AN INVESTIGATION INTO MENTAL EFFICIENCY

IN AN INDIAN AFTERNOON SCHOOL

a study in educational psychology

AN INVESTIGATION INTO MENTAL EFFICIENCY IN AN INDIAN AFTERNOON SCHOOL

by

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P R E F A C E

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C O N T E N T S

TABLES

AN INVESTIGATION INTO MENTAL EFFICIENCY IN AN INDIAN AFTERNOON SCHOOL

(A) INTRODUCTION:

This section describes an investigation into a problem that was brought to the fore by the establishment of afternoon schools for Indian children in Natal in recent times. In many centres one school building caters for two groups of children under two different sets of teachers, one group receiving its schooling generally from 7.30 a.m. to 1 p.m. and the other group generally from 1 p.m. to 5 p.m. This "platoon" system came into being in order to meet the tremendous demand for school accommodation by Indian children without the necessity of having to erect new school buildings (Cooppan, 1955). While these schools did alleviate the problem of insufficient school buildings to an appreciable extent, their establishment gave rise to other problems (Gangaa, 1940; Natal Indian Teachers' Society, 1954; Bechoo and Lalla, 1955; Natal Indian Teachers' Society, 1956).

One of these concerned the question of whether afternoon schooling was as effective as schooling during the morning from the point of view of the intellectual efficiency of the children taught. The commonsense view would be that after a night's rest children in morning schools would respond to tuition much more favourably than children in afternoon schools, who came to school at midday or thereabouts after having dissipated their morning freshness in activities of various kinds in and around the home.

Even in "normal" schools, afternoon sessions have not been popular with many educationalists. Rusk (1919) says: "The majority of writers ..... maintain that there is a considerable increase in fatigue in the afternoon, and that the afternoon session is physically harmful and educationally valueless". He goes on to suggest that for schools under Government control in Britain, afternoon sessions for infants should be abandoned; for junior

pupils, afternoon sessions should be shortened; and that Wednesdays and Thursdays should be declared half-holidays with a Saturday morning session substituted.

The problem of mental efficiency in the afternoon is thus an important one. For if it is true that teaching in the afternoon is wasteful and ineffective as compared to teaching in the morning for no other reason than that children are lethargic in the afternoon, it would constitute a serious argument not only against the practice of giving pupils intellectual work in the afternoons in "normal" schools, but more particularly against the present policy of creating and maintaining purely afternoon schools for Indian children on part of the Natal Education Department.

The investigation to be described was an experimental attempt to ascertain whether the morning hours were conducive to more efficient intellectual work on the part of children than the afternoon hours. The study had, therefore, a very strong practical implication for educational policy.

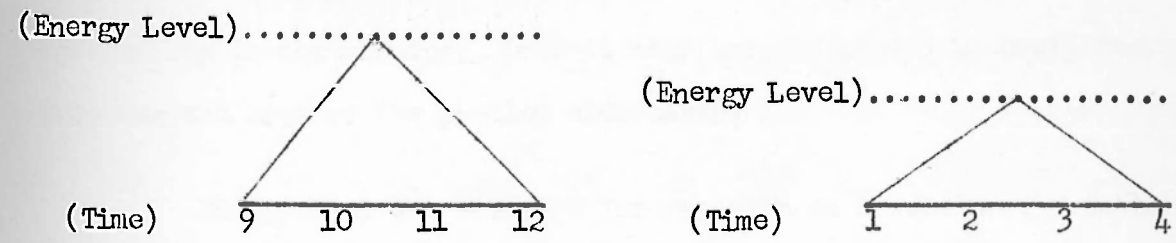
(B) ACKNOWLEDGMENTS:

The researcher is indebted to those teachers who responded to a questionnaire asking for their opinions on the problems of teaching in afternoon schools; to Mr. D.P. Nundoo, Principal of the St. Aidan's Boys' Platoon School, for allowing his pupils to be used for the experiment; to Mr. B.B. Maharajh, the then Acting-Principal of the school, for his active participation in the experiment each day; to Mr. K.R. Nair, Principal of the St. Aidan's Government-Aided Indian Boys' (Morning) School, for invaluable assistance in organisational matters; to Dr. G.D. Logue, for making his Non-Verbal Intelligence Test available to the experimenter; and, finally, to the Principals of the Durban South, Clairwood Boys', South Coast Madressa, and H.S. Done Schools, for assistance in the marking of several hundred test scripts.

(C) THE PROBLEM:

In the past, a good deal of attention has been given by educationalists to the daily sequence of subjects on the class time-table. Text-book writers on methods of teaching and principles of education have often urged that subjects believed to require the greatest amount of mental effort should be taken during the morning when children are fresh and those believed to require lesser intellectual effort should be taken towards the end of the school day when pupils are jaded through the work of the morning (Rusk, 1919; Raymont, 1941; Sturt and Oakden, 1948; "The Method Teachers", 1951). Thus it has been the general procedure in primary schools to have the "harder" subjects such as arithmetic, reading, and grammar in the morning and the "easier" subjects such as art, poetry, and handwork in the afternoon.

This view is also endorsed by McRae (1934). He quotes Averill as saying that there are diurnal variations in the mental efficiency of children, illustrated (by Averill) as follows:-



"Diagram showing the probable rise and fall of available energy during a school day"

The diagram is explained by Averill thus: "The morning hours are probably somewhat better than the afternoon hours, more energy being available in the former than in the latter period. It appears also to be the case that the capacity to work rises to its highest point around the middle of the session, i.e., about ten-thirty in the morning, and again about three in the afternoon. It is probably lowest at the beginning of the session (i.e. at nine and at two o'clock). As compared with the high point in the

forenoon session there is reason to believe that the high point of the afternoon session is apparently lower. Energy for work, in other words, follows a parallel course in both sessions (starting low and increasing up to the middle point), but is on a distinctly lower plane in the afternoon".

"The corollaries connected with time-table formation are obvious. A warming-up period is necessary at the beginning of each session; the most difficult subjects, for example, mathematics and grammar, should appear when energy is most abundant; and towards the end of each session, less strenuous activities should occupy the child".

Nearly all writers who take this view have in mind the "normal" school that begins in the morning and closes in the afternoon. The setting up of afternoon schools has created a novel situation and caused a great deal of uncertainty in respect of the traditional ideas as to which subjects should be taught when. What is happening now when some schools begin after midday and close in the early evening? Children in such schools work at their sums at 1 o'clock or thereabouts in the afternoon after spending the morning hours engaged in work and play at home instead of at 8 o'clock or thereabouts in the morning. Does it make any difference in pupil response? This was the crux of the problem undertaken.

The problem was selected for research as a result of a preliminary study of opinions among teachers who had had experience of teaching in afternoon schools. Questionnaires[1)] were sent out to a number of teachers, mainly in Durban and Districts, having such experience. They were asked if they had encountered any special difficulties in the teaching of children in afternoon schools, which did not apply to the teaching of pupils in "normal" schools, and if so, to name not more than three of the most serious of them.

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1) See Appendix I.

One hundred and ninety-five teachers, including many principals of long experience, responded. Of those, 138 had had experience of teaching in both morning and afternoon schools, 55 had taught only in afternoon schools while 2 did not state the nature of their experience. 173 of the 195 teachers (83.7%) maintained that teaching in afternoon schools was characterised by special drawbacks which did not apply to teaching in morning schools, while 22 (11.3%) mentioned that they encountered no particular handicap. Table I (page 6) indicates the nature of the difficulties mentioned and their frequencies.

It will be seen that the most frequently mentioned difficulty was that children come to the afternoon school tired out through the activities of the morning and, therefore, did not respond to tuition as well as children in morning schools, who came to school fresh and alert. Gangaa (1940) and Bechoo and Lalla (1955) make the same point in their memoranda presented to the Natal Education Department. The following excerpts from three questionnaires give a fair description of the views held in respect of this particular difficulty:-

One teacher wrote: "The children are tired physically, and as a result are unable to concentrate on their school work. It takes a long time to tone them to do work. The morning children are physically fit and not tired.

"Many children go to vernacular classes in the morning and when these children come to the English school in the afternoon, they are mentally tired.

"After a heavy lunch the children become sluggish and lazy. They are indifferent to work. Their energy, it seems, has been sapped".

Another teacher wrote: "The school begins at about midday - the beginning of the drowsy period of the day. Children are far from fresh

TABLE I

NATURE AND FREQUENCY OF DIFFICULTIES OF TEACHING IN AFTERNOON SCHOOLS MENTIONED BY 173 ASSISTANT TEACHERS, VICE-PRINCIPALS, AND PRINCIPALS.

Nature of Difficulty	Number of Teachers mentioning Difficulty	Percentage
1. Children come to school tired out mentally and physically.	150	86.7
2. Restricted hours of afternoon school not enough for completion of syllabuses.	85	49.1
3. Heavy traffic during late afternoon a hazard to children returning home.	29	16.8
4. Parents of afternoon school children suffer additional financial obligations compared to parents of morning school children.	25	14.5
5. Inadequate salaries of most afternoon school teachers, unsatisfactory conditions of work, and related difficulties.	23	13.3
6. Children inattentive because of interruption of their morning play, having to watch morning school at games, thoughts of home in the late afternoon, anxiety.	22	12.7
7. Children return home when darkness has set in.	21	12.1
8. Wide age range in classes.	17	9.8
9. Afternoon school considered "inferior" by its own pupils, by general public, and by morning school staffs and pupils.	17	9.8
10. Teachers made tired by long hours of work.	15	8.7
11. No time and facilities for pupils to engage in extra-mural activities such as sports.	13	7.5
12. Afternoon school teachers have lower academic and professional qualifications than morning school teachers.	11	6.4
13. Enforced open-air classes, lack of shelter.	9	5.2
14. No physical training for children, or physical training at "wrong" time (after lunch).	9	5.2
15. Miscellaneous: unsuitable furniture; children come in clothes soiled by morning play; children feel hungry by time school closes; principals compelled to take classes instead of being left to supervise teachers; classrooms not swept and aired after closure of morning school; children have no time for homework; discipline poorer - bad habits developed by children during free morning hours; inadequate educational equipment, e.g., lack of school libraries, etc., etc.	41	23.7

and are both physically and mentally tired. This is particularly so during summer. Imagine doing arithmetic between 1 p.m. and 2 p.m. on a typical summer's day"!

A third teacher wrote: "Attention to work is not as good as that shown during the morning session. Much of their energy is wasted during the morning and children are inclined to be restless and sleepy during the afternoon.

"Children do not show much interest in their work. Both the teacher and the pupils feel too tired to give of their best in the afternoon school. From the experience gained in the morning and afternoon schools I can safely say that the standard of work in the morning is much superior to that of the afternoon school".

To supplement the opinions of teachers, it was decided to ascertain the attitudes of afternoon pupils themselves towards the afternoon school. A brief questionnaire was given to the 144 children who were finally used in the study to be described, after the conclusion of the experiment. Table II (page 8) indicates the questions asked and the children's responses to them.

It will be noted that the chief difficulty mentioned by teachers, namely, that of having to teach tired pupils, is underlined by the pupils themselves, nearly half of them believing that they can do better work at school in the morning hours when they are fresh,

In order to gain some idea of the kind of activities in which afternoon school children indulged during the morning, which, it was believed, reduced their intellectual efficiency in the afternoon, the pupils used in this study were asked to list all that they had done during the

TABLE II

TYPE OF SCHOOL PREFERRED BY AFTERNOON SCHOOL CHILDREN

Question: If there were room for you in a morning school and in an afternoon school, which school would you like to attend? Underline ONE of the following: Morning School Afternoon School Not Particular.

Kind of School Chosen	Number of Pupils	Percentage
Morning School	132	91.7
Afternoon School	10	6.9
Not Particular	2	1.4
Totals	144	100.0

REASONS FOR TYPE OF SCHOOL PREFERRED BY AFTERNOON SCHOOL CHILDREN

Question: If you have chosen "Morning School" or "Afternoon School", give a reason (or reasons) why you like that kind of school. If you have underlined "Not Particular", you must not answer this question.

Reasons given by 132 Children for Preferring Morning School	Number of Pupils	Percentage
(a) Fresh in the morning and can do better work.	62	47.0
(b) Will have the afternoon free for play, the cinema, etc.	21	15.9
(c) Will finish school early. (Nothing more specified, but probably (b) was meant).	19	14.4
(d) "Like the morning" or "like morning school". (Nothing further specified).	13	9.8
(e) No fees to pay.	11	8.3
(f) Better education given in the morning school.	11	8.3
(g) Miscellaneous.	22	16.7

Reasons given by 10 Children for Preferring Afternoon School	Number of Pupils	Percentage
(a) Can do "other work" in the morning, e.g.,marketing, or going to the mosque (vernacular classes).	6	60.0
(b) Too cold to wake up in the morning.	1	10.0
(c) "Same things" learned in the afternoon as in the morning school.	1	10.0
(d) "Like the afternoon". (Nothing more specified).	1	10.0
(e) "Have all kinds of tests in the afternoon school". (Obvious reference to the present research which was confined only to the afternoon school!).	1	10.0

morning of the day on which they wrote their preliminary intelligence test. The following activities were listed:-

TABLE III

MORNING ACTIVITIES OF 144 AFTERNOON SCHOOL CHILDREN

Nature of Activity	Number of Pupils mentioning it	Percentage
(a) Going on errands for parents: shopping, marketing, taking little brother to morning school, etc.	132	91.7
(b) Active play: ball, cycling, marbles, cricket, climbing trees, etc.	96	66.7
(c) Domestic chores within the home: washing, sweeping, ironing, baby-sitting, making the fire, polishing floors, chopping wood, fetching water, etc.	82	56.9
(d) School work (homework).	44	30.6
(e) Domestic work outside the home: mowing, watering, weeding, washing car, carpentry, odd repairs, cleaning fish pond, sweeping yard, washing the dog, cutting the hedge, etc.	30	20.8
(f) Attendance at vernacular school.	27	18.8
(g) Sedentary amusement: reading novels, reading newspapers, listening to the wireless, sitting down in tea-rooms and barber shops, watching fights, watching builders at work, chatting, etc.	22	15.3
(h) Activities on behalf of self: going to the library, having a bath, plucking fruit, feeding pets, going to the barber's, going to the tuck shop, etc.	17	11.8
(i) Active assistance to others: pushing cars, polishing cars, pushing wheel-barrows for shopkeepers, helping with deliveries, assisting in shops, etc.	13	9.0
(j) Visiting relatives.	11	7.6
(k) Miscellaneous.	8	5.6

Some of the activities listed above are largely "physical", others largely "mental" in nature. It was believed by the great majority of teachers that both types of activities, indulged in from dawn to midday, reduced the efficiency of children for intellectual work in the afternoon. Many of the children themselves held the same view.

The problem of reduced mental efficiency on the part of afternoon school children appeared, then, to be the most important teaching difficulty from the point of view of teachers and the most important learning difficulty from the point of view of pupils. This was the problem selected for study. Stated in operational terms that would permit experimentation the following hypothesis was formulated: Children come to the afternoon school tired as a result of various activities of a physical and mental sort undertaken during the morning. They do not, therefore, attain the same heights of intellectual efficiency as they would have done if they had come to school in the morning. This was the hypothesis to be tested experimentally.

(D) REVIEW OF PREVIOUS STUDIES:

(a) The Nature of Fatigue:

The expressions "fatigued", "mentally fatigued", "physically fatigued", and "both mentally and physically fatigued" or their synonyms were used freely by teachers to describe the condition of afternoon school children.

The field of fatigue has interested experimentalists from early times. But, as Woodworth and Schlosberg (1955) point out, "fatigue" is an extremely broad term, with half a dozen different meanings. As in the case of "intelligence", "instinct", and "emotion", uncritical acceptance of the term "fatigue" by investigators has caused a great deal of confusion in technical literature on the subject. As far back as 1917, Dodge wrote: "..... few psychological subjects have so widely interested investigators in the allied sciences (as fatigue). Few seem to have at once such far-reaching bearings on psychological theory and the conduct of human affairs. Few present such a bewildering literature, with such an array of apparently mutually contradictory experimental results. None is more confused with an equal pressure for practical working rules". Indeed, many writers have

suggested that the term "fatigue" should be excluded from precise scientific discussion in favour of more specific concepts (Ellis and Shipe, 1903; Muscio, 1921; Watson, 1924; Moore, 1942).

One psychological dictionary (Drever, 1952) defines "fatigue" a follows: "Diminished productivity, efficiency, or ability to carry on wor because of previous expenditure of energy in doing work; on the subjectiv side the complex of sensations and feelings, and the increased difficulty of carrying on, experienced after a prolonged spell of work; must be distinguished from 'boredom', which may be described as a subjective feeling of fatigue, due to monotony or lack of interest, rather than the expenditure of energy. Fatigue may be mental, muscular, sensory, or nervous".

The definition given above is a fair statement of some of the older usages of the term "fatigue". At the same time, it gives some indication of how and why confusion has arisen over the concept. The definiti makes three points, all of which have been questioned in recent times. Firstly, it indicates that the term has been used to denote three different conditions, namely, decrease in work output, neuromuscular inefficiency, and a complex of subjective experiences. Secondly, a distinction is made between different kinds of fatigue. Finally, a particular theory of fatigu is implied in the use of the phrase "expenditure of energy", namely, the mechanical, energistic theory of fatigue. Each of these points will be dealt with in turn below.

Bartley and Chute (1947), after making a systematic examination of previous work in the field, have made a serious attempt to reformulate the concept of fatigue as well as concepts allied to it. They point out that "fatigue" has meant different things to different branches of science. For the psychologist, fatigue was something pertaining to muscle and nerve activity, the classic example being the study of the behaviour of nerve-muscle preparations under electrical stimulation. For the biochemist also,

fatigue pertained to the tissues but here the emphasis was on how much work a muscle may do, how much fuel (glycogen) it required to do it, and what waste products were formed in the process. Fatigue, for the psychologist, pertained sometimes to performance measured in terms of work output while sometimes it was regarded as a subjective matter. For the physician, especially for the psychiatrist, fatigue was usually seen as subjective although its basis was often sought in physiology. And in recent times the term has been applied even to inanimate objects and one encounters terms such as "metal fatigue".

A vast amount of research has been carried out in the various scientific fields under the title "fatigue", but in view of the different interpretations given to the concept a large amount of confusion has resulted. In all these investigations there have been three areas of interest, namely, subjective feelings of tiredness, etc., decrement in performance, and modifications in the physiological state of the organism. All three conditions have usually been loosely labelled as "fatigue", with the subjective phenomena receiving the least attention because they could not be treated in a simple, quantitative fashion, and because of their frequent lack of correspondence with so-called objective manifestations. Sometimes, the adjectives "subjective" (or "psychological"), "objective", and "physiological" have been appended to the term "fatigue" to differentiate the three categories, subjective experience, diminution in work output, and modifications in body physiology (Collins and Drever, 1933; Bills, 1934; Gray, 1952; Osgood, 1953).

The exposition of Bartley and Chute recognises these three conditions as being separable and not necessarily correlated.

Starting from known experience, they limit the term "fatigue" to refer only to "the experiential pattern arising in a conflict situation in which the general alignment of the individual may be described as aversion.

This particular pattern involves feelings of limpness and bodily discomfort which, besides being undesirable in themselves, are frequently taken as tokens of inadequacy for activity. The subjective constituents of this fatigue pattern are not to be taken as epiphenomena, or as symptoms of fatigue, but as fatigue itself".

Fatigue is described by the terms aversion, lassitude, weariness, impotence, and inability. Boredom or ennui may form part of the fatigue picture and are described by the terms dissatisfaction, satiety, disinterest and irksomeness.

The term "impairment" is reserved for physiological change in tissue "which reduces its ability to participate in the larger aspects of organic functioning. Impairment is identifiable only through the methods of physiology and biochemistry. Reduction in the ability of the organism as a whole to perform is no criterion for the presence of impairment". Unlike fatigue, impairment is never directly experienced. Bartley and Chute claim that no clear-cut distinction between fatigue and impairment had ever been made and consistently maintained before.

Performance is designated as "work output" and this "includes all overt activity that is measured either in the laboratory or in industry". In the intact organism, output is no measure of fatigue or impairment. Output may only be so used when such systems as nerve-muscle preparations are being used.

According to Bartley and Chute, therefore, the three factors - fatigue, impairment, and work output are semi-independent variables (Seashore, 1951). Fatigue (feeling of tiredness, etc.) may arise either in conjunction with impairment of the tissues during exercise or it may appear in the absence of any physical activity simply through mental conflict. Similarly, impairment may be present without the experience of fatigue as in the case of a keen athlete during a sporting event. In the same way,

work output may decrease as a result of either fatigue or impairment, or for still other reasons. With adequate motivation, impairment of the tissues may result in neither feelings of fatigue nor reduced work output. Knight and Remmers (1923) have shown, for instance, that intense desire to make a college fraternity has kept men at a high degree of mental efficiency in spite of only one or two hours of sleep for five nights with severe physical exertion each day. They did twice as well on addition tests as other college students taking the test under ordinary classroom conditions with no strong incentive. In other words, there is no one-to-one correlation between fatigue, impairment, and work output.

The concepts of fatigue and impairment developed by Bartley and Chute are most useful in experimentation. Whereas, previously, fatigue, impairment, and work output were hopelessly confused, giving rise to contradictory results in the laboratory, the formulations of Bartley and Chute help to throw light on phenomena not satisfactorily accounted for before. In an experiment by Poffenberger (1928), for instance, decrease in output was studied in four tasks, namely, addition, sentence completion, intelligence tests, and judging of compositions over a 5½-hour period. Subjective reports were taken from the 13 subjects every 20 minutes, ranging from "extremely good" to "extremely tired". The curves show that feeling tone declined continuously from the beginning in all tasks, whereas output remained the same in two, fell in one and actually rose in the other. The results were in line with the findings of Thorndike (1917) that the "curve of satisfyingness" is not identical with the "curve of work".

In another study, reports of feelings were secured from subjects engaged in the addition of six-place numbers on six different scales of "bored-interest", "relaxed-strained", "irritated-pleased", "peppy-fatigued", "sleepy-wide-awake", and "attentive-inattentive" (Bamarck, 1939). The curves for these variables duplicated each other almost exactly, and all took the same downward curve.

In explaining discrepancies between subjective reports and work output, Poffenberger and his group hold that in these cases output is only maintained at the cost of greater effort and expenditure of energy in doing the same amount of work. However, no one has yet demonstrated that increased energy consumption actually occurs (Woodworth and Schlosberg, 1955). From the point of view of Bartley and Chute, on the other hand, that fatigue and work output are semi-independent factors, the divergence of Poffenberger's curves would not constitute a puzzle.

For long fatigue was regarded as being essentially a somatic problem, and evidence of it was sought through physiological and biochemical procedures. In recent times, however, the early assumptions with regard to the physiological concomitants of both "muscular" and "mental" fatigue have given way to uncertainty and doubt. Fryer (1950) summarises the present position thus: "Fatigue was defined early by physiologists as a chemical condition resulting from accumulated waste products or toxins. This theory was based on experiments showing that during work nerve fibres give off carbon dioxide and heat, Nissl substance of nerve cells is absorbed, there is a reduction of glycogen of muscle fibres, and increases of carbon dioxide and lactic acid take place in muscles. The theory, however, was discounted by such other evidence as the selection of lactic acid as fuel, in preference to dextrose, by the heart muscle.

"Comparing the metabolism of the body as a whole during rest and mental work, the Benedicts and Carpenter (1909, 1930) found slight increases in heart and breathing rates, in the elimination of water vapour, carbon dioxide, and heat, and in the absorption of oxygen. Similar metabolic changes have been reported by various investigators. ..... The only undisputed physiological correlate of all work, either physical or mental, is an increase in heart rate. Benedict and Benedict (1930) computed the extra caloric demands of one hour of intensive mental work as being met by one oyster cracker or one-half of a salted peanut! Nothing that has been

measured in blood, urine, sweat, temperature, circulation, or respiration changes significantly between rest and work".

Fryer concludes: "Physiological investigations ..... have contributed little positive knowledge to our understanding of fatigue ..... It would seem that most work could be performed indefinitely as far as any accompanying changes in metabolic processes are concerned. The hope of a physiological index of fatigue has not beeen realised. Such evidences of fatigue as inaccuracies and blockings (Bills, 1931) occurring in skilled processes appear to be due to anxiety and tension, toward which the study of fatigue has now turned. Fatigue is essentially a psychological and an adjustment or morale problem".

This conclusion is strikingly close to the personalistic standpoint of Bartley and Chute with regard to the genesis of fatigue.

(b) Kinds of Fatigue:

In the past, it has been the practice to distinguish between different kinds of fatigue such as "mental fatigue", "muscular fatigue", "sensory fatigue", "nervous fatigue", "combat fatigue", "operational fatigue", "convoy fatigue", etc. The distinction between physical (muscular) fatigue which arises from activities such as sawing wood and psychological (mental) fatigue which arises, say, during cramming for an examination, is the most commonly encountered in psychological and educational literature (e.g., Hughes and Hughes, 1948; McRae, 1934; Fox, 1925).

The basic study of muscular fatigue is the study of the nerve-muscle preparation[1)] under electrical stimulation. Although a good deal of knowledge has accrued from this line of research, not all the processes of

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1) A "nerve-muscle preparation" is a muscle and attached motor nerve dissected out of the hind leg of a frog, and kept moist in saline solution

muscular contraction have yet been clearly understood even in such a simple setting (Woodworth and Schlosberg, 1955).

In the intact organism, the problem becomes far more complex. The nearest approach to the study of the nerve-muscle preparation is the study of the functioning of a single member. Thus, in one form of the ergograph, the middle finger is made to lift a weight repeatedly and the movements are recorded in the form of strokes (ergogram). It has been found that all ergograms start out with strong strokes and end up with weak ones or failure to lift the weight at all. In between, however, there are all sorts of variations that are dependent upon the rate and type of work required by the ergograph, the instructions given, incentives, and the personality of the subjects. No worthwile general laws have resulted from ergographic studies and the method has been more or less discarded in recent years (Woodworth and Schlosberg, 1955).

At the opposite extreme to muscular work is mental work. However, the general view now seems to be that there is no such thing as pure mental work; some muscles are involved in the thinking process (Woodworth and Schlosberg, 1955; Bartley and Chute, 1947). Where the intact organism is concerned, no clear line can be drawn between physical and mental work. Bills (1948) states explicitly: "Earlier attempts to distinguish between physical or muscular work, on the one hand, and mental work, on the other, have been given up because of ample demonstration that no such clear dichotomy exists. For, on the one hand, there is no purely muscular work which is free from the control of the central nervous system with its conscious voluntary component; and, on the other hand, there is no purely mental work carried on in complete independence of motor sets, reinforcing tensions, or small muscle activities".

Since no clear distinction can be made between physical work and mental work, it follows that the concepts of "muscular fatigue" and "mental fatigue" also become invalid. This is the view of most writers to-day

(Pintner, 1931; Collins and Drever, 1933; Griffith, 1935; Trow, 1937; Sandiford, 1941; Bartley and Chute, 1947).

Collins and Drever write: "If, by mental fatigue, we mean the expenditure of energy and accumulation of poisonous substance in the central nervous system, and by muscular fatigue, the expenditure of energy and accumulation of poisonous substances in the muscles, then it seems impossible to have mental fatigue which does not involve muscular fatigue, or muscular fatigue which does not involve mental, for all muscular activity involves the nervous centres, and all mental activity causes some contraction or tension in various groups of body muscles".

Bartley and Chute (1947) regard not only the distinction between "muscular" and "mental" fatigue as invalid but also all other distinctions between different kinds of fatigue. They state: "Since fatigue is experiential, and since 'experiential' and 'mental' are common synonyms, all fatigue is mental and the term no longer differentiates between kinds of fatigue". They believe that although occasions for the production of fatigue are many and varied, fatigue produced in one situation has an essential similarity with fatigue present in any other, that is to say, the fatigue (in their restricted sense) which arises during muscular activity is essentially similar to the fatigue which occurs in the course of mental activity. "Classification in terms of part function", they say, "not only denies the unity of the organism, but also throws little if any light on the nature of fatigue".

(c) Theories of Fatigue:

Thorndike (1914) has described two groups of theories often advanced to account for "mental fatigue", in the sense of temporary diminution of mental efficiency. The first he calls "mechanical" theories. These regard mental work as being similar to the work of an engine. Just as an engine in functioning depletes its store of fuel reserves, so mental work is believed to use up a store of mental energy, the store being replenished during rest.

The second group, called "biological" or "response" theories, regard mental work as the action of certain situation-response bounds, assuming tendencies unfavourable to their action to be produced as work is done and to die out during rest.

"According to the Mechanical theories", says Thorndike, "fatigue is intrinsic or direct and negative or subtracting, in the sense that an activity in and of itself weakens its own efficiency by being exercised without rest, as a reservoir by discharging water lowers its pressure. According to the Biological theories, fatigue is ..... extrinsic or indirect and positive or additive, in the sense that an activity, by being exercised without rest, produces certain by-products, or releases certain forces, external to it, which check it".

The ordinary layman probably harbours some kind of mechnical theory to explain diminishing efficiency on a task continued without rest. In their descriptions of tired afternoon school children, many teachers used the expressions "their energies are sapped", or "they expend all their energies", or words to that effect, indicating that they, too, hold some type of mechanical theory. The dictionary meaning given above, in using the phrase "previous expenditure of energy in doing work", also seems to presuppose some such theory.

Thorndike, however, finds several objections against such theories. The first is that curves of work are irregular and not even as, say, the curve for the pressure from a reservoir from which water runs out faster than it runs in. To explain the irregularity by calling in subsidiary factors such as incitement, warming-up, and the like, is simply to admit that mere loss of energy is not a sufficient cause of changes in work output. Allied to this is the fact that the mechanical theories have no important place for the factors of interest and repugnance which play so large a part in determining the amount of work done. Their place is monopolised by rest and work,

respectively. Finally, recent investigations have shown that very little energy is expended during mental work.

Thorndike favours the biological or response theories. He says that an animal tends to repeat a connection when repeating it brings a satisfying state of affairs, and may be expected to discontinue it when repeating it annoys him (cf., his Law of Effect in Learning Theory). It is more likely that an animal discontinues or decreases mental work because continuing it annoys him rather than because its reserves of energy have run low. The more promising theory, he says, will be one that explains why continued mental work ultimately becomes less satisfying.

Thorndike believes that this is what the biological theories try to do. Work without rest, they maintain, becomes less satisfying (1) by losing the zest of novelty, (2) by producing ennui, a certain intellectual nausea, sensory pains and even headache, and (3) by imposing certain deprivations, e.g.,from physical exercise, social intercourse, or sleep.

Bartley and Chute (1947) also reject the energistic conception of fatigue and account for it in terms of confoict within the individual organism. They say that the common practice of comparing men and machines has perpetuated the energy idea of fatigue. Energy is certainly involved, but the crucial determinant is organisation. Conflicts, defined as disruptions in the organisation of the individual, are constantly developing within the organism. Many of them find resolution in appropriate action, others are inadequately resolved, and still others fail to find resolution at all. Pervasive bodily discomfort is one of the most common outcomes of unresolved conflict. As this sets in, the individual becomes increasingly aware that his present behaviour should be changed. When relief of bodily discomfort is prevented and action is frustrated, fatigue usually develops. Fatigue, therefore, pertains to the individual as a whole. It is a personal matter and is consistent with the individual's ideals, goals, etc. It is an outcome of conflict, an expression of frustration.

It is clear that such a view of fatigue is closely related to psychoanalytic theory with its concepts of frustration, conflict, and anxiety. It represents, therefore, an advance over both the naive, mechanical, energistic theories and the somewhat superficial biological or response theories. According to it, there would be no essential difference between the early morning fatigue of the neurasthenic and the fatigue arising in work situations. It is certainly a far cry from one's everyday notions of fatigue to the psychoanalytic orientations of Bartley and Chute.

(d) Work Output:

The review of literature thus far makes it clear that the traditional views on fatigue are undergoing revision. It has been suggested that the most recent methodological advance has been the distinction between fatigue and impairment. What of the allied concept of output or work efficiency?

Although, as pointed out above, no clear distinction can be drawn between physical and mental work, we may, for purposes of exposition, follow Collins and Drever (1933) and regard work as being predominantly physical or predominantly mental. According to this view, physical work and mental work become points at opposite ends of a continuous scale, the extremeties of which, labelled "purely physical work" and "purely mental work" may be regarded as merely hypothetical. An example of physical work would be "muscular" work with the ergograph or dynamometer; an example of mental work would be "mental" multiplication of pairs of numbers.

Collins and Drever (1933) say that efficiency in both kinds of work proceeds along similar lines. They follow Ebbinghaus and Kraepelin in distinguishing a number of phases in the work curve. There is an initial spurt (Antrieb) reflecting the zeal and enthusiasm of the subject as he begins the task and an end spurt (Schlussantrieb) when the individual, becoming aware that he is nearing the end of the task, makes an additional effort and

output is increased. In between, the curve shows a warming-up period (Anregung), a familiarisation or adaptation phase (Gewöhnung), and spurts after "fatigue" and disturbance (Ermudüngsantrieb and Störingsantrieb).

Work curves have received particular attention in industrial psychology, and for a long time the existence of definite phases in the curve of efficiency as well as the existence of diurnal variations as between morning and afternoon work have been taken for g ranted. However, Rothlisberger and William (1939) who conducted elaborate experiments at the Hawthorne Plant of the Western Electric Company found that a flat constant work period was characteristic of the daily work process. The work of Rothe (1946, 1947, and 1951) also throws doubt on the existence of any typical curve of efficiency that will be true for all situations; rather, it brings out the importance of taking in to consideration individual differences among workers and the effectiveness of financial incentives. Milton (1952), reviewing the literature on the subject, regards the daily work curve as a "myth".

In respect of predominantly mental work also, Thorndike (1914), after subjecting all the published data up to 1913 to a searching analysis, found no convincing evidence to support a theory of stages in the curve of work nor did he find any consistent evidence of real differences between early and late work. He says: "The most important fact about the curve of efficiency of a function under two hours or less continuous maximal exercise is that it is, when freed from daily eccentricities, so near a straight line and so near a horizontal line. The work grows much less satisfying or much more unbearable, but not much less effective. The commonest instinctive response to the intolerability of mental work is to stop it altogether. When, as under the conditions of the experiments, this response is not allowed, habit leads us to continue work at our standard of speed and accurac

It seems, therefore, that several hours of continuous mental work with maximum effort causes a negligible decline in the amount and quality

work done. Cattell (1941) underlines this view and suggests that the concept of purpose should not be ignored. He says: "Attempts to make comprehensive laws of a mechanical kind about the work curve itself has proved abortive. In work and fatigue, as in learning, we must invoke in the end the concept of purpose. There is no fatigue as long as a purpose itself is not fatigued".

This is an admirable statement of the fact that in all studies of "fatigue" the question of motivation should be regarded as crucial. Husband (1947) brings out the important role of motivation by a homely example. He says: "Fatigue follows prolonged exertion and requires rest, preferably sleep. Its effects upon motivation is negative; the more tired a person is the less he desires to do anything. But fatigue itself is in turn partially dependent upon motivation. Boring tasks tire one much more quickly than interesting activities. We may play tennis for hours, but a half hour spent in weeding the garden leaves us exhausted". Most previous studies make only indirect references to the problem of motivation, or none at all.

(e) <u>The Measurement of Deterioration in Work Output on Predominantly Mental Tasks:</u>

A great deal of work has been done in the past to ascertain the degree to which output on predominantly mental tasks deteriorated in the hope that the amount of loss would function as an index of "mental fatigue". It was believed that "fatigue" would cause the quantity to diminish and the quality to deteriorate, the latter usually indicated by an increase of errors (cf., Adams, 1927). Two methods[1)] have been developed, the continuous and the interpolation method (Collins and Drever, 1933; Fryer, 1950).

In the continuous method, the subject is set a single, definite task which he pursues for hours or even days and the work output is assessed

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1) Some writers classify methods of "measuring fatigue" in other ways. For example, Stroud (1938) divides them into "subjective" and "objective", and Starch (1924) into "direct" and "indirect".

at regular intervals on the same task for signs of possible deterioration ("fatigue"). In the interpolation method, the work on which the subject is engaged is interrupted at intervals during which he is given a standard task which is different from the work he has been doing. The efficiency with which the interpolated tests are performed at the different times from beginning to end is regarded as evidence of mental condition.

As examples of the continuous method, the works of Thorndike, Arai, and Starch and Ash are among the most well-known. Multiplication, without the use of paper and pencil, was first used in 1911 by Thorndike in the measurement of diminished output. He got each of his sixteen subjects to work continuously at multiplying pairs of three-place numbers on one day for periods of four to twelve hours except for one brief lunch break. The next day they worked from a half to one hour on the same task. The amount of "fatigue" was measured by the difference in time taken to do the same amount of work with the same accuracy at the end of the first day and at the beginning of the test on the next day (i.e., after a long rest) (Thorndike, 1914).

The work of Arai (described in Thorndike, 1914) is perhaps the most spectacular in the study of deterioration of output by the continuous method. In her main experiment, multiplication of pairs of four-place numbers, without the use of paper and pencil, was carried out by herself as subject, for no less than four successive days from about 11 a.m. to 11 p.m., without any intervals for meals. Her efficiency declined on each day, but less on the fourth than on any one of the other days.[1)]

Starch and Ash (1917) used addition for two hours as the experimental task. They found that the number of additions was only reduced from 14 to 13.4 per half-minute interval.

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1) Huxtable, White and McCartor (1946) have repeated Arai's experiment and re-interpreted some of her findings.

Thorndike (1914), after reviewing the work of many others who have used the continuous method, such as Burgerstein, Höpfner, Bettman and Aschaffenburg, Cattell and Dolley, Oehrn, Bergström, Weygandt, Vogt, Woodworth, Bolton, Kafemann, Heilman, Specht and Whipple, as well as his own, reaches the conclusion that there is little or no difference between early and late work. He says: "A man can work (at a 'mental' task) for several hours at his utmost, and at the end do nearly as well as he will after full rest. Except when the function exercised is very disagreeable, either in toto or in the degree of restraint which it demands, the loss during the work period is often indiscernible ..... Such statements as Binet's 'Tout effort est accompagne d'une certaine fatigue' (made in 1898), give then a wrong impression of the amount and rate of fatigue."

The interpolation method of studying deterioration in performance has been used extensively in both laboratory and school studies. Thorndike (1914) has outlined the contributions of fourteen of the more outstanding workers who have used this method from 1879 to 1913, when experimental work on "mental fatigue" was at its height. Since then there has been somewhat of a lull, but some of the more significant researches between the time of Thorndike's review and the present will also be mentioned below.

Thorndike (1900) gave 240-700 children tests in adding, multiplying, marking misspelled words on a page of print, memorizing lists of 10 digits, 5 nonsense syllables, 10 letters and 6 simple forms, and counting dots, at the beginning of the morning period and again at the end of the afternoon one. The factors of novelty and practice were controlled. He found that the subjects performed more or less as well in the late afternoon as in the early morning.

These results were confirmed by King in 1907 (quoted by Thorndike, 1914). She tested fifth-grade children at different times in addition, multiplication, and judgment. Their total relative efficiency was found to be as follows:-

9.30 a.m.	103
10.30 a.m.	98
11.30 a.m.	106
1.30 p.m.	92
2.30 p.m.	101

Winch (quoted in Thorndike, 1914), carried out two experiments that are of direct relevance to the present research. In the first, which was carried out in 1910, he found that day workers attending evening schools lost one-sixth of their efficiency during the evening in solving problems, computation, memorizing the gist of passages, and writing shorthand. This is the greatest loss of efficiency shown by any study (Sandiford, 1941). In the second experiment, carried out in 1911, he used school children and found that problem aritmetic was not done so well at 4 p.m. as at 9.40 a.m. In three or four days, however, the superiority of the morning performance decreased markedly.

The findings of Thorndike and King, described above, have been confirmed in studies by Heck, Ritter, Sikorski, and Friedrich (all quoted in Thorndike, 1914). Heck, for instance, in an elaborate study with school children tested efficiency in mechanical arithmetic at four periods in the school session with the following results:-

Time	Units of Work Done	Percentage Correct
9.10 a.m.	140.37	87.40
11.05 a.m.	142.57	86.08
1.10 p.m.	142.67	86.17
2.30 p.m.	143.68	85.46

Though the differences between early and late work are in the expected direction, they are negligible.

Concluding the survey of school studies up to 1913, Thorndike (1914) says: "There is remarkable unanimity ..... that ability (in italics) to work is, in school pupils, throughout and at the close of the school session, almost or quite unimpaired. ..... It is clear that the assertions made in text-books on school hygiene that there are great and important differences between the results of tests at different periods of the school session, are quite unjustifiable. The very results referred to in support of these assertions disprove them".

Researches in this field since Thorndike's time have not been as profilic as before. If anything, the work done since then has confirmed the negative findings of previous investigators. Three of the more well-known studies will be mentioned.

Gates (1929), in a study of the course of work during the school day, found that in functions such as addition, multiplication, visual memory, auditory memory, recognition, and completion, efficiency was lowest in the first and highest in the last morning period. A slight drop followed the lunch break with a subsequent rise between 2 and 3 o'clock. He concluded: "One thing is quite certain: the ordinary work of the school day is not so severe as to reduce efficiency perceptibly. In fact, achievement is higher at nearly every hour than it is at the beginning of the day. In the main, the differences are small. Aside from the suggestion that such functions as writing, drawing, or other light work requiring speed and accuracy of movement might well be given in the first afternoon period, it would appear to make little difference when reading, arithmetic, and other studies are conducted".

Whiting and English (1925) used a battery of five tests with undergraduates. The battery included tests to measure accuracy of physical work, accuracy of mental work, speed of mental work, difficulty of physical work, and difficulty of mental work. It was administered twice - at 8.30 a.m. and

at 4.30 p.m. The differences between morning and afternoon work were found to be not statistically significant.

Stainer (1929) used 532 children, ten to sixteen years of age. The subjects engaged in simple addition for five-minute intervals every 45 minutes during the school day which began at 9 a.m. and ended at 3.45 p.m. They showed a steady improvement throughout the forenoon, the peak being reached at 11.50 a.m., but thereafter efficiency remained fairly constant.

It is clear from the literature cited above that in the laboratory as well as in school situations both interpolation and continuous methods of study have failed to reveal any notable deterioration in output as a result of "fatigue" in as far as predominantly mental work is concerned. Nor have any substantial differences between early and late work been established. Sandiford (1941) says: "Measurements of the actual decreases in efficiency occasioned by the daily sessions in school show figures ranging from 1 to 5 per cent. instead of the 50 to 70 per cent. that many teachers suppose".

Thorndike's conclusion, arrived at in 1914, still appears to hold good. More recently, Ellis (1952) has said: "All work, both mental and physical, requires the expenditure of energy and results in fatigue, but the amount of energy used in mental work appears to be rather small in comparison with that used in vigorous physical work involving the larger muscles of the body". The expectation that continuous work of a predominantly mental nature must necessarily arouse "mental fatigue" and result in large deterioration of output seems to have been a carry-over from the universally acknowledged phenomenon of decline in performance in predominantly physical work involving the large muscles. It seems, however, that, provided motivation is maintained, predominantly mental work can be sustained for long periods without serious loss in efficiency.

(f) Symptoms of "Mental Fatigue".

Authors who believe that continuous mental work must diminish efficiency in all other forms of work, that is to say, those who believe in "generalised fatigue", have, in the past, made attempts to find symptoms of this generalised diminution of efficiency.

The symptom chiefly studied has been the two-point threshold upon various parts of the skin in the belief that a decrease in sensitiveness or a widening of the threshold indicated a reduction in general mental efficiency. Griesbach was among the first to use this method (Starch, 1924). Using school children, he tried to determine the amount of fatigue produced by various types of school work. Specific fatigue values were assigned by him and his followers to the different school subjects. Thus Wagner (quoted in Sandiford, 1941), on the basis of aesthesiometric tests, graded the subjects according to difficulty as follows:-

Mathematics (the standard) ...	100
Latin	91
Greek	90
Gymnastics	90
History and Geography	85
French and German	82
Natural History	80
Drawing and Religion	77

Other avenues have also been explored in the assessment of symptoms of fatigue, such as word-association tests, tests of visual accommodation, tapping with a stylus, variations in blood pressure, in pulse, in respiration, sensitivity to pain, and so on.

Nothing conclusive has been established. Starch (1941) believes that all these methods are too remote to function as precise indicators of

fatigue. Even the ergographic method, though useful in the study of work of a predominantly muscular nature is only a very indirect and dubious method of investigating fatigue associated with work of a predominantly mental nature. Similarly, Thorndike (1914) considers that attempts to discover some convenient symptom and measure of fatigue are misguided.

The so-called fatigue coefficients attributed to the different school subjects are also regarded as valueless. Sandiford (1941) says: "It is probable that the way subjects are taught has more effect than the content of subjects, some teachers being more fatiguing than others, or at least more boring. And it should be remembered that boredom may be just as effective in reducing the output of pupils as real fatigue".

(g) The Place of the Present Experiment:

The outline of the literature given above indicates that findings in the field of "mental fatigue" prove, on review, to be negative in character, though not unanimously so. What then was the justification for the present study? In what way did it differ from previous researches?

As pointed out previously, the aim of the present investigation was to assertain whether children in afternoon schools worked at reduced mental efficiency as believed by the majority of their teachers and by a large number of the pupils themselves. It differed from previous studies in at least five respects.

Firstly, it took place in a novel context. Whereas, nearly all past studies of performance in school at different times of the day were carried out with pupils in "normal" schools which opened in the morning and closed in the afternoon, the present study used as subjects children in schools which were set up by the educational authorities to function only in the afternoon. The nearest approach to this setting, as far as is known, was that of Winch and that of Whiting and English (both quoted above). In

both investigations, mature subjects, not children, were used. Winch found fairly large differences between morning and evening work, while Whiting and English, using under-graduates, found none between morning and afternoon work.

Secondly, the study differed from most of the others in method. Previously, two methods were popular in the investigation of reduced mental efficiency as reflected by output, namely, the continuous and the interpolation. The design of the present study was cross-sectional in the sense that the performance of a group of children on intellectual tasks was taken during the morning of one day and compared with the performance of the same group of children on equivalent tasks done on the afternoon of the next day.

Thirdly, the present research had the advantage of the work of Bartley and Chute (1947). This proved of value in two ways. It enabled the study to steer clear off the confusion in conceptual terminology that had plagued investigations in the past and it made it possible for the researcher to define the study in more precise terms and control factors whose importance was not given due recognition before. It was proposed to adhere strictly to the distinctions between fatigue (subjective experience of boredom, aversion to work, etc.), impairment (physiological changes in body metabolism), and work output. Except where otherwise indicated within inverted commas, these terms will be used in the sense suggested by Bartley and Chute, for the rest of this account.

Whereas, previously, the possible influence of the subjective factor on work output does not seem to have been given due attention in studies of mental efficiency, the matter was considered vital in the present investigation. It was proposed to control the factor of fatigue in order to see if variations in morning-afternoon work output appeared in its absence.

Control of the fatigue factor is a more specific statement of the more general problem of motivation. In past researches, tasks of a mechanical nature, such as addition and multiplication, were generally set in order that scores obtained by the subjects at different intervals during the progress of work would be strictly comparable. While this procedure facilitated statistical manipulation of the results, prolonged attention to a mechanical kind of task introduced a new, disturbing factor - that of boredom and monotony and their possible deleterious effects on performance.

As pointed out above, boredom could be just as much responsible for decline in performance as impairment (neuromuscular failure). It has, for example, been shown by Robinson and Bills (1926) and by Robinson (1934) that there is greater decrement in performance on homogeneous tasks such as addition than on non-homogeneous tasks such as an intelligence test. The use of mechnical operations in studies of decline in mental efficiency suffers from the defect that if and when decrement appears, it is not possible to tell whether it is due to the boring nature of the task itself or to impairment.

To ascertain the effects of either boredom or neuromuscular inability on work efficiency, it is necessary that one of the factors should be controlled. It does not seem that this problem was adequately handled in most previous studies, due to the failure to distinguish between fatigue and impairment. In the present investigation, it was decided to eliminate, or, at least, minimise the factors of boredom and monotony by motivating the subjects to work at full capacity in order to ascertain whether output declined in their absence.

Fourthly, it was decided to pay special attention to a point emphasized by Fox (1925). Reviewing previous studies in the field, Fox states that one of the main reasons for the failure of investigators in the past

to throw light on the nature of "fatigue" was that search was made "in the wrong direction". Experimenters on "fatigue", he says, had concentrated on capacity or accuracy instead of on variability in performance, for example, at different times of the day in the case of school children. He quotes experiments by Winch, Smith, Reed, and Wager, as well as one of his own, to show that although actual scores on the given tasks remained more or less unchanged at the different times at which they were recorded during the work process, variability in performance differed markedly. "Variability is of the very essence of fatigue", he concluded. In the present study, it was decided, therefore, to compare morning and afternoon scores on tests not only in respect of actual scores, gross output, and accuracy, but also in terms of variability in pupil response during the two sessions in order to test Fox's contention. This was to be done by a comparison of the standard deviations of morning and afternoon performance since the standard deviation is the most accurate measure of variability (Smith, 1947).

Finally, the fact that the children used in the experiment worked and played during the morning hours before coming to school in the afternoon differentiated the present study from most previous researches. An indication of the kind of activities in which afternoon school children engaged in the morning has already been given. What children do before coming to school is considered important by some educationalists. McRae (1934), for instance, says: "Children do at times come to school genuinely fatigued, for example, children in country districts who are obliged to do a share of farm-work before leaving home. The teacher should simply allow such children a period of rest before asking them to take any very strenuous part in school activities".

(E) EXPERIMENTAL DESIGN:

The experiment had to be so designed as to show in objective terms

whether there was in school children any loss in capacity in the afternoon to learn and to do work of an intellectual nature in terms of accepted statistical criteria and using as many dimensions of investigation as possible. Thus, if any loss did appear, the experiment should reveal not only the extent of the loss but also the branches of intellectual work - language or arithmetic or working at an intelligence test - in which deterioration was greatest. It should also show what kind of children suffered the greatest incapacity - the bright or the dull, the older or the younger, the brighter-younger or the brighter-older, the duller-younger or the duller-older, those with more years of schooling to their credit or those with lesser. Further, statistical comparisons between morning and afternoon performance should be possible not only in respect of actual scores on the various tests, but also in respect of total output and accuracy of work under both conditions. Finally, not only should it be possible to test the means of morning and afternoon scores for statistical significance, but also the variability in performance during the two sessions.

The general procedure decided upon was to test a group of children during the morning almost continously from 8 o'clock to 12 o'clock and then to re-test the same children almost continuously from 1 o'clock to 5 o'clock on the following day and compare their morning and afternoon scores on the different tests. The programme was set about as follows:-

The Sample

As teachers who responded to the questionnaire were believed to have had mainly the sub-standards in mind when reporting inferior pupil response in the afternoon, indeed, many of them explicitly said so, it would have been most appropriate to use Class I and Class II children in the study. However, there were serious obstacles in the way of using these children, such as the difficulty of obtaining suitable tests for the

very young, the difficulty of testing them in large groups, the limited time at the disposal of the experimenter, and so on. For these reasons, it was decided to use pupils from Std. II to Std. V, inclusive, and to leave the lower grades for a separate study at a later date.

The St. Aidan's Indian Platoon School which is situated about four miles from the centre of Durban was used. 160 pupils from it were first given Logue's Non-Verbal Intelligence Test which has been standardised for Durban Indian children (Logue, 1954 and 1956). Of these, 144 were present for all the tests, so that only their scores are presented below.

The sample of 144 was divided into two groups, A and B, of 72 boys each, matched for age and intelligence. The reason for doing this will be given later. Each of the two groups was then divided into four sub-groups of 18 pupils each, called brighter-younger (A_1 and B_1), brighter-older (A_2 and B_2), duller-younger (A_3 and B_3), and duller-older (A_4 and B_4), in such a way that each sub-group of Group A had a counterpart in Group B, matched for age and intelligence, as shown in the following table:-

TABLE IV

AGE AND I.Q. OF THE TOTAL SAMPLE, GROUPS, AND SUB-GROUPS

DESCRIPTION	CODE NO.	N	MEAN AGE	MEAN I.Q.
Total Sample:	-	144	14 Yrs. 0 Mths.	100.69
Groups:	A	72	13 Yrs. 11 Mths.	100.68
	B	72	14 Yrs. 0 Mths.	100.71
Sub-Groups: (Brighter-Younger)	A_1	18	12 Yrs. 6 Mths.	118.72
	B_1	18	12 Yrs. 6 Mths.	118.78
(Brighter-Older)	A_2	18	15 Yrs. 2 Mths.	105.50
	B_2	18	15 Yrs. 2 Mths.	105.50
(Duller-Younger)	A_3	18	12 Yrs. 8 Mths.	95.11
	B_3	18	12 Yrs. 8 Mths.	95.17
(Duller-Older)	A_4	18	15 Yrs. 6 Mths.	83.39
	B_4	18	15 Yrs. 7 Mths.	83.39

It will be noted that the corresponding groups and sub-groups are identical in numbers and almost identical in age and I.Q.

The Tests Used

It was decided to use four kinds of tests - silent reading (vocabulary), intelligence, mechanical arithmetic, and silent reading (paragraph comprehension). Each of the tests had to be in two versions, one for the morning and the other for the afternoon, both versions to be equivalent in difficulty. The following tests were used:-

(1) The National Bureau Elementary Test of Silent Reading (Vocabulary), Forms A and B.

This is a test of meanings of words and consists of 40 multiple-choice questions. Actual test time, 10 minutes.

(2) The New South African Group Test of Intelligence, Junior, Forms A and B.

This consists of six sub-tests, three verbal and three non-verbal, comprising 150 problems in all. It was given not as a test of intelligence but as an intellectual exercise. Raw scores, not I.Qs., were used. Actual test time, 55 minutes.

The manual accompanying the test prescribes a rest interval of at least 15 minutes midway through the test (National Council for Social Research, 1955). This was not given to the children, the aim being to maintain continuous intellectual pressure for some time. Also, a slight re-arrangement in the time allocations for Sub-Tests 3 and 4 was made as a result of previous experience with the Test. Sub-Test 3 was allowed 7 minutes instead of the prescribed 9, and Sub-Test 4, 17 minutes instead of 15.

(3) The National Bureau Test of Mechanical Arithmetic, Forms A and B.

This contains four sub-tests involving integers as follows:-

addition, 30 sums; subtraction, 40 sums; multiplication, 33 sums; division, 31 sums; total, 134 sums. The prescribed test time is 4 minutes for each sub-test (National Bureau of Educational and Social Research), but 7½ minutes was allowed, making a total of 30 minutes for the whole test.

(4) The National Bureau Elementary Test of Silent Reading (Paragraph Comprehension).

This consists of 30 multiple-choice questions on 14 paragraphs dealing with different topics. Actual test time, 20 minutes.

Control of Practice Effect

It is a well-known fact that when unsophisticated pupils are tested twice on equivalent forms of the same test, with only a short interval between test and re-test, they do better on the second test because of practice with the first. In the present experiment, this would have had the effect of covering up any decrease in the afternoon performance if the first testing programme took place in the morning, and it would have inflated morning scores relative to afternoon scores if the tests were first administered in the afternoon. The problem was overcome by splitting the total sample of 144 into two matched groups of 72 each. Group A (comprising Sub-Groups A_1, A_2, A_3 and A_4) did its first set of tests in the morning and its second set in the afternoon of the next day, while Group B (comprising Sub-Groups B_1, B_2, B_3 and B_4) did its first set in the afternoon and its second set in the morning of the following day. This design had the effect of cancelling out practice effects when the morning and afternoon scores of both groups were combined for purposes of comparison.

The care taken to match Groups A and B and their corresponding sub-groups with respect to age and intelligence was necessary in order to

avoid the possibility of one of the groups deriving more benefits from practice on the first set of tests than the other. It is known that practice effects vary with intelligence. Peel (1951), for instance, found that differential practice effect on intelligence tests was related directly to the initial level of intelligence, reaching a maximum at 120-130 I.Q., and then diminishing.

Control of Fatigue

The importance of combating fatigue (or lack of adequate motivation) in studies of work decrement has been pointed out earlier. In this particular study, two methods of motivating the pupils to do their best on both series of tests were open to the researcher. The first was to rouse their spirit of competition in the following ways:-

(1) The pupils could be told that they were competing with other schools. This would be easily believed as the researcher was also working at about the same time in neighbouring schools on other projects (inter-school competition).

(2) They could be told that, in addition to the above, an order of merit would be drawn up for their own group as in a school examination (intra-group competition).

(3) The pupils could be told, after the first series of tests, that they would be given a second chance to prove their worth and that only the higher of their pairs of marks on each of the equivalent pairs of tests would be credited to them and the lower discarded (self-competition. Incidentally, Peens (1949) found that this type of competition was the most effective).

It will be noted that the real purpose of the experiment was not to be revealed to the subjects. This was not done even after the experiment was concluded.

Secondly, either by itself or in addition to the method described above, motivation could be ensured by selecting test material that would appeal to the pupils. The educational equivalent of the concept of motivation is the concept of interest. If tests were used that caught the interest of pupils, fatigue could be kept at bay.

Whether to use both or one of these methods became a delicate problem. In the end, practical considerations won. One of the main aims of the research was to throw light on what was happening in the afternoon school in respect of mental efficiency under ordinary afternoon school conditions. In other words, if the results were to be directly applicable to the afternoon school as it functioned daily, no extraordinary motivating factors such as inter-school or intra-group or self-competition should be introduced, although it is recognized that the last two methods are often employed in the classroom particularly at examination time. This study, however, was not intended to resemble a school examination. The practical aims of the research demanded, therefore, that motivation by extraneous means should be abandoned in favour of a method that prevails, or should prevail, in the classroom on any day of school and not only at examination time.

In view of this, it was decided to rely for motivation upon tests that roused interest by the nature of their content and format. It was necessary also that these tests should be simple at the beginning so as to whet the intellectual appetite and not frustrate through initial difficulty. Further, they should be relatively short and heterogeneous in content so as not to become boring.

The four tests finally chosen were believed to fulfil all these criteria. All the tests began at such a simple level that even the dullest could start off with a few correct answers. Thus, although the subjects ranged from Std. II to Std. V, the vocabulary and paragraph comprehension

tests were those meant for European children in Stds. I, II, and III. The mechanical arithmetic test of the four fundamental processes in integers is applicable from Std. II to Std. VIII (age 7 to 17 years in the case of European children). As indicated previously, the prescribed time for each of its sub-tests was nearly doubled. Finally, the intelligence test given, was one that is normally used for European children between 8 and 11 years of age, whereas, the average age of the sample was 14 years. However, although the tests were pitched low for the benefit of the weaker pupils, it did not turn out that the brighter ones had matters their own way, for all the tests become really difficult towards the end. Out of 1,152 scripts, only one scored full marks, and that was in paragraph comprehension. In mechanical arithmetic, no pupil completed any sub-test although the prescribed time limit was nearly doubled. Even the brightest pupil was thus fully extended.

The intelligence test was the longest, entailing 55 minutes of actual thinking time, but it was made up of six sub-tests, namely, figure analogies, classification of word pairs, number series, verbal reasoning, pattern completion, and word analogies, these being given 9, 7, 7, 17, 10, and 5 minutes respectively, with intervals between sub-tests during which instructions were given on the manner of working the next exercise. Despite its length, the intelligence test was voted as the one most "liked" by the pupils at the end of the experiment.

Miscellaneous Matters

The experiment proper was scheduled to last two days, Thursday, February, 28th, and Friday, March 1st, 1957. For results to be comparable, it was important that conditions of temperature, humidity, and light should be more or less similar on both days. Control of weather was beyond the ingenuity of the experimenter, but as it turned out, conditions were almost

identical on both days, Temperature inside the hall in which the testing took place was noted at hourly intervals, the following being the maxima: Thursday - morning 82°, afternoon 83°; Friday - morning 84°, afternoon 85°. Humidity, according to the local newspapers, was not very different on the two days. Light deteriorated at about 4.30 p.m. on both days and it was fairly dark by 5 p.m., but electric lights were not used. The school provided the usual supplementary lunch on both days.

Order of Testing

The four tests were given in the order - vocabulary, intelligence, arithmetic, and paragraph comprehension. At the first administration, the testing programme lasted 4 hours, from 8 o'clock to 12 o'clock in the morning, and from 1 o'clock to 5 o'clock in the afternoon. At the second administration, the programme lasted 3 hours 40 minutes, that is, from 8 o'clock to 11.40 in the morning, and from 1 o'clock to 4.40 in the afternoon, the reduction of 20 minutes on the re-test being due to the fact that instructions were then more quickly grasped by the pupils (practice effect). One interval of 15 minutes was given after the intelligence test.

TABLE V

TIME SCHEDULE FOR TEST AND RE-TEST

	MORNING		AFTERNOON	
	First Test	Re-Test	First Test	Re-Test
Vocabulary	8.00 - 8.30	8.00 - 8.25	1.00 - 1.30	1.00 - 1.25
Intelligence	8.30 - 10.20	8.25 - 10.10	1.30 - 3.20	1.25 - 3.10
Interval	10.20 - 10.35	10.10 - 10.25	3.20 - 3.35	3.10 - 3.25
Arithmetic	10.35 - 11.20	10.25 - 11.05	3.35 - 4.20	3.25 - 4.05
Comprehension	11.20 - 12.00	11.05 - 11.40	4.20 - 5.00	4.05 - 4.40

The actual testing time at each sitting was 115 minutes. The rest of the time, apart from the interval, was spent in instructing the children how to do the tests by means of actual examples. During these periods, the atmosphere resembled that of the ordinary classroom with the experimenter (who is a qualified schoolteacher) doing the teaching and the pupils responding with answers. The same experimenter conducted all the tests.

(F) RESULTS:

Morning and afternoon performances were compared in respect of four measures, as follows:-

(1) Actual Scores obtained by the pupils.

(2) Output Scores, that is, the total number of problems attempted, whether correct or incorrect.

(3) Accuracy Scores, obtained by dividing the number of items correct by output in the case of each pupil on each test and multiplying by 100 to eliminate decimal points.

(4) Standard Deviations in respect of all three measures mentioned above.

As regards the criterion for statistical significance, it was decided to accept a probability value of .01 or lesser for significance in all the t-tests of this Report.

The following tables of results are largely self-explanatory:-

TABLE VI

MEAN ACTUAL SCORES OF TOTAL SAMPLE (N = 144)

Test	Morning	Afternoon	A[1)]	t[2)]	P
Vocabulary	18.73	19.69	0.171	2.461	>.01
Intelligence	77.26	75.55	0.410	1.569	>.01
Arithmetic	76.10	75.56	3.046	0.572	>.01
Comprehension	17.05	17.79	0.220	2.159	>.01

TABLE VII

MEAN OUTPUT SCORES OF TOTAL SAMPLE (N = 144)

Test	Morning	Afternoon	A	t	P
Vocabulary	31.53	32.47	0.434	1.526	>.01
Intelligence	134.10	132.40	0.617	1.276	>.01
Arithmetic	99.20	98.99	7.884	0.355	>.01
Comprehension	26.74	26.84	15.514	0.253	>.01

TABLE VIII

MEAN ACCURACY SCORES OF TOTAL SAMPLE (N = 144)

Test	Morning	Afternoon	A	t	P
Vocabulary	59.40	60.64	0.318	1.780	>.01
Intelligence	57.61	57.06	1.209	0.909	>.01
Arithmetic	76.71	76.51	8.062	0.351	>.01
Comprehension	63.77	66.31	0.174	2.435	>.01

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1) The test of significance used in these tables where A-values are given is that proposed by Sandler (1955). His method is based on a simplification of Student's t-test for correlated measures. The formula for the computation of A is

$$A = \frac{\Sigma d^2}{(\Sigma d)^2}$$

where d represents the difference between the morning and afternoon score of a pupil on any test.

2) Significance can be estimated directly from A by means of a table provided by Sandler (1955). In Tables VI, VII and VIII, however, t-values have been included as they are the more familiar indices. t may be deduced from A by the formula

$$t = \sqrt{\frac{N-1}{AN-1}}$$

Tables VI, VII and VIII show that the morning is not significantly superior to the afternoon on all four scholastic tests and on all three measures - actual score, output and accuracy. The results are consistently negative in respect of the hypothesis of the study, namely, that morning performance is significantly superior to afternoon performance.

It is interesting to note that in vocabulary and comprehension, performance was consistently better in the afternoon on all three measures, though not significantly so.

The scores of the total sample were then compared in respect of variability in morning and afternoon performance with the following results:-

TABLE IX

STANDARD DEVIATIONS OF ACTUAL SCORES OF TOTAL SAMPLE (N = 144)

Test	Morning	Afternoon	r[1]	t[2]	P
Vocabulary	S.D.: 7.664	S.D.: 7.172			
	S.E.: 0.453[3]	S.E.: 0.424	.805	1.334	>.01
Intelligence	S.D.: 23.544	S.D.: 23.141			
	S.E.: 1.392	S.E.: 1.368	.856	0.400	>.01
Arithmetic	S.D.: 20.035	S.D.: 19.550			
	S.E.: 1.185	S.E.: 1.156	.938	0.843	>.01
Comprehension	S.D.: 6.177	S.D.: 5.507			
	S.E.: 0.365	S.E.: 0.326	.763	2.107	>.01

1) The coefficients of correlation in Tables IX, X and XI have been computed by the product-moment method. The particular formula employed was the following, given by Garrett (1947, p. 292):

$$r = \frac{\Sigma XY - NM_xM_y}{\sqrt{\left[\Sigma X^2 - NM^2_x\right]\left[\Sigma Y^2 - NM^2_y\right]}}$$

2) The values of t in Tables IX, X and XI have been computed by the following formula which is applicable when standard deviations are correlated (Garrett, 1947, p. 216):

$$t = \frac{\sigma_{m_1} - \sigma_{m_2}}{\sqrt{\sigma^2_{\sigma_1} + \sigma^2_{\sigma_2} - 2r^2_{12}\sigma_{\sigma_1}\sigma_{\sigma_2}}}$$

3) The standard errors of the standard deviations given in Tables IX, X and XI have been obtained by the following formula (Garrett, 1947, pp. 194 - 196):

$$S.E. = \frac{\sigma}{\sqrt{2(N-1)}}$$

Tables VI, VII and VIII show that the morning is not significantly superior to the afternoon on all four scholastic tests and on all three measures - actual score, output and accuracy. The results are consistently negative in respect of the hypothesis of the study, namely, that morning performance is significantly superior to afternoon performance.

It is interesting to note that in vocabulary and comprehension, performance was consistently better in the afternoon on all three measures, though not significantly so.

The scores of the total sample were then compared in respect of variability in morning and afternoon performance with the following results:-

TABLE IX

STANDARD DEVIATIONS OF ACTUAL SCORES OF TOTAL SAMPLE (N = 144)

Test	Morning	Afternoon	r[1]	t[2]	P
Vocabulary	S.D.: 7.664	S.D.: 7.172			
	S.E.: 0.453[3]	S.E.: 0.424	.805	1.334	>.01
Intelligence	S.D.: 23.544	S.D.: 23.141			
	S.E.: 1.392	S.E.: 1.368	.856	0.400	>.01
Arithmetic	S.D.: 20.035	S.D.: 19.550			
	S.E.: 1.185	S.E.: 1.156	.938	0.843	>.01
Comprehension	S.D.: 6.177	S.D.: 5.507			
	S.E.: 0.365	S.E.: 0.326	.763	2.107	>.01

1) The coefficients of correlation in Tables IX, X and XI have been computed by the product-moment method. The particular formula employed was the following, given by Garrett (1947, p. 292):

$$r = \frac{\Sigma XY - NM_xM_y}{\sqrt{\left[\Sigma X^2 - NM^2_x\right]\left[\Sigma Y^2 - NM^2_y\right]}}$$

2) The values of t in Tables IX, X and XI have been computed by the following formula which is applicable when standard deviations are correlated (Garrett, 1947, p. 216):

$$t = \frac{\sigma_{m_1} - \sigma_{m_2}}{\sqrt{\sigma^2_{\sigma_1} + \sigma^2_{\sigma_2} - 2r^2_{12}\sigma_{\sigma_1}\sigma_{\sigma_2}}}$$

3) The standard errors of the standard deviations given in Tables IX, X and XI have been obtained by the following formula (Garrett, 1947, pp. 194 - 196):

$$S.E. = \frac{\sigma}{\sqrt{2(N-1)}}$$

TABLE X

STANDARD DEVIATIONS OF OUTPUT SCORES OF TOTAL SAMPLE (N = 144)

Test	Morning	Afternoon	r	t	P
Vocabulary	S.D.: 8.223	S.D.: 8.031			
	S.E.: 0.486	S.E.: 0.475	.591	1.103	$>.01$
Intelligence	S.D.: 16.804	S.D.: 17.703			
	S.E.: 0.994	S.E.: 1.047	.574	0.643	$>.01$
Arithmetic	S.D.: 14.959	S.D.: 15.238			
	S.E.: 0.885	S.E.: 0.901	.891	0.486	$>.01$
Comprehension	S.D.: 4.364	S.D.: 4.114			
	S.E.: 0.258	S.E.: 0.243	.570	0.856	$>.01$

TABLE XI

STANDARD DEVIATIONS OF ACCURACY SCORES OF TOTAL SAMPLE (N = 144)

Test	Morning	Afternoon	r	t	P
Vocabulary	S.D.: 14.061	S.D.: 15.222			
	S.E.: 0.831	S.E.: 0.900	.625	1.213	$>.01$
Intelligence	S.D.: 16.692	S.D.: 15.886			
	S.E.: 0.987	S.E.: 0.939	.887	1.277	$>.01$
Arithmetic	S.D.: 12.413	S.D.: 11.984			
	S.E.: 0.734	S.E.: 0.709	.863	0.831	$>.01$
Comprehension	S.D.: 17.586	S.D.: 16.380			
	S.E.: 1.040	S.E.: 0.969	.700	1.187	$>.01$

It will be seen that there are no significant differences in variability between morning and afternoon performance on all four tests and in all three measures. Again, the results are consistently negative. The standpoint of Fox (1925), which has been stated earlier, that afternoon performance is more variable than morning performance, has not been substantiated.

Treated as a whole, therefore, the total sample of 144 pupils consistently showed no significant differences between their morning and afternoon performance in all four tasks on the 24 statistical comparisons made above.

The sample was then divided into two groups of brighter and duller pupils with 72 in each. The brighter group was formed by combining Sub-Groups A_1, A_2, B_1 and B_2, and the duller group by combining Sub-Groups A_3, A_4, B_3 and B_4. The mean I.Q. of the former was 112.13 and of the latter 89.27. The morning and afternoon scores of each group was as follows:-

TABLE XII

MEAN SCORES OF BRIGHTER GROUP (N = 72)

Test	Type of Score	Morning	Afternoon	A[1]	P
Vocabulary	Actual	21.56	22.49	0.324	>.01
Intelligence	"	89.78	87.99	0.715	>.01
Arithmetic	"	84.92	84.46	3.116	>.01
Comprehension	"	19.30	19.75	0.919	>.01
Vocabulary	Output	33.64	34.48	0.778	>.01
Intelligence	"	135.91	136.07	126.819	>.01
Arithmetic	"	102.91	103.02	81.188	>.01
Comprehension	"	27.49	27.74	2.593	>.01
Vocabulary	Accuracy	63.97	65.22	1.241	>.01
Intelligence	"	66.04	64.63	0.293	>.01
Arithmetic	"	82.42	81.92	0.764	>.01
Comprehension	"	70.09	71.20	1.082	>.01

TABLE XIII

MEAN SCORES OF DULLER GROUP (N = 72)

Test	Type of Score	Morning	Afternoon	A	P
Vocabulary	Actual	15.91	16.89	0.357	>.01
Intelligence	"	64.74	63.11	0.918	>.01
Arithmetic	"	67.28	67.07	16.111	>.01
Comprehension	"	14.81	15.82	0.275	>.01

1) Since they are not really necessary, the corresponding t-values have not been given from this point onwards as they were in Tables VI, VII and VIII.

TABLE XIII (Continued)

MEAN SCORES OF DULLER GROUP (N = 72)

Test	Type of Score	Morning	Afternoon	A	P
Vocabulary	Output	29.42	30.46	0.907	>.01
Intelligence	"	132.31	128.74	0.284	>.01
Arithmetic	"	95.50	94.97	2.764	>.01
Comprehension	"	25.99	25.91	38.722	>.01
Vocabulary	Accuracy	54.07	55.36	0.407	>.01
Intelligence	"	48.93	49.02	6.375	>.01
Arithmetic	"	70.29	70.49	3.773	>.01
Comprehension	"	56.92	61.04	0.195	>.01

It is clear that the morning and afternoon performance of neither the brighter nor the duller pupils show any significant differences on all four tests and in all three measures on 24 statistical tests. Here, too, the results are consistently negative. Standard deviations were not compared as previous figures for the total sample (vide Tables IX, X and XI) strongly suggested negative results.

In the next break-down, the sample was divided into two groups of younger and older pupils with 72 in each. The younger group was formed by combining Sub-Groups A_1, A_3, B_1 and B_3, and the older by combining Sub-Groups A_2, A_4, B_2 and B_4. The mean age of the former was 12 years 7 months, and of the latter, 15 years 4 months. Their scores were as follows:-

TABLE XIV

MEAN SCORES OF YOUNGER GROUP (N = 72)

Test	Type of Score	Morning	Afternoon	A	P
Vocabulary	Actual	17.23	18.31	0.281	>.01
Intelligence	"	72.66	71.25	1.305	>.01
Arithmetic	"	69.62	70.23	1.716	>.01
Comprehension	"	15.46	16.84	0.123	<.01

TABLE XIV (Continued)

MEAN SCORES OF YOUNGER GROUP (N = 72)

Test	Type of Score	Morning	Afternoon	A	P
Vocabulary	Output	30.98	32.05	0.710	>.01
Intelligence	"	133.06	131.64	1.666	>.01
Arithmetic	"	94.91	94.88	84.407	>.01
Comprehension	"	26.24	26.43	5.418	>.01
Vocabulary	Accuracy	55.35	56.76	0.378	>.01
Intelligence	"	54.54	53.96	4.965	>.01
Arithmetic	"	73.12	73.74	3.320	>.01
Comprehension	"	58.77	63.51	0.135	<.01

TABLE XV

MEAN SCORES OF OLDER GROUP (N = 72)

Test	Type of Score	Morning	Afternoon	A	P
Vocabulary	Actual	20.24	21.07	0.429	>.01
Intelligence	"	81.86	79.85	0.571	>.01
Arithmetic	"	82.59	81.31	0.437	>.01
Comprehension	"	18.64	18.74	2.569	>.01
Vocabulary	Output	32.09	32.89	1.096	>.01
Intelligence	"	135.16	133.17	0.963	>.01
Arithmetic	"	103.50	103.11	5.046	>.01
Comprehension	"	27.24	27.21	293.000	>.01
Vocabulary	Accuracy	62.68	63.82	1.483	>.01
Intelligence	"	60.43	59.69	1.360	>.01
Arithmetic	"	79.59	78.66	0.548	>.01
Comprehension	"	68.24	68.72	2.833	>.01

The tables show that the morning is not significantly superior to the afternoon for intellectual work either in the case of the younger or the older pupils on all four tests and in all three measures on 24 statistical tests. Again the results are consistently negative against the morning. On the contrary, afternoon performance is significantly better than morning performance with the younger children in the case of actual and accuracy scores in comprehension. This point will be discussed later.

A more detailed analysis of the results, using smaller groups, was next attempted. The sample was divided into the Sub-Groups shown in Table IV. The scores were as follows:-

TABLE XVI

MEAN SCORES OF BRIGHTER-YOUNGER SUB-GROUP (N = 36)

Test	Type of Score	Morning	Afternoon	A	P
Vocabulary	Actual	19.67	21.31	0.219	>.01
Intelligence	"	85.81	82.67	0.467	>.01
Arithmetic	"	78.56	79.31	2.191	>.01
Comprehension	"	17.78	18.67	0.506	>.01
Vocabulary	Output	32.53	34.31	0.265	>.01
Intelligence	"	134.06	134.56	27.420	>.01
Arithmetic	"	98.14	98.92	3.778	>.01
Comprehension	"	26.75	27.61	0.567	>.01
Vocabulary	Accuracy	60.46	62.11	0.687	>.01
Intelligence	"	64.01	61.44	0.208	>.01
Arithmetic	"	80.05	80.17	12.931	>.01
Comprehension	"	66.46	67.61	4.762	>.01

TABLE XVII

MEAN SCORES OF BRIGHTER-OLDER SUB-GROUP (N = 36)

Test	Type of Scores	Morning	Afternoon	A	P
Vocabulary	Actual	23.44	23.67	10.843	>.01
Intelligence	"	93.75	93.31	30.264	>.01
Arithmetic	"	91.28	89.61	0.499	>.01
Comprehension	"	20.81	20.83	483.000	>.01
Vocabulary	Output	34.75	34.64	107.375	>.01
Intelligence	"	137.75	137.58	26.050	>.01
Arithmetic	"	107.67	107.11	5.585	>.01
Comprehension	"	28.22	27.86	1.746	>.01
Vocabulary	Accuracy	67.47	68.32	53.969	>.01
Intelligence	"	68.06	67.82	4.169	>.01
Arithmetic	"	84.78	83.66	0.306	>.01
Comprehension	"	73.72	74.78	0.919	>.01

TABLE XVIII

MEAN SCORES OF DULLER-YOUNGER SUB-GROUP (N = 36)

Test	Type of Score	Morning	Afternoon	A	P
Vocabulary	Actual	14.78	15.31	2.629	>.01
Intelligence	"	59.50	59.83	30.264	>.01
Arithmetic	"	60.67	61.14	5.969	>.01
Comprehension	"	13.14	15.00	0.154	<.01
Vocabulary	Output	29.42	29.78	18.527	>.01
Intelligence	"	132.06	128.72	0.587	>.01
Arithmetic	"	91.67	90.83	2.831	>.01
Comprehension	"	25.72	25.25	1.789	>.01
Vocabulary	Accuracy	50.24	51.40	0.833	>.01
Intelligence	"	45.06	46.48	0.847	>.01
Arithmetic	"	66.18	67.31	0.934	>.01
Comprehension	"	51.08	59.41	0.094	<.01

TABLE XIX

MEAN SCORES OF DULLER-OLDER SUB-GROUP (N = 36)

Test	Type of Score	Morning	Afternoon	A	P
Vocabulary	Actual	17.03	18.47	0.314	>.01
Intelligence	"	69.97	66.39	0.421	>.01
Arithmetic	"	73.89	73.00	1.856	>.01
Comprehension	"	16.47	16.64	21.556	>.01
Vocabulary	Output	29.42	31.14	0.513	>.01
Intelligence	"	132.56	128.75	0.549	>.01
Arithmetic	"	99.33	99.11	26.906	>.01
Comprehension	"	26.25	26.56	7.248	>.01
Vocabulary	Accuracy	57.89	59.32	0.792	>.01
Intelligence	"	52.79	51.56	1.902	>.01
Arithmetic	"	74.39	73.66	5.547	>.01
Comprehension	"	62.75	62.66	100.100	>.01

It is clear from the four preceding tables that morning work shows no superiority over the afternoon on all four tasks and in all three measures on 48 statistical tests. On the contrary, the afternoon session had the advantage in the case of the duller-younger sub-group in respect of actual and accuracy scores in comprehension, a point that will be taken up later.

Finally, the sample was divided into standard groups in order to ascertain whether differences between morning and afternoon performance appeared on the basis of level of attainment of the pupils.

It will be noted in Table XX that N for all classes totals 126 whereas the whole sample comprised 144. This was because some pupils fell away when matching of halves of each class was done, as for the entire group, in order to neutralise practice effects (vide p. 37 of this Report).

TABLE XX

MORNING AND AFTERNOON PERFORMANCE BY STANDARD GROUPS

Test	Type of Score	Std.	N	Session Favoured	A	P
Vocabulary	Actual	II	30	Afternoon	0.898	>.01
Intelligence	"	"	"	Afternoon	3.822	>.01
Arithmetic	"	"	"	Afternoon	6.444	>.01
Comprehension	"	"	"	Afternoon	0.156	<.01
Vocabulary	Output	II	30	Afternoon	12.438	>.01
Intelligence	"	"	"	Morning	0.294	>.01
Arithmetic	"	"	"	Morning	4.565	>.01
Comprehension	"	"	"	Afternoon	16.031	>.01
Vocabulary	Accuracy	II	30	Afternoon	0.361	>.01
Intelligence	"	"	"	Afternoon	0.427	>.01
Arithmetic	"	"	"	Afternoon	1.651	>.01
Comprehension	"	"	"	Afternoon	0.157	<.01
Vocabulary	Actual	III	34	Afternoon	0.573	>.01
Intelligence	"	"	"	Morning	23.225	>.01
Arithmetic	"	"	"	Afternoon	146.333	>.01
Comprehension	"	"	"	Afternoon	1.045	>.01
Vocabulary	Output	III	34	Afternoon	24.125	>.01
Intelligence	"	"	"	Afternoon	23.220	>.01
Arithmetic	"	"	"	Morning	2.151	>.01
Comprehension	"	"	"	Morning	3.485	>.01
Vocabulary	Accuracy	III	34	Afternoon	0.281	>.01
Intelligence	"	"	"	Afternoon	112.625	>.01
Arithmetic	"	"	"	Afternoon	3.450	>.01
Comprehension	"	"	"	Afternoon	0.406	>.01

TABLE XX (Continued)

Test	Type of Score	Std.	N	Session Favoured	A	P
Vocabulary	Actual	IV	42	Afternoon	3.469	>.01
Intelligence	"	"	"	Morning	0.479	>.01
Arithmetic	"	"	"	Morning	1.036	>.01
Comprehension	"	"	"	Morning	2.359	>.01
Vocabulary	Output	IV	42	Afternoon	1.209	>.01
Intelligence	"	"	"	Morning	1.742	>.01
Arithmetic	"	"	"	Afternoon	551.667	>.01
Comprehension	"	"	"	Morning	3.656	>.01
Vocabulary	Accuracy	IV	42	Morning	1308.500	>.01
Intelligence	"	"	"	Morning	0.489	>.01
Arithmetic	"	"	"	Morning	0.499	>.01
Comprehension	"	"	"	Morning	14.650	>.01
Vocabulary	Actual	V	20	Afternoon	2.325	>.01
Intelligence	"	"	"	Morning	0.453	>.01
Arithmetic	"	"	"	Morning	93.000	>.01
Comprehension	"	"	"	Afternoon	1.378	>.01
Vocabulary	Output	V	20	Afternoon	0.354	>.01
Intelligence	"	"	"	Morning	48.889	>.01
Arithmetic	"	"	"	Afternoon	4.389	>.01
Comprehension	"	"	"	Afternoon	25.000	>.01
Vocabulary	Accuracy	V	20	Morning	15.139	>.01
Intelligence	"	"	"	Morning	0.363	>.01
Arithmetic	"	"	"	Morning	1.319	>.01
Comprehension	"	"	"	Afternoon	1.689	>.01

Of the 48 statistical tests shown in the above table, not one significantly favoured the morning. On the contrary, the two differences that did prove to be significant favoured the afternoon performance of Standard II.

Conclusion:

One may conclude, therefore, that the main hypothesis of the study, namely, that morning performance on intellectual tasks is significantly superior to afternoon performance, has remained consistently unsubstantiated

on no less than 168 tests of statistical significance in which morning and afternoon scores of pupils belonging to an afternoon school and ranging from Std. II to Std. V were compared. The absence of significant differences in favour of the morning applies, without exception, to all three measures of work - actual score, output score, and accuracy score. Nor were any significant differences in variability of work found between morning and afternoon performance for the total sample. Considering the powerful nature of the statistical test of significance applied throughout this study and the consistency of the findings, the results could be regarded as conclusive within the framework of the investigation.

(G) DISCUSSION:

The results of this investigation go against everyday notions that the morning is conducive to better intellectual work than the afternoon. In the experiment described, the morning hours favoured neither the more intelligent pupils nor the less, neither the older nor the younger, neither the brighter-younger nor the brighter-older, neither the duller-younger nor the duller-older, and neither the upper nor the lower standards. It seems that afternoon school teachers, at least those in charge of pupils from Std. II to Std. V, need not be demoralised by the fear that they are working with intellectually less efficient children than morning school teachers.

"The human body", says Sandiford (1941), "is a wonderful mechanism which, given a fair chance, will respond to demands made upon it in most surprising and gratifying ways". If it is the case that the afternoon hours are inherently unsuited to serious school work, then afternoon performance on intellectual tasks would show inferiority in relation to morning performance. If, on the other hand, neither the morning nor the afternoon possesses any inherent advantage over the other for intellectual work, then one could reasonably anticipate that children who become accus-

tomed to afternoon work would do somewhat better in the afternoon than in the morning, just as children who are accustomed to working in the morning would be expected to do somewhat better in the morning. It would merely be a matter of being conditioned to a particular time context.

Some evidence in favour of the acclimatisation hypothesis has emanated from the present study for it was seen that some of the differences were actually in favour of the afternoon session. Thus, at the .01 level of confidence, six of the differences favoured the afternoon and none favoured the morning. Three of these were in respect of actual scores and three in respect of accuracy scores in the paragraph comprehension results of the younger, the duller-younger, and the Std. II pupils (vide Tables XIV, XVIII and XX). If the level of confidence is lowered to .05, no less than eleven significant differences favour the afternoon in respect of actual and accuracy scores as against one for the morning, thus:-

TABLE XXI

SIGNIFICANT DIFFERENCES BETWEEN MORNING AND AFTERNOON SCORES AT THE .05 LEVEL OF CONFIDENCE

Test	Type of Score	Group/Sub-Group	N	Session Favoured
Vocabulary	Actual	Total Sample	144	Afternoon
Vocabulary	Actual	Brighter-Younger	36	Afternoon
Comprehension	Actual	Total Sample	144	Afternoon
Comprehension	Actual	Duller-Younger	36	Afternoon
Comprehension	Actual	Younger	72	Afternoon
Comprehension	Actual	Std. II	30	Afternoon
Comprehension	Accuracy	Total Sample	144	Afternoon
Comprehension	Accuracy	Duller-Younger	36	Afternoon
Comprehension	Accuracy	Duller	72	Afternoon
Comprehension	Accuracy	Younger	72	Afternoon
Comprehension	Accuracy	Std. II	30	Afternoon
Intelligence	Accuracy	Brighter-Younger	36	Morning

The most reasonable conclusion to be derived from these results would be as follows: Neither the morning nor the afternoon possesses any inherent superiority for intellectual work. Pupils conditioned to doing

all their serious work during the one session or the other may do somewhat better work on some tests during the session to which they are accustomed. With the data available, no explanation can be advanced to account for the fact that all the differences favouring the afternoon pertained to the two language tests and none to the intelligence and arithmetic test.

How may the results of the present study be interpreted in terms of the theoretical framework advanced earlier, that is, in terms of the distinction between fatigue, impairment, and work output? The variable studied in this experiment has been work output in the absence of fatigue; and it has been shown that under these conditions work output shows no deterioration.

What of the possibility of impairment? It has been stated earlier that change for the better or worse output is no indication of impairment or absence of it. Under conditions of intense motivation the effects of impairment on output may not become apparent, at least for some time. The fact that afternoon school children show no decrement in output is, therefore, no proof that they do not suffer some measure of impairment as a result of active work and play in the morning followed by hours of school work in the afternoon. The interest of the present experiment, however, was on output. The measurement of impairment is the province of physiology and biochemistry and, therefore, beyond the scope of the present study. Nevertheless, the possibility of impairment in afternoon school children seems to be a very remote one.

The problem of fatigue has been dealt with in terms of motivation, which, in turn, has been defined as a problem in interest as far as classroom procedure is concerned. Given the motivation or interest, it is unlikely that deterioration in class performance will result. Even under rigorous laboratory conditions decrement in performance on predominantly

mental tasks has generally failed to appear in spite of the intensification of pressures to a degree not normally encountered in daily life.

In the school, with its restricted hours of work, constant change of occupation, and frequent pauses between lessons, the chances of there being a large decline in performance as the school day wanes, are more remote than in laboratory-controlled experiments. As Pintner (1931) points out, this seems to contradict the experience of many teachers. "They report", he says, "that children are tired out at the end of the school day; that they cannot do 'hard' subjects, such as arithmetic as well as they can in the forenoon. The psychologist believes that what is happening here is not fatigue at all, but physical restlessness due to constraint, boredom due to uninteresting subject-matter, increasing desire to play as the time for play draws near ..... By monotonous, senseless drill, by uninteresting subject-matter, by stupid teaching we may bore our pupils and drive them to hate school and all learning, but even then we are not likely, during the few hours of school each day, to occasion mental fatigue. The chances are that few, if any, students in school or college ever become mentally fatigued". This view is supported, among others, by Valentine (1950) and Smith (1954). In short, there is little danger of "overtaxing the brain" and causing nervous breakdowns as the older writers feared (e.g., Sully, 1910).

The implication is that if a whole class happens to show indifferent response to school work in the afternoon, it is due probably to fatigue or boredom (as defined in this report) rather than to any actual impairment of the mental faculties. A class showing signs of fatigue and boredom does not require the teacher's sympathy; they are a hint that the teacher should dig deeper into his professional resources to create interest, for this experiment has shown that, normally, children are capable of reaching the same mental heights in the afternoon as they are in the morning.

It has been pointed out earlier that extraordinary forms of motivation such as inter-school or intra-group rivalry were avoided in the testing programme in order to keep as close as possible to normal classroom routine. In spite of this precaution, however, it is quite clear that the nature of the tests, their format, the presence of the experimenter and the manner in which the whole testing schedule was administered constituted a departure from ordinary classroom experience and thereby functioned as motivating influences in their own rights. However, these factors cannot be regarded as having distorted the results in any way since they applied to both the morning and afternoon sessions and so, like practice effect, were neutralised. The case would have been the same even if competition had been used as a motivating factor.

Finally, is it possible that afternoon performance did not show a drop because what was done during the experiment was testing of children and not learning by children, and that teaching children and testing them are two different matters? This, also, is unlikely.

It implies that in the teaching situation more intellectual effort is demanded of children than was the case in the testing situation and that, therefore, there is a greater tendency towards diminished mental efficiency during the ordinary school day than there was during the present experiment. It is believed, on the contrary, that the experimental programme was intellectually more demanding than the programme of an ordinary school day. The pupils worked under pressure throughout, being timed by stop-watches on thought-provoking tasks. No mere reproduction of learned facts was involved. There was very little of actual writing to be done by pupils. Pencils were used and rulers forbidden in order to provide as much time as possible for thinking. For the same reason, the tests selected were pitched relatively low, in order to encourage even the dullest child to think so as to reduce guessing which would not have involved much mental

effort. Not many pupils completed the tasks in the time given, and most of them who did complete tests did so only by wildly guessing the last few answers as the allotted time expired.

In contrast, normal class routine is a more leisurely matter than was the experimental programme. In class, there are more intervals between lessons for rest and recuperation on the part of the children, there are frequent changes of lessons, "easier" subjects alternate with the "harder" ones, there is humour, there are interruptions of one kind or another, and so on. The experimental programme, on the other hand, was deliberately conducted with clock-like precision, and though interest was maintained throughout, there was little relaxation of intellectual pressure. Even during those periods when teaching was done by the experimenter, it was the pupils who were made to do all the thinking and provide all the answers.

Although the results of the present experiment are conclusive and in line with those of previous related investigations, it must be made clear that just one experiment such as the one described cannot give the full picture of what happens in the Indian afternoon school as far as efficiency on intellectual tasks is concerned. There is need for further experimentation. It would be useful to replicate this study using only girls or only "morning school" children; or the more arduous but immediately more important task of carrying out a similar experiment with the sub-standards may be undertaken, for it should be noted once more that the study described here concerned relatively mature pupils, whereas, when teachers report reduced mental efficiency in the afternoon school, they generally have the very young ones in mind. However, until such time as evidence to the contrary is forthcoming, teachers in afternoon schools should plan their work on the assumption that there is no deterioration of intellectual functions in the children they teach in the afternoon.

ABSTRACT

Questionnaires answered by a number of suitably experienced Indian teachers revealed that there was a wide-spread conviction that pupils in Indian afternoon schools did not and could not work at their full mental potential because they had lost their morning freshness and were tired and unfit for school work in the afternoon.

To check this, 144 pupils of an afternoon school were tested on intellectual tasks in the morning and in the afternoon in order to ascertain whether there were any significant differences in performance between the two sessions. Tests of vocabulary, intelligence, mechanical arithmetic, and paragraph comprehension were used.

Performance during the two sessions was compared in respect of actual scores, accuracy, gross output, and variability on the four tests. The data was broken down in several ways on the bases of age, intelligence, and level of attainment of the pupils for the purpose of making detailed comparisons. In all, 168 tests of statistical significance were carried out.

It was found that on none of the measures did morning work show superiority over afternoon work at the .01 level of significance. On the contrary, six of the differences significantly favoured the afternoon.

It was concluded that neither the morning nor the afternoon possesses any inherent advantage over the other for work of an intellectual nature in school. The apparent superiority of the afternoon on six of the differences (eleven, if the .05 level of significance was used) was attributed to the fact that the pupils used in the study were conditioned to schooling in the afternoon.

It was stressed that motivation was of crucial importance in studies of this kind. It was suggested also that the drawing of a clear-

cut distinction between fatigue and impairment would do much to clear the confusion that has characterised work in this field previously.

ANNEXURE

UNIVERSITY OF NATAL

INSTITUTE FOR SOCIAL RESEARCH

KING GEORGE V AVENUE DURBAN TELEPHONE 59852

QUESTIONNAIRE: INDIAN STUDY

TO TEACHERS WHO ARE IN OR WHO HAVE PREVIOUSLY TAUGHT IN AFTERNOON PLATOON SCHOOLS:

With the sanction of the Education Department and the kind permission of your Principal, a research is being conducted into the influence of certain environmental and cultural factors on the performance of Durban Indian School children on intelligence and scholastic tests. Your own co-operation is indispensable to the success of the project and is now sought.

In the present state of Indian education Afternoon Platoon Schools are fulfilling a most important function in that they are providing education for thousands of children who would otherwise be out of school. However, the interest here is not upon the merits of the Afternoon School System but upon some of its possible disadvantages from the pedagogical or teaching point of view, as providing bases for research.

You, as an individual who is in direct daily contact with the children involved, are in a very favourable position to outline the disadvantages of the system. If you consider that disadvantages exist, it will be highly appreciated if you list not more than three of the difficulties that you experience in teaching children in the afternoon, difficulties that are peculiar to the Afternoon School and not experienced by teachers in the regular Morning Schools, or, at least, not experienced to the same extent.

Write down your difficulties behind this sheet in order, beginning with what you consider your most serious difficulty, and hand the sheet to your Principal who will forward it to me.

If you feel that there are no educational difficulties peculiar to the teaching of children in the afternoon, please state so behind this sheet. You are not being asked to imagine difficulties where there are none. A negative return will be just as highly appreciated as a positive one.

It must be emphasized that your own personal opinion deriving from your own personal experience is being sought. Hence your reply should not result from a discussion of the matter, say, with the rest of the staff. There are no "right" or "wrong" opinions.

Your contribution will be kept confidential. The interest is on what is said rather than on which particular individual says it. Therefore, you need not sign your name at the bottom of the sheet if you do not wish to do so.

It is confidently expected that in the interests of research you will favour us with your opinion.

C. RAMPHAL
RESEARCH FELLOW

Note for Principal:

As soon as all your teachers have completed their questionnaires, please forward them to me, c/o Institute for Social Research, University of Natal, Howard College, King George V Avenue, Durban.

P. T. O.

SCHOOL:

Do you think that there are certain difficulties peculiar to the teaching of children in an Afternoon School? (Please answer Yes or No):

.....

If your answer is "Yes", outline below three of these difficulties, taking care that if you mention more than one difficulty, they do not "overlap". You may be as detailed as you like. Examples from personal experience will be most welcome.
If your answer is "No", you need not proceed further.

1. .....

.....

.....

.....

2. .....

.....

.....

.....

.....

3. .....

.....

.....

.....

.....

Have you ever taught in (1) a "Morning" School? .....
(2) an "Afternoon" School? .....

Length of teaching experience in completed years:

.....
Date

.....
Name of Teacher

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