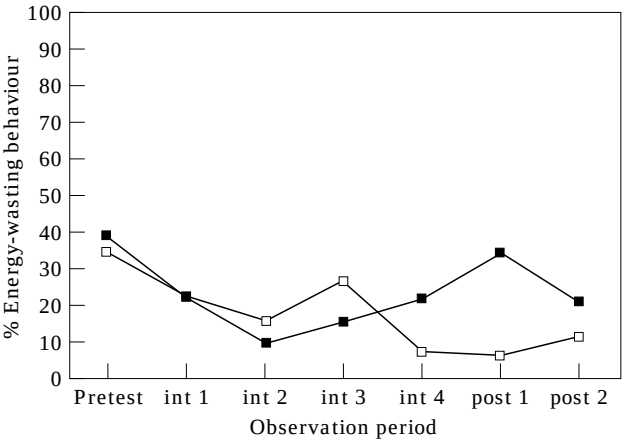

FIGURE 3. Energy-wasting behaviour with regard to remaining energy consumption behaviours before, during, and after the interventions (Int) with the programme (—■—) and with comparative feedback (—□—).

from 74·1 per cent (pretest) to 22·6 per cent (second post-test). In contrast, the energy savings of employees who received the basic programme fell back to the level of the pretest after a temporal reduction of energy-wasting behaviour.

Starting with a moderate level of energy-wasting behaviour in both conditions (in the basic programme condition 38·4% and in the comparative feedback condition 34·1%, see Table 4), the comparative feedback also encouraged the employees to reduce their energy-wasting activities within the remaining category of energy-related behaviour (to 11·9%). Employees in the basic programme condition reduced their energy-wasting behaviour to a lesser degree (from 34·4 to 20·9%) after a temporal regression, immediately after the end of the cam-

TABLE 3
*Percentage energy-wasting behaviour related to turning off workstation lights before, during, and after the interventions (Int) with the basic programme without (*n=*33) and with comparative feedback (*n=*34)*

Intervention	Observation period						
	Pretest	Int1	Int2	Int3	Int4	Post1	Post2
Basic programme	68·9	58·2	40·8	50·2	42·7	41·6	59·5
Basic programme +comparative feedback	74·1	40·7	42·6	49·6	24·4	13·3	22·6

The task goal for the basic programme condition was a reduction to 17·2 per cent and for the comparative feedback, condition a reduction to 18·2 per cent energy-wasting behaviour.

TABLE 4
*Percentage energy-wasting behaviour related to remaining energy consumption behaviours before, during, and after the interventions (Int) with the basic programme without (*n=*11) and with comparative feedback (*n=*12)*

Intervention	Observation period						
	Pretest	Int1	Int2	Int3	Int4	Post1	Post2
Basic programme	38·4	22·4	9·8	15·3	22·8	34·6	20·9
Basic programme + comparative feedback	34·1	21·5	16·3	26·7	7·4	6·9	11·9

The task goal for the basic programme condition was a reduction to 9·6 per cent and for the comparative feedback condition, a reduction to 8·5 per cent energy-wasting behaviour.

paign. The differences between the two conditions on the four time measures were multivariate significant ($F(3, 19)=3{\cdot}27$, $p<0{\cdot}05$). Owing to the capricious pattern of energy-wasting behaviour within the basic programme condition (see Figure 3), the multivariate effect has to be ascribed to a cubic trend effect ($F(1, 21)=8{\cdot}94$, $p<0{\cdot}01$).

Discussion

In the present study, we examined how energy consumption behaviour could be reduced through comparative feedback in an industrial organization. In one unit of a metallurgical plant, employees received a basic programme intervention consisting of information about energy conservation, goal-setting, and feedback on their own conservation behaviour. In addition to this basic programme, employees in another unit received comparative feedback about the performance of two other units. The most important finding of the present study was that comparative feedback had a much larger impact on energy-wasting behaviour than the basic behavioural change programme. The results clearly showed that employees in the comparative feedback condition saved more energy than employees who only got information about their own performance. The effectiveness of comparative feedback is striking considering the fact that the basic behavioural change programme by itself resulted in significant energy savings. Even after 6 months, the overall reduction in energy-wasting behaviours within the unit which only received the basic programme was still nine per cent compared to the situation before the intervention.

At this point, an important question is whether the remarkable reduction of energy-wasting behaviours can be uniquely ascribed to the comparative feedback information. Although there were no indications for any difference between the two conditions on the main dependent variables before the start of the campaign, possible alternative explanations for the behavioural effects of comparative feedback could result from the fact that the number of employees in the unit which received comparative feedback was considerably smaller than the number of employees in the unit that received the basic programme. This difference may have had an effect on other variables. For instance, it is possible that employees who work in a relatively small unit talk more with each other (about energy matters) than employees who work in a large unit. In addition, a small unit allows more supervision and control of energy-related behaviour, and small-unit employees may experience a stronger sense of commitment. As a consequence, it might have been easier to address the smaller unit as a group than the larger unit. However, these explanations do not seem to be very plausible because the results showed that the degree of communication about energy savings and sense of commitment did not differ between the two units. Moreover, the finding that employees in the comparative feedback condition did perceive less external control from the management than employees in the basic programme condition shows that unit size-related variables are not responsible for our findings. It is also not very likely that employees in the comparative feedback condition were more motivated to save energy at the start of the intervention than the basic programme employees, because initial attitudes were the same for both units. Finally, the initial differences in energy-saving behaviour between the two units were small and, in view of the lower level of energy waste in the comparative feedback unit, inhibited rather than facilitated energy savings.

Thus, the larger amount of energy savings of the comparative feedback unit can be ascribed to the motivational effect of comparative feedback. That the comparative feedback manipulation was straightforward and the comparative information encouraged employees to save energy is evident: compared to the employees from the basic programme condition, employees who received comparative information were more curious to know how the other unit performed, and they indicated that they were well-informed about it. They were also more competitive.

Thus, comparison information creates a competitive orientation that encourages employees to perform almost always better than employees who receive only a basic package of measures, consisting of educational information, intragroup feedback, and goal-setting. They saved more energy with respect to all energy-related behaviours. However, it does not seem very likely that the large effect of comparative feedback was only caused by the rewarding aspect of winning a competition. In that case, one would have expected the effect to disappear as soon as the reward was omitted. A striking finding of the present study is that employees in the comparative feedback condition were capable of continuing with the realized savings, even in the absence of feedback. It seems likely that the introduction of comparative feedback also resulted in a stronger identification with their own group. Following this reasoning, people will contribute extra

efforts to distinguish their own group from the other group and will be intrinsically motivated to be economical with energy. Simultaneously, this results in a greater effort to contribute to the collective organizational interest. Because people perform the desired behaviour relatively often, they learn to behave that way and this results in new habits. This reasoning can explain why there was still a considerable reduction in energy-wasting behaviour 6 months after the intervention.

The explanation that comparative feedback employees were intrinsically motivated to be energy thrifty is supported by the finding that these employees also realized savings on other behaviours, about which no feedback was given (i.e. shutting off machines and the remaining energy consumption behaviours). Obviously, there seems to be a transfer to other related behaviours. The goal in the feedback condition was also considered more feasible than the goal in the basic programme condition. Employees felt competent to achieve the goal performance, indicating a large extent of internal control.

As indicated in the introduction, it was not clear before the comparative feedback intervention that information about the performance of others would have a positive effect. Comparative feedback could also have resulted in demotivation if the own performance had continuously been worse than the performance of the comparison group. The present results do not provide any insight into the possible negative effect of comparative feedback as the employees in the comparative feedback group were not confronted with the situation that they performed worse than other groups during a longer period, despite extra efforts. Therefore, the results of this study do not imply that comparative feedback cannot lead to demoralization among employees.

It is remarkable that behavioural change took place with hardly any changes in attitudes. From an 'attitude-to-behaviour' perspective, we hypothesized that behavioural change would only occur after a change in attitudes and intentions (*cf.* Fishbein & Ajzen, 1975; McGuire, 1985; Ajzen, 1991). Nevertheless, the present study shows that there were large effects on behaviour, especially in the comparative feedback condition, but hardly any effects on cognition. Changes in attitudes do not seem to be a prerequisite for behavioural change when one chooses instruments that aim at modification of behaviour, such as feedback and comparative information about the performance of others. However, it should be noted that, preceding the interventions, employees' energy-related cognitions were already quite positive.

Comparative feedback turns out to be a powerful strategy for changing the behaviour of employees within organizations. The combination of concrete feedback about their own performance and about the performance of other groups of employees results in a competitive orientation, and more effort from the employees, and leads to more energy savings which, even 6 months after the termination of the intervention, are considerably higher than before the start of the intervention. The additional impact of comparative feedback is remarkable in view also of the considerable energy savings from the basic programme. In line with earlier research (Siero *et al.*, 1989), the elements of the basic programme (educational information, goal-setting and feedback, and supervision and control) contributed to a significant reduction of energy-wasting behaviour, even 6 months after the end of the campaign.

We think that the instruments which were discussed and studied in this research are in principle suitable for changing organizational behaviours other than energy consumption. A basic condition is that the behaviour that has to be changed is accurately specified and measured in such a way that employees perceive the feedback as reliable and contingent on their own behaviour. Only by specifying the behaviour in measurable, identifiable entities will it be possible to change behaviour effectively. The interventions that have been described here, particularly comparative feedback, are effective instruments to motivate employees to change their behaviours, for example, with regard to safety, quality of work, and efficiency.

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Notes

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(1) The present research was part of a larger study in which this third unit was involved in a so-called participation condition. For the sake of brevity and because the participation intervention was totally different from the

interventions in the present study, the results from this third intervention are not considered here.
(2) For technical reasons, reporting compressed air leakages is left out of consideration here.

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