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DISSERTATION

**EVALUATION OF A PERSONAL HEAT STRESS
MONITOR UNDER DYNAMIC CONDITIONS**

Submitted by

Cynthia Ellwood

Department of Environmental Health

In partial fulfillment of the requirements

For the Degree of Doctor of Philosophy

Colorado State University

Fort Collins, Colorado

Summer 2000

UMI Number: 9986279

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COLORADO STATE UNIVERSITY


March 26, 1999


WE HEREBY RECOMMEND THAT THE DISSERTATION PREPARED
UNDER OUR SUPERVISION BY CYNTHIA ELLWOOD ENTITLED
EVALUATION OF A PERSONAL HEAT STRESS MONITOR UNDER DYNAMIC
CONDITIONS BE ACCEPTED AS FULFILLING IN PART REQUIREMENTS
FOR THE DEGREE OF DOCTOR OF PHILOSOPHY.


COMMITTEE ON GRADUATE WORK

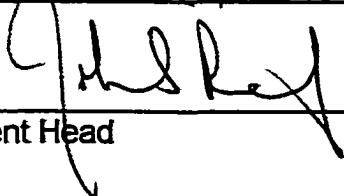










Advisor) 

Department Head

ABSTRACT OF DISSERTATION

EVALUATION OF A PERSONAL HEAT STRESS MONITOR UNDER DYNAMIC CONDITIONS

The Quest Electronics Questemp[®] II Personal Heat Stress Monitor was evaluated as to the ability of the adjusted-ear temperature measured and recorded by the instrument to equal a synchronous recording of the esophageal temperature and this equality would be maintained throughout all transient conditions.

Two female and eight male subjects each performed eighteen tests in a hot environmental chamber. Each test included an exercise and rest phase. The tests were differentiated by exercise and rest temperatures, presence or absence of air movement, metabolic exercise load and clothing. The internal heat load was generated by having each subject exercise on a stationary bicycle.

The instrument is intended to be used in conjunction with an effective heat stress management program as an alerting device when the wearer's core temperature has risen to unsafe levels. The study has shown that the monitor has deficiencies in accurately determining the body's core temperature. These deficiencies lie in the monitor's calibration method and the internal algorithm, which manipulates the actual ear canal temperature to an adjusted-ear temperature.

Taking into account these deficiencies, the instrument can serve as an adjunct tool in the overall management of employee exposure to heat stress, which includes environmental assessment, medical surveillance, worker education and self-determination.

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1.0 Introduction

Environmental heat and humidity, various degrees of protective clothing requirements, and physical work demands are present in work conditions where occupational heat stress is prevalent. When workers are placed in this type of environment, they will experience several physiological responses to the heat stress. These responses include increased heart rate, a rise in core body temperature and initiation of the sweating mechanism. The combinations of these responses are referred to as physiological heat strain. The severity of heat strain will not only depend on the magnitude of the total heat stress, but also on the efficacy of an individual's thermoregulatory mechanism.

The physiological responses of heat strain, under tolerable heat stress conditions, enable the body to regulate its core temperature, thus maintaining a thermal steady state. Exposure to intolerable heat stress conditions can overtax the body's thermoregulatory defenses and lead to an ever-increasing core body temperature, heart rate, and sweat loss. The result of such strain may result in an increased risk of heat illnesses, ranging in intensity from mild cardiovascular strain to severe central nervous system damage.

The major heat illnesses are heat cramps, heat syncope, heat exhaustion and heatstroke. Heat cramps are involuntary muscle spasms and generally

occur in voluntary skeletal muscles of the legs, arms and abdomen or in the specific muscles that have been exercised. Heat syncope involves a pooling of the blood in the lower extremities and dilated cutaneous vessels. This leads to systemic and cerebral hypotension and if left unchecked, results in unconsciousness. Heat exhaustion can occur in an individual with normal or elevated core body temperature. Its symptoms include weak, rapid pulse, hypotension while in the upright position, headache, fatigue, nausea, and clammy, moist skin. Heatstroke is the most severe heat illness and is a true medical emergency. In the case of heatstroke, an uncontrolled rise in core body temperature occurs which often results in damage to the central nervous system and numerous vital organs.

Heat stress evaluation in the occupational environment attempts to predict the heat strain of a working population by measuring environmental parameters and estimating internal heat loads. The environmental parameters include meteorological measurements of ambient air temperature, air movement, radiation, and water vapor pressure of the air. Internal heat load is estimated through different forms of task analysis, which range from placing the job into various work load categories, to detailed task analyses techniques, similar to those used in ergonomic evaluations. Over 14 different heat stress indices have been developed; none of which has been universally accepted as a valid system for predicting heat strain in a working population.

The lack of a universal system is, in part, due to the extreme complexity of interactions of determining heat stress factors. Those factors involve the transfer of heat between the skin and the environment and the factors that determine the unloading of metabolic heat from within the body to the skin. Factors that operate in the former heat transfer process include air temperature, air speed, relative humidity, temperature and emissivity of the surrounding solids, skin water vapor pressure, skin temperature, effective surface area of the skin, and clothing. Some factors involved with unloading metabolic heat from the body to the skin are metabolic heat production, skin temperature, core temperature, circulation of blood to vital organs, working muscles and skin, sweat production, and the level of hydration. Attempting to relate all the factors involved with drawing heat from the body to the skin and then releasing the heat to the environment within one heat stress index has been unsuccessful.

Regardless of this nonsuccess, the wet bulb globe temperature (WBGT) index has been accepted as the standard for evaluating heat stress by the American Conference of Governmental Industrial Hygienists, the National Institute for Occupational Safety and Health, the Occupational Safety and Health Administration, and the International Standards Organization (1,2,3,4).

Despite the acceptance of the WBGT index, the index does not provide consistent and reliable predictions for individual heat strain. Inherent limitations of the index fail to account for unacclimatized, unfit workers; workers that are unhealthy or are taking medication that may interfere with their thermoregulatory

system; healthy workers of different heat tolerance levels; subjective biases in an evaluator's determination of the metabolic (internal) heat production; the lack of a safe tolerance time and a time for recovery when the internal and external heat loads do not allow heat balance to be established; and different clothing than assumed in the empirical derivation of the index.

A more accurate assessment of whether the occupational environment will lead to heat strain should involve determining heat strain parameters of the worker. Physiological monitoring of the worker would allow a direct determination of the worker's health status. Core body temperature is a measure of the thermal state of the body (5). As such, its value will reflect the effects of environmental heat loads, physical work demands, individual variables, and wearing protective clothing. Ideally, core temperature would be measured in the pulmonary artery; however, non-invasive surrogates must be substituted in workplace environments. There are four requirements for an ideal surrogate as a measure of core temperature; 1) the site must be convenient, 2) the values obtained must not be influenced by environmental conditions, 3) the measured changes must reflect subtle changes in arterial blood temperature, and 4) the response time of the surrogate temperature change in following the actual core temperature change must be at a sufficient rate (6,7). An individual's core temperature is often measured at the esophagus, rectum, mouth, or external ear canal. It is essential that an accurate measure of the thermal state of the body also fit within the limitations found in occupational environments.

An instrument that measures external aural canal temperature, the Questemp° II, is currently being used as a personal heat stress monitor in occupational environments. It has not been determined, however, if the instrument serves as an accurate surrogate measure of core temperature. This research project evaluated and compared the accuracy and reliability of the Questemp° II personal heat stress monitor to the thermal state of the body, under various physiological conditions, as measured by esophageal temperature.

2.0 Literature Review

2.1 Occupational Heat Stress

Heat stress is the combination of environmental factors and physical work factors that constitute the total heat load imposed on the body. The environmental parameters of heat stress are the air temperature, water vapor pressure, radiant heat, and air movement. Physical work contributes to the total heat stress imposed on an individual by producing metabolic heat in proportion to an individual's work intensity. The type and amount of clothing worn also affect the total heat stress on an individual, which influences the exchange of heat between the body and the environment.

Heat strain is a series of physiological responses to heat stress. General physiological responses are in the forms of an increase in mean core body temperature, elevated heart rate and an increase in sweat rate and amount. The severity of heat strain will depend not only on the magnitude of the total heat stress, but also on an individual's thermoregulatory mechanism and the physiological factors that influence it.

Heat stress is termed either compensable or uncompensable. Heat stress that is compensable can be tolerated and the thermoregulatory process is able to maintain a thermal steady state. Uncompensable heat stress cannot be

tolerated due to the inability of the body's thermoregulatory mechanism to achieve or maintain a thermal steady state. Under the circumstances of uncompensable heat stress, there is a rise in core body temperature ensued by one or more heat illness.

Heat illnesses have been described as a spectrum of disorders that range in intensity from mild cardiovascular strain to severe central nervous system damage. Heat illnesses have been given distinct terms which may lead some individuals to assume that each malady is a clearly defined entity, however, there is considerable pathophysiological overlap between them. The pathological classifications of heat illnesses are heat cramps, heat syncope, heat exhaustion and heat stroke.

Heat cramps are involuntary muscle spasms and generally occur in voluntary skeletal muscles of the legs, arms and abdomen or in the specific muscles that have been exercised. Individuals that experience heat cramps do so after several hours of strenuous exercise or work when large volumes of sweat have been secreted, large volumes of water have been consumed and small volumes of urine have been excreted. Heat cramps begin as small twitches in the affected muscles. There is a localized contraction affecting only a few muscle bundles that can be accurately located by the victim. As one bundle relaxes, an adjacent bundle contracts. The alternating contractions give the victim the feeling that the cramp is wandering through the muscle. Severe heat cramps can be excruciatingly painful.

Several studies have indicated that heat cramps are more prevalent in unacclimatized individuals than acclimatized persons. A review of heat illnesses by Shibolet, *et al*, suggest that acclimatized individuals are less likely to experience heat cramps as compared to unacclimatized persons (8). Two additional analyses, as cited in *Human Performance and Environmental Medicine at Terrestrial Extremes*, support improved heat cramp resistance with heat acclimation (9).

A mild form of heat illness is heat syncope and occurs fairly early in the course of heat exposure. It usually occurs when an individual is involved in strenuous work or exercise or when there is a sudden rise in ambient temperature or humidity. Heat syncope is associated with a series of cardiovascular events such as the shunting of a large volume of blood through dilated cutaneous vessels, postural pooling of blood, reduced venous return to the heart, reduced cardiac output, and cerebral ischemia. A study by Bean and Eichna showed that the cardiovascular adaptations resulting from heat acclimation lead to a rapid decline of syncopal episodes (10).

Heat exhaustion is usually characterized by nonspecific symptoms such as a weak, rapid pulse, low blood pressure while in the upright position, headache, dizziness, and general weakness. More specifically, heat exhaustion is believed to be caused by ineffective circulatory adjustments compounded by a depletion of extracellular fluid due to excessive sweating. An individual may have an elevated or normal core body temperature with profuse sweating and

normal mental capacity. In euhydrated individuals, Sawka, *et al*, observed heat exhaustion at a rectal core body temperature of 38.5 C for 25% of the subjects, while 75% of the subjects experienced heat exhaustion at 39.1 C (11). All subjects experienced heat exhaustion before a rectal temperature of 40 C was achieved (11). Sawka's research suggests that heat exhaustion can occur over a wide range of rectal temperatures without indicating a specific threshold temperature where the illness will predictably occur.

Heat exhaustion is associated with two forms of dehydration. Water depletion heat exhaustion can result in a matter of hours and is characterized by thirst and oliguria, and can be completely relieved by the administration of pure water. Salt depletion heat exhaustion is due to a negative salt balance resulting from either low dietary NaCl, high losses of NaCl through excessive sweating, or both. This form of heat exhaustion is not characterized by thirst and cannot be relieved by administration of salt-free fluids. Salt depletion heat exhaustion requires at least 3 to 5 days to develop and usually occurs in unacclimatized individuals who have not fully adapted their electrolyte conserving mechanisms associated with acclimatization.

Heatstroke is differentiated from heat exhaustion by higher core body temperatures, more severe changes in neurological status, and the degree of serum enzyme elevation. Significant alterations in neurological symptomology include confusion, disorientation and coma. Widespread health effects from heatstroke include the destruction of cell membranes, body-wide tissue damage

and global organ dysfunction. The rectal core body temperature that is the boundary between heat exhaustion and heatstroke is usually defined as 39.4 to 40.0 C (9).

It has been observed that the severity of health effects due to heatstroke is dependent on three body temperature factors. A debate, however, continues regarding the contributory importance of each factor, whether acting alone or in combination, and their influence upon heatstroke severity. Those factors include the absolute increase in body temperature, the rate of rise in body temperature, and the duration of the hyperthermia. A rise in core body temperature sufficient to cause heatstroke can be reached: 1) actively, by pursuing physical activities; 2) passively, by gaining heat from the environment; 3) following the deterioration of heat dissipation; or, 4) through a combination of these events.

It is estimated that over six million workers in the United States may be exposed to occupational heat stress (12). Jensen analyzed workers' compensation claims filed in 1979 for heat illnesses (4). The results of the study found the highest rate of compensation cases for heat illness are in agriculture (9.16 cases per 100,000), construction (6.36/100,000) and mining (5.01/100,000) (4). More recent statistics indicate that agriculture, construction and mining are still the leading industries for exposure to occupational heat stress. In 1991, Dr. Antonia Novello, Surgeon General of the U.S. Public Health Service, stated that agricultural workers are at the highest risk of developing heat stroke compared to all other workers, including miners and construction

workers (13). The conference at which Dr. Novella spoke recognized "occupational cardiovascular disease - heat stroke" as one of the leading work related diseases and injuries for agricultural workers (14). In addition to agricultural and construction workers, one recent study identified disaster relief workers at risk to heat stress. A review of reported injuries and illnesses among the Illinois National Guard troops during a flood relief response in 1993 found heat-related injuries and illnesses accounted for the most frequent injury diagnosis (15). The relief effort lasted from July 5 to August 18, 1993. During this period, 23 of 119 injuries were reported as heat-related injuries.

While heat stress has been directly linked to occupational illnesses, it also plays a role in the safety-related behavior of workers. It has been shown that the safety-related behavior of workers is detrimentally affected and increases with increasing heat load (16). The influence of heat stress on safety can easily be seen when accident rates increase in heat exposed workers during hot seasonal periods versus cooler seasonal periods. A study of 500 helicopter accidents and incidents due to pilot error was conducted during the months of May through October (17). The study compared heat stress conditions on days with and without the occurrence of pilot errors. The results found a dose-response relationship between heat stress and pilot error. The relationship indicated an increased risk of pilot error as the ambient air temperature increased.

Human performance has been shown to decline as the mean core body temperature rises (16,18). Moreover, performance limits for workers to safely and effectively complete their tasks are encountered prior to the limits of physiological functioning. A body temperature rise of 1.67 C has been represented as the physiological tolerance limit for humans (18,19). Whereas, the temperature values of 1.33 C, 0.88 C, and 0.22 C, represent the rise in core body temperature for the onset of impaired mental performance, degradation of tracking performance, and the limitation to successfully perform dual tasks, respectively (18).

An additional observation regarding heat stress and worker performance involves worker perception and interpretation of heat strain symptoms. The general sensations of fatigue or exhaustion experienced by workers performing strenuous tasks are not easily distinguishable from more serious symptoms of hyperthermia. Even when the symptoms are noticed, highly motivated workers may choose to ignore the signs of imminent danger, thus placing themselves in a potentially life-threatening situation.

2.2 Human Thermoregulation

Body temperature is non-uniform between the core of the body, the extremities, and the tissues of the skin (20). The temperatures of the entire body, however, are somewhat simplistically classified as core body temperature (T_c) and skin temperature (T_{sk}) (21). The core body temperature is defined as

the temperature of the deep central area including the heart, lungs, abdominal organs, and the brain.

The regulation of core body temperature primarily involves physiological adjustment of the cardiovascular and the secretory systems in an attempt to maintain homeostasis. The cardiac muscle, smooth muscles of the blood vessels, and the eccrine glands are controlled by the autonomic nervous system via sympathetic and parasympathetic nerve fibers. The central controller is the hypothalamus, where the integration of afferent signals and the generation of efferent signals occurs.

The hypothalamus receives signals from temperature receptors located in the skin and in deep body sites (9). The temperature receptors located in the deep body sites are known to exist in the area of the carotid arteries and postulated to exist in the hypothalamus (9). There are three types of temperature receptors in the skin: 1) One type reacts to heating with a transient burst of activity along with an increase of static activity; 2) one type reacts to cooling with a transient burst of activity with an increase of static activity; and 3) the last type reacts to warming and several other stimuli with a continuous discharge (9). It is unclear as to the exact weighting of the signals received in the hypothalamus. It is believed the signals are integrated in the hypothalamus and a response is initiated based on hypothalamic interpretations relative to a temperature set point. The set point is the reference temperature used by the hypothalamus in the control of all thermoregulatory responses. It is the set point

value that determines the threshold for each thermoregulatory response. The temperature set point is not fixed and is known to be affected by physical training, heat acclimation, time of day, pyrogenic agents and the menstrual cycle. If these factors alter the set point, then there is a corresponding change in the threshold for each effector response.

The effector signals generated in the hypothalamus lead to responses of the sweat (eccrine) glands, active vasodilation of the skin arterioles, abolishment of the vasoconstrictor signal on the cutaneous superficial veins, and possibly vasoconstriction of the deep veins that drain skeletal muscle (9,22).

Vasodilation of the skin arterioles facilitates increased skin blood flow volume to the surface of the skin. The passive venodilation of the cutaneous superficial veins provides a reduction in skin blood flow rate via the vessels inherent compliant capacity, thus providing a longer transit time at the surface of the skin. The possible vasoconstriction of the deep veins draining the skeletal muscle allows the warmed blood to return to the core only after it has flowed through the skin, rather than returning to the core directly from the deep muscles. These responses increase skin blood flow in an attempt to enhance radiant and convective heat transfer from the skin surface to the environment.

Sympathetic cholinergic fibers innervate the eccrine glands and stimulate the sweating response. The sweating response transfers heat from the skin surface to the environment through the evaporation of sweat from the surface of the skin. The increased skin blood flow carries large quantities of warmed blood

from the core to the skin surface where it is cooled and then returned to the core. If the initial rise in skin blood flow and sweat secretion does not sufficiently cool the core, the negative feedback loop within the thermoregulatory system increases the effector signals. The subsequent response is then 1) to further increase skin blood flow; and 2) to first, recruit more eccrine glands and second, to stimulate an increase in sweat secretion of previously responding eccrine glands.

The effector signal upon the eccrine glands is not only affected by a continued rise in T_c , but is also enhanced by a rise in local skin temperature. It is currently unclear, however, as to the effect of local skin temperature upon observed increases in sweat response. The local skin temperature may facilitate an increase in the neurotransmitter release, or possibly the increased skin temperature sensitizes the eccrine gland to the neurotransmitter (9).

When increased muscular activity (exercise or work) is performed in a temperate environment, heat generated from the increase in muscle metabolism will cause an increase in core body temperature without a concomitant rise in skin temperature. The hypothalamus receives information on this core body temperature rise and initiates heat-dissipating responses which are generally sufficient to re-establish thermal balance.

In contrast, when strenuous work or exercise is performed in a hot environment, there can be a rise in core body temperature due to increased muscular activity and heat gain by the skin through radiant and/or convective

heat exchange from the environment. Under these circumstances the capacity of the thermoregulatory system can be exceeded. An increase in muscular activity in a hot environment poses three fundamental problems. The first is the competition between the skin and the active muscle for blood flow, such that these two demands may exceed the pumping capacity of the heart. The second is the increase in skin blood flow displacing central blood volume into the cutaneous veins, thus lowering cardiac filling pressure and stroke volume. When this occurs, a reduction in cardiac pumping capacity occurs when the demand for blood flow is highest. A third problem arises in that copious sweating (without adequate rehydration) can lead to dehydration and result in decreased blood volume. This adds to the already compromised lowered central blood volume caused by the increased skin blood flow and muscular demands.

The physiological tolerance of the human body to hyperthermia has been determined based on information obtained during the use of systemic hyperthermia as a treatment method for metastatic systemic cancer. Systemic hyperthermia has a temperature limitation of 42 C based on normal organ tolerance of the liver and the brain (23). Information on localized hyperthermia of the brain and spinal cord indicates that the safe upper limit lies in the range of 42.0 to 42.5 C for 60 minutes and at 43 C for 10 to 20 minutes (24).

2.3 Heat Stress Measurement

During increased muscular activity in hot environments, the magnitude of strain that heat stress imparts on the body depends on the rate of metabolic heat

production, the core to skin temperature gradient, cutaneous blood flow, the rate of sweat production, evaporative heat loss, relative humidity, air movement, radiant heat load, and the ambient air temperature. An ideal method to determine heat stress in the workplace would consider all these factors. It has proven to be extremely difficult to incorporate all the interactions of the above factors into a usable measure of heat stress. As a result, the parameters used to assess heat stress have been based on the pathways for heat exchange: evaporation, convection, conductance, and radiation. The parameters measured to calculate or estimate the potential effects of the environment are the meteorological measurements of ambient air temperature, air movement, radiation, and the water vapor pressure of the air. Some heat stress assessment methods have also attempted to determine heat production from metabolic activity and incorporate that value into a heat stress formula. The goal of current heat stress assessment methods has been to combine the environmental and metabolic factors in such a way, that an index value is obtained. The heat stress index value is then used as a predictive term of physiological heat strain. The attempt has been to create an index that provides the same physiological meaning regardless of the magnitude of the parameters that contribute to the index. In addition to having physiological significance, several researchers have stated that the determination of heat stress indices should: incorporate non-complex measurements and calculations; be applicable to a wide range of work conditions; and be proven in industrial practice (25). Five indices of heat stress

that attempt to meet the above criteria have been recommended for field use. These indices are the Corrected Effective Temperature (CET); the Predicted Four-Hour Sweat Rate (P4SR); the Belding and Hatch Heat Stress Index (HSI); the Wet Globe Temperature Index (WGT); and the Wet Bulb Globe Temperature Index (WBGT).

The Corrected Effective Temperature scale was derived through an adaptation of the Effective Temperature (ET) scale. The ET scale was intended to assess the subjective comfort of dry and wet bulb temperatures and air movement, using as reference still, saturated air in which the immediate sensations of warmth experienced were identical to those in a test climate. The test climate was generated through various combinations of dry and wet bulb temperatures and air movement. The CET was developed by replacing the dry bulb temperature with a globe temperature to account for radiant heat. The CET is presented as a nomogram and can be obtained by connecting the globe temperature and the wet bulb temperature and noting the point at which the line intersects the curves representing air velocity. The CET is then read from the curve at the appropriate air velocity.

As will be noted for other heat stress indices, the CET has limitations with regard to specifications of an ideal heat stress index. The CET exaggerates the effects of high dry bulb temperatures in air movements of 0.0-3.5 meters per second, and underestimates the effects of low air movement in hot and humid environments. Additionally, the same CET generated through different climates

does not impose the same physiological strain as determined through rectal temperature, tolerance times, and heart rates. Since the scale does not consider work rates performed in the environment, the obtained CET would be without value if the energy expenditure of the worker was not noted.

The Predicted Four Hour Sweat Rate (P4SR) scale was devised empirically by exposing young, physically fit, acclimatized men to a variety of climates under different energy expenditure levels, while wearing shorts or overalls in a sitting position, and measuring their sweat losses. The nomogram developed from this data is used to determine the amount of sweat loss to be expected from individuals exposed to heat stress conditions for 4 hours. The P4SR is presented as a nomogram and consists of three parts: a straight line scale representing the globe temperature, a straight line scale representing the wet bulb or modified wet bulb temperature, and a series of curves between the lines representing the P4SR at different air velocities. A value greater than 4.5 liters for the P4SR predicts that fit, well acclimatized men will not be able to tolerate 4 hours of exposure in the environment.

Inherent limitations of the scale include modifying the wet bulb temperature to account for differences in the dry bulb and globe temperatures; energy expenditure levels exceeding the value generated from sitting in a rest position; and clothing worn that imposes a greater stress than imposed by shorts. The scale is limited in predicting sweat losses for unacclimatized and physically unfit individuals since its was derived from fit, acclimatized, young

men. The scale has been found to be inaccurate in low humidity environments and is not recommended for use below a relative humidity of 40% (26). The scale is questionable in environments that are not stable for a 4 hour period, since the sweat rate can change depending on different environmental conditions. An advantage of the P4SR scale is that it can be a useful predictor of sweat losses, and therefore, of the water requirements for the individuals working in the environment.

The Heat Stress Index (HSI) was constructed on the basis of heat-exchange coefficients for radiation, convection and for metabolic heat production. The sum of the coefficients represents the total heat load to be dissipated by sweat evaporation (E_{req}) towards the maintenance of thermal balance. The likelihood that thermal balance could be obtained is dependent on the evaporative capacity (E_{max}) of the environment. The potential for thermal balance is determined from the ratio of E_{req} to E_{max} , assuming the skin to be fully wetted with sweat. The value for the HSI is this ratio times 100. An HSI equal to 100 is interpreted as the maximum strain tolerated by physically fit, acclimatized young men. An HSI of zero indicates no thermal strain, whereas values between 0 and 100 indicate increasing levels of heat strain as 100 is approached. There are two equations used to determine the heat exchange coefficient, one for workers clothed in a shirt and trousers, and another for workers in shorts and shoes (semi-nude).

An advantage of the HSI is that it incorporates the total heat load from both the climatic conditions and the heat generated from physical activity. One disadvantage is the complexity of obtaining the heat exchange coefficients necessary in calculating the HSI.

The Wet Bulb Globe Temperature Index (WBGT) is determined through three temperature measurements: air temperature (air), globe temperature (globe), and natural wet bulb temperature (nwb). Air velocity readings are not required as the effects of air movement are reflected in the wet bulb temperature. The three temperature measurements of the WBGT index combine the effects of relative humidity, air temperature, air movement and radiation into one value through the following calculations:

for outdoors in sunshine:

for indoors or outdoors in shade:

where, *nwb* = normal wet bulb temperature; *globe* = globe temperature; *air* = dry bulb temperature.

Limits of heat exposure have been developed which relate the WBGT index with different workload levels. The limits were developed to prevent workers from exceeding a core body temperature of 38 C (100.4 F) during a heat stress exposure. Studies performed by Lind on his self-defined Prescriptive Zone (PZ) were used as the basis in determining the combinations of environmental heat loads and physical work loads which 95% of an acclimatized population could tolerate without their core body temperatures exceeding 38 C.

In the PZ, an individual's core body temperature is dependent only on work intensity, rather than the combination of work intensity and climatic factors. In the range of environmental heat where the climatic conditions in combination with workload influence the core body temperature, the zone is referred to as the Environmental Driven Zone (EDZ). The environmental temperatures and workloads at the boundary between the upper level of the PZ and the lower level of the EDZ are referred to as the Upper Limit of Prescriptive Zone (ULPZ) (25). The original environmental values of the ULPZ collected by Lind were expressed as the Effective Temperature Index. The ET values were converted to the WBGT index using Minard's graph developed in 1964 at the Naval Research Medical Institute (25). The ULPZ limits obtained in this manner were then adopted by the American Conference of Governmental Industrial Hygienists as the Heat Stress Threshold Limit Values (TLVs) (1).

One criticism of these exposure limits is that they were determined from data collected in reference to the Effective Temperature scale, which is a subjective comfort scale. Several researchers have concluded that the TLVs for heat stress are lower than necessary to protect workers and that mental performance is unimpaired at WBGT index values higher than the limits (27). An additional criticism stems from observing different physiological responses at the same WBGT index. This is due to different combinations of climatic parameters of air temperature, relative humidity and radiation calculated to give the same WBGT index (27).

The Wet Globe Temperature (WGT) is determined from a wet globe thermometer, which consist of a bimetallic thermometer set inside a blackened globe. The globe is covered with a blackened cloth that is saturated with distilled water throughout the WGT measurement period. The wet globe thermometer integrates heat loss by convection, radiation, and evaporation into one index. It is presumed that the wet globe exchanges heat with the environment by the same mechanisms as a nude man with fully wetted skin in the same environment. The major advantage of the WGT is its simplistic design and ease of use. It is also extremely durable and the most portable of all the instruments currently used in occupational settings. The WGT requires a stabilization period of 5 to 15 minutes depending on the heat load of the surrounding environment.

The WGT has several disadvantages. The index does not incorporate the heat load due to physical activity into its design. Due to its large wet surface area, relative humidity and air movement adversely affect the WGT. The WGT has been compared to the WBGT index in both laboratory and field settings resulting in high correlation. However, in settings that are hot and dry, the WGT index reads significantly lower than the WBGT index. Thus, in lower relative humidity environments, the large wet bulb of the WGT responds with greater evaporative heat loss than the WBGT (3).

Each of the indices described has its own inherent limitations, which were briefly discussed. The indices also share a number of limitations that stem from

the original research conducted to establish the particular index. The indices call for the adoption of simplifying assumptions that do not have universal validity. All the indices described above used young, physically fit, acclimatized 'standard' men to establish the heat stress index for the strain response under investigation. A standard man is defined as weighing 70 kilograms and having a skin surface area of 1.8 square meters (3). Through personal observations, the segment of the working population performing work in hot environments does not meet the criteria for a standard man. The protocol for most research studies had the men dressed in either shorts and shoes (semi-nude) or in lightweight shirt and trousers. There are many working environments that allow for the workers to wear only a lightweight shirt and trousers, however, there are also many environments that require the use of protective equipment that inhibits heat loss through evaporation.

For those indices where the metabolic rate of physical activity must be determined, energy expenditure tables have been established. The values that must be assigned from the table assume, once again, that the worker is a standard man. This assumption can lead to an underestimation or overestimation of a worker's actual energy expenditure rate. An additional limitation in determining metabolic rate from the tables is the lack of consideration on the influences of metabolic activity from dietary intake or medication. From the perspective of applying the values obtained from the tables to an actual workforce, one must also consider that one worker may not

perform the same job in a similar manner as another worker. This would result in two different energy expenditure values for the same task, which results in difficult management of heat stress evaluations within an industrial setting.

One final limitation is the assumption that skin temperature is always 35 C when determining the heat exchange coefficient between the skin and the surroundings. It is accepted that skin temperature is influenced by skin blood flow, which in turn is influenced by metabolic activity and the air temperature surrounding the skin. Most working conditions do not provide the factors that allow the skin temperature to remain at 35 C.

As previously stated, the goal of a heat stress index is to define the total heat load in terms of predictive physiological heat strain. The discussion above clearly demonstrates that the most popular indices are deficient in this area. The occupational health and safety profession is continuously working towards establishing a safe and healthful workplace. With regards to heat stress, the objective is to limit the degree of health risk associated with a worker's exposure to a hot environment. Risk has been defined in terms of a percentage of the working population reaching a specified level of physiological strain at a combination of heat stress parameters. The problems inherent in estimating the probability of strain (for a universal population) lie in two factors: 1) the absence of consistency between heat stress indices characterizing the same level of heat stress; and 2) the variability of human response to one level of heat stress.

As previously discussed, the degree of heat stress depends on many factors. No one heat stress index has been able to account for all these factors, therefore, the available indices can only partially represent the total thermal load. Additionally, each index attempts to characterize the environment through the collection of different heat stress parameters. As a result, the most popular indices may differ widely in their assessment of environments having equivalent heat stress. Figure 1 is a psychrometric chart where lines of equivalent heat stress, according to different heat stress indices, have been plotted (28). The lines (a through d) were determined by considering different combinations of temperature and water vapor pressure and calculating the same heat stress level as the reference climate. Ideally, the indices should agree in their assessment of heat stress and converge into a single line. Clearly, this is not the case, and the differences between the indices lead one to ask the question: Which index will provide the most accurate assessment of the environment in terms of predictive heat strain?

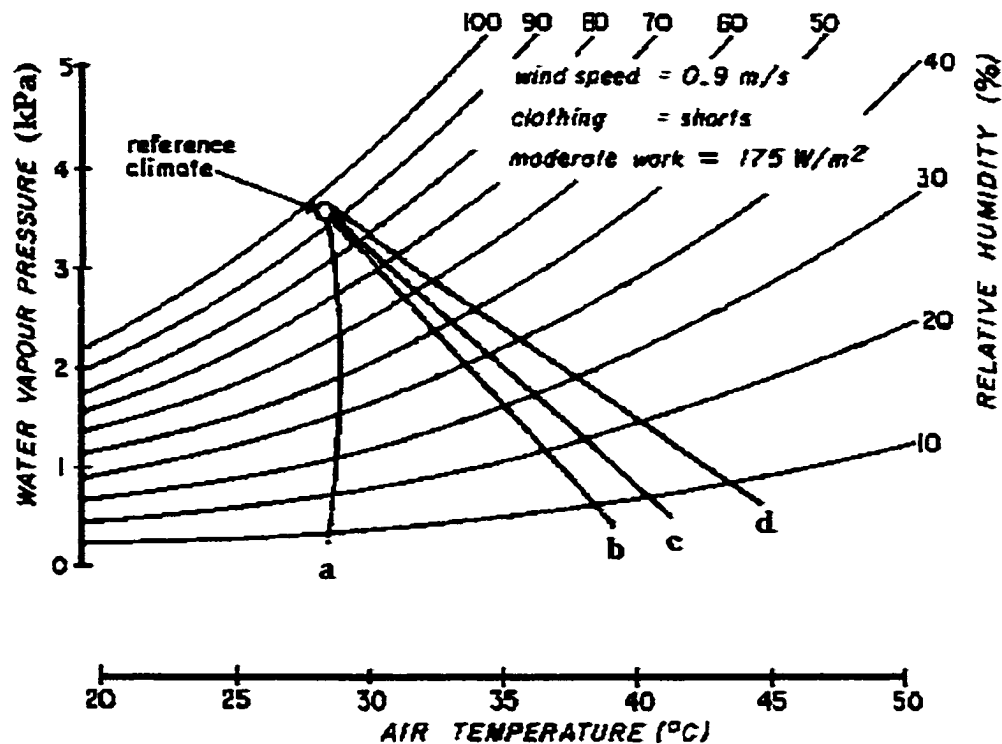


Figure 1: Environments of equivalent heat stress assessed by four heat stress indices (28). Legend: a: Predicted Four Hour Sweat Rate; b: Effective Temperature Index; c: Heat Stress Index; d: Wet Bulb Globe Temperature Index

The second problem in estimating the probability of strain for a universal population is the variability of human response to one level of heat stress. This is illustrated in Figure 2, which plots the frequency distributions of rectal temperatures for 99 nude, acclimatized men exposed for five hours to a single combination of workload and thermal environment. The curves clearly demonstrate that individuals respond to the same level of heat stress with varying levels of heat strain as determined through rectal temperature.

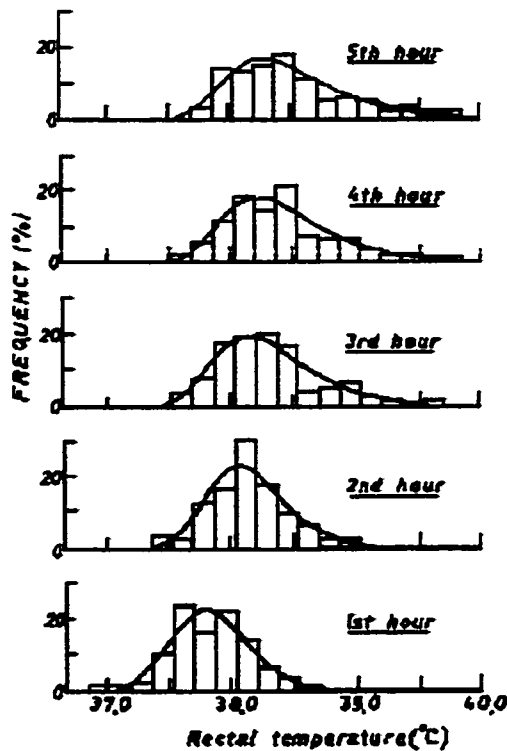


Figure 2: Hourly frequency distributions of rectal temperature for ninety-nine acclimatized men exposed to a single combination of workload and thermal environment (28).

Given the inherent limitations of heat stress indices, the different numerical value of each index in assessing the same level of heat stress, and the variability of human response to the same level of heat stress, it is reasonable that a direct measure of physiological strain would be of greater value in determining the degree of health risk associated with exposure to a hot environment. As previously stated, human thermoregulation involves input to the hypothalamus with regards to core body temperature and skin temperature,

with effector responses in the circulatory and eccrine systems. Therefore, it would seem possible that one or more of these systems could provide an adequate parameter to determine physiological heat strain. The parameters that have been used to evaluate heat strain are heart rate, sweat production, skin temperature, and core body temperature. Since the entire thermoregulatory system operates to keep the core body temperature within a very narrow temperature range, the most fundamental criterion for heat strain should be the ability to maintain the core body temperature to within the range prescribed by the thermoregulatory center. When measurements indicate the core body temperature is above this range, then it can be assumed that physiological over-strain has occurred.

2.4 Measurement of Core Body Temperature

Prior to discussing the measurement of core body temperature, it is imperative to define core body temperature. It was previously discussed that core body temperature (T_c) was the temperature of the deep central area that included the heart, lungs, abdominal organs, and the brain. However, the temperature within this area is not uniform, thus it is incorrect to define it in terms of one single value without noting the location at which the temperature was obtained (20,29,30,31,32). More accurately, core body temperature relates to a representative core temperature obtained by placing a temperature sensor in a natural orifice, which is always specified (30). When core body temperature is obtained via one natural orifice (e.g., oral temperature) it should be noted that

the value will not represent the average temperature of all the internal organs within the core. As noted, the core is not uniform in temperature and the temperature within a given region depends on: 1) the metabolic rate of the contiguous regional tissues; 2) the quantity and source of the blood flow to that region; and 3) the temperature gradients between adjoining body regions (9,20).

Research has shown that the temperature of the blood within the pulmonary artery best represents the mean core body temperature (9). The blood flowing into the pulmonary artery originates from the venous return to the heart, which has two thermal components: blood draining from the core tissues, and blood draining from the peripheral tissues. The core tissues are more involved in heat production, whereas the peripheral tissues are more involved in heat loss. Thus, the blood temperature within the pulmonary artery represents the balance between heat loss and heat production in the time it takes the blood to flow from the core and peripheral tissues to the pulmonary artery. However, the determination of pulmonary arterial temperature requires invasive techniques and must be performed in controlled surgical settings. In most experimental and clinical studies, temperatures obtained from a natural orifice must be used to determine core body temperature. Thus, it is important to know the temperature relationship between these sites and the pulmonary artery.

There are four requirements for an ideal surrogate as a measure of core temperature: 1) the site must be convenient, 2) the values obtained must not be influenced by environmental conditions, 3) the measured changes must reflect

subtle changes in pulmonary arterial blood temperature, and 4) the response time of the surrogate temperature change in following the pulmonary arterial blood temperature change must be at an acceptable rate. The locations where core body temperature has been measured are at the rectum, mouth, esophagus, and tympanum/external auditory meatus.

2.4.1 Rectal Temperature

The heat stress exposure limits adopted by the American Conference of Governmental Industrial Hygienists (ACGIH) and the National Institute for Occupational Safety and Health (NIOSH) were established to prevent the core body temperature from exceeding 38 C, obtained rectally. Many researchers and clinicians have used rectal temperature because it is a comfortable and non-invasive measurement site. However, it has been shown that rectal temperature exhibits inertia, thus it responds slowly to rapid changes in heat input and heat loss as determined by pulmonary arterial or aortic temperature (30,33,34,35). The result of a delay in rectal temperature changes following heat loss or heat gain is that during rapid warming, rectal temperature is lower than other central temperature sites, and during rapid cooling, rectal temperature is higher than other central temperature sites. More importantly though, rectal temperature follows rather than leads thermoregulatory reactions during transient conditions (30,33,36). This phenomenon can lead to erroneous conclusions in thermoregulatory studies utilizing rectal temperature as a measure of core temperature with regards to central and peripheral temperature receptors and

their role in thermoregulation. Additionally, an error would be expected in establishing a heat stress limit based on rectal temperatures. If rectal temperature lags behind the central blood temperature in thermal transient working conditions, the actual central blood temperature may be higher than the acceptable upper limit of 38 C when the rectal temperature is measured at this value. Under these conditions, workers will not be protected from heat related illnesses even when the ACGIH and NIOSH heat stress limits have not been exceeded.

Relative to other monitoring sites, rectal temperature is greater in value during thermoneutral, steady state conditions (32,33,35,36,37,38). Under these conditions, rectal temperature is generally 0.24 C and 0.35 C higher than esophageal and oral temperatures, respectively (36). In transient conditions, rectal temperature has a long time delay and lower amplitude response with respect to other measurement sites. Rectal temperature is generally higher than esophageal, oral and tympanic membrane temperature during rapid cooling, and exhibits values less than the temperatures at these sites during rapid warming (32,33,39).

2.4.2 Oral Temperature

Oral temperature is assumed to approximate blood temperature due to the tongue's perfusion by the lingual branch of the external carotid artery (34). Oral temperature is obtained by placing a temperature-sensing device in the heat pockets located beneath the tongue, with the mouth closed. The junction of

the base of the tongue and the floor of the mouth forms two pockets. There is one pocket on either side of the frenum. Placement of the temperature sensors has been shown to be significant in that differences of 0.2 C have been observed from the left to right pocket (29).

The equilibrium time necessary to obtain stable oral temperatures can be as high as 20 minutes, but generally ranges from 3 to 10 minutes (36,40,41). The stabilization time for oral temperature has been found to be influenced by the ambient environment. Mairiaux *et al* found that as the air temperature increased from 23 to 50 C, the equilibrium time for a stable oral temperature decreased from 8 minutes to 4 minutes, respectively (40).

During the measurement of oral temperature, the subject must breathe through the nose in order to minimize ventilation effects seen in mouth breathing. Oral temperature measurements are also affected by the ingestion of hot or cold fluids and smoking (29). Localized heating and cooling of the skin on the head and face has been shown to influence oral temperature. McCaffrey *et al* heated and cooled five subjects in a double-climate chamber where the head and body were exposed to different temperatures (42). Oral temperature values followed the temperature pattern seen in head skin temperature rather than the mean skin temperature of the body. These trends were seen in whole body and head heating and cooling; and in localized head cooling (42).

Sloan and Keatinge observed the effects of cooling the face on 14 subjects through obtaining concomitant oral and esophageal temperatures (43).

The results indicated that the depression of oral temperature was minimized when the head and face of the subjects was insulated (43). It was also shown that the cold environments in the study led to cheek cooling and subsequent cooling of the parotid saliva, resulting in decreased oral temperature values (43).

Relative to other measurement sites, oral temperature has been found to be lower in value in thermoneutral, steady state conditions (32,34,36,43,44). In an ambient environment of 18 to 24 C, Sloan and Keatinge found esophageal temperature values to be greater than oral temperature in the range of 0.9 to 1.1 C (43). At higher room temperatures of 25 to 44 C, the esophageal/oral temperature difference decreased to 0.45 C. Cranston *et al* found a difference between esophageal and oral temperature to be 0.09 C at a room temperature of 19 to 24 C (36). In an ambient environment of 24 C, a steady state mean difference of 0.06 C was found by Edwards *et al* in a study involving six males and six females (32). Livingston *et al* found an esophageal/oral temperature difference of 0.2 C in control subjects sitting in still air at 24 to 26 C (44). Subjects sitting in an environment of -32 C exhibited oral temperatures less than the minimum temperature limitation (35 C) on the thermometer (44). The subjects showed a slight increase in rectal and esophageal temperature upon initial exposure to the -32 C air temperature, followed by a gradual decline (44). Near the end of the test period (90 minutes), the rectal temperature had returned to its original value, while esophageal temperature was 0.15 C below its initial value (44). Thus, oral temperature was dramatically affected by the cold

environment, while rectal and esophageal temperature were not significantly influenced. The observation of an excessively low oral temperature upon exposure to a cold environment is consistent with the results seen by Sloan and Keatinge (43). In another study by Ilesley *et al*, five patients were monitored during a pre-operative period for pulmonary artery temperature, rectal temperature and oral temperatures (34). The mean oral temperature was 0.4 C below the mean pulmonary artery temperature, and 0.63 C below the mean rectal temperature (34).

Mairiaux *et al* conducted a study on five male subjects investigating the response of esophageal, rectal and oral temperature during heat transients (40). The subjects were exposed to a steady work condition of moderate level in a constant air temperature of 36.5 C; and to variations in air temperatures at 23 and 50 C while at a steady workload. The investigators found that during the moderate level exercise and air temperatures in the scenarios described, the esophageal/oral difference was less than the esophageal/rectal difference. Additionally, the esophageal/rectal difference increased over the study period, while the esophageal/oral difference was barely modified as a function of time (40). The authors concluded that oral temperature provided the best estimate of esophageal temperature over rectal temperature (40). However, the mean oral temperature values were greater than the mean esophageal temperature values at the end of all phases of the test periods. The results seen by the investigators differ from other research in that esophageal temperature is most

often greater than oral temperature, even in ambient air temperatures similar to those used in the above study (32,36,43,44). In conclusion, most studies have determined that oral temperature values are not always independent of the environmental conditions.

Edwards *et al* and Mairiaux *et al* have also shown that pattern variations in oral temperature lag behind esophageal temperature responses (32,40). The observed lag time in both studies was not as great as rectal temperature but was considered significant by the investigators (32,40).

2.4.3 Esophageal Temperature

Esophageal temperature is obtained by inserting a temperature-sensing probe either through the nasal cavity or the mouth, and then swallowing the probe. Often, insertion must be aided by swabbing the probe with a topical anesthetic, or by applying the anesthetic directly to the throat. The probe must also be secured to prevent slippage of the sensing element from the desired depth within the esophagus. This is accomplished by taping the probe to the bridge of the nose (45). The insertion depth of the probe is extremely important in that there is a temperature gradient within the esophagus (36,46,47). The desired depth is at the location where the esophagus and the left atrium of the heart are in contact (6). Above this location, pulmonary ventilation may heat or cool the temperature sensor (36,45). Jaeger *et al* have shown that cold air inhalation influenced esophageal temperature above an insertion depth of 43.7 cm beyond the nares (45). The average height of the subjects in the study was

175 cm. Cranston *et al* found an acceptable insertion depth of 47 cm beyond the lips (36). It was at this depth that the investigators observed a steady state temperature that was higher than at all other depths measured. Radiological examination showed that the tip of the temperature sensor was located immediately above the cardiac sphincter (36). The height of the subjects used in this study was not provided.

If radiological examination is not feasible, the proper insertion depth can be determined through anatomical measurements. Researchers at the US Army Research Institute of Environmental Medicine in Natick, Massachusetts found that an anatomical measurement of one-fourth a subject's height can be used to estimate the distance from the nares to the heart level within the esophagus (9,48). A "hot spot" can then be determined by slowly inserting the probe deeper into the esophagus, then pulling the probe out past the 1/4 height depth, while observing the probe temperature at each interval. The hot spot is then assumed to be the location where the left atrium is in contact with the esophagus (48).

Swallowing saliva and eructation have been shown to lower the esophageal temperature (31,36). Cranston *et al* found maximum decreases of 0.14 C and 0.06 C following swallowing and eructation, respectively (36). These values were observed while the subjects were nose breathing, with the mouth sealed, while in resting state.

Most researchers agree that esophageal temperature is the best approximation of the temperature of the blood within the heart that can be

obtained without surgical intervention (7,30,39). Shiraki *et al* measured esophageal, rectal, tympanic, pulmonary artery and aortic arch temperatures during large and rapid changes in body temperature induced by iatrogenic hyperthermia in the treatment of metastatic cancer (7). During steady state conditions, esophageal temperature was equal to pulmonary artery temperature. During increases and decreases in body temperature, esophageal temperature more accurately reflected pulmonary artery temperature than the other monitoring sites. The esophageal temperature values did exhibit an observed mean lag time of 120 seconds during heating and 47 seconds during cooling (7). The lag times for the esophageal temperatures were always smaller than the lag times for all other measurement sites.

Cooper and Kenyon studied hospital patients under induced hypothermia as an aid in cardiovascular surgery (39). Aortic, esophageal and rectal temperatures were monitored during the cooling, surgical and rewarming phases in order to investigate the relationship of esophageal and rectal temperatures to aortic temperature; and to determine which of these temperatures provided a more accurate index of aortic blood temperature. A maximum temperature deviation of 0.25 C was observed with the esophageal values, while rectal temperature had a maximum deviation of 0.65 C. Rectal temperature also rose more slowly than esophageal temperature, thus showing an increased lag time consistent with other research (7,33,34,39). The investigators concluded that esophageal temperature more closely followed para-aortic temperature and was

a better indicator of blood temperature leaving the heart than was rectal temperature (39).

When esophageal temperature is taken at heart level, it is intermediate between oral and rectal temperature. In 40 subjects resting in an ambient temperature of 19 to 24 C, Cranston *et al* found the mean esophageal temperature to be 0.09 C higher than oral temperature and 0.24 C lower than rectal temperature (36). Saltin and Hermansen monitored esophageal and rectal temperatures while subjects were at rest and at 3 workload levels (37). Rectal temperature was higher than esophageal temperature at rest and at each of the exercise levels. The average differences were 0.06 C at rest, and 0.12 C, 0.14 C, and 0.16 C at 26%, 51% and 69% maximum oxygen uptake, respectively (37). Additionally, the esophageal temperature showed a more rapid response to exercise than did rectal temperature (37). Esophageal temperature rapidly rose upon initiation of exercise, and rapidly returned to pre-exercise levels after the exercise. The rectal temperature response was much slower for both the initiation and termination of exercise. Saltin *et al* performed a study similar to his earlier work, but altered the ambient air temperature in addition to changing exercise levels. The results were similar, in that esophageal temperature was more responsive to varying exercise levels performed in different ambient temperatures, and exhibited a shorter lag time than did rectal temperature (49).

Edwards *et al* and Gibson *et al* performed very similar studies in an attempt to determine the relationships of external auditory canal, rectal and

gastrointestinal tract temperatures to esophageal temperature (31,32).

Transient core body temperature changes were induced through immersion into a hot, then a cold bath; and through intermittent light exercise. A mathematical model was then derived to enable prediction of esophageal temperature from the values made at any one of the other measurement sites (31,32). Esophageal temperature responded similarly in both studies. Esophageal temperature had the largest rises and declines upon exposure to the hot and cold conditions, and showed the smallest lag times. Both research groups preferred esophageal temperature measurements as an indicator of core body temperature, however, they also conceded to the difficulties of obtaining esophageal temperature for field use (31,32).

Esophageal temperature, thus, meets three of the four requirements for an ideal surrogate of core body temperature: 1) it is not influenced by environmental conditions when it is correctly measured; 2) its values reflect subtle changes in pulmonary arterial blood temperature; and 3) its response time is the smallest relative to all other measurement sites. However, the procedure that must be followed to obtain an accurate esophageal temperature value does not render the site convenient (31,32).

2.4.4 Tympanic/External Auditory Canal Temperature

Researchers studying thermoregulation make a distinction between mean core body temperature and regulated temperature. As previously defined, mean core body temperature is the temperature of the deep central area which

includes the heart, lungs, abdominal organs, and the brain, and is viewed as a measure of the thermal state of the body as a whole. Regulated temperature is defined as the input related to internal temperature that is processed in the integrative centers of thermoregulation. One researcher, Benzinger, believes that the "center" of the human body with respect to temperature is located at the preoptic-supraoptic region of the hypothalamus, and that the temperature of the blood in the brain best reflects the temperature of this "center" (50). Due to the inaccessibility of the brain, Benzinger has designated the tympanic membrane temperature as an equivalent temperature due to the shared blood supply of both areas, (i.e., the internal carotid artery). Thus, Benzinger believes that tympanic membrane temperature reflects regulated temperature. While Benzinger believes that the main thermoregulatory responses are elicited primarily by the central-brain temperature, other researchers believe that thermoregulatory responses generated in the hypothalamus respond to central-brain, central-core and peripheral temperature receptors. These same researchers have used tympanic membrane temperature as a measure of mean core body temperature, and not as a measure of regulated temperature. Thus, the use of tympanic membrane temperature as a surrogate for core body temperature has been historically controversial. Some researchers believe it reflects regulated temperature and have devoted a great deal of time and effort towards its establishment as such; other researchers have studied tympanic membrane temperature as a measure of mean core body temperature. It is

those researchers investigating the tympanic membrane's temperature relationship to mean core body temperature that are interested in finding a surrogate measure of the thermal state of the body.

A true tympanic membrane temperature requires that the temperature probe be placed on the tympanum. This procedure has been shown to be painful and injurious to some individuals (6,51,52). Most researchers, however, do not insert the probe to the tympanum, thus obtaining an external aural canal temperature. An external ear (aural) canal temperature is measured by placing a temperature sensor in an ear plug and inserting the plug into the external auditory meatus. It has been found, though, that there is a temperature gradient along the wall of the meatus. Cooper *et al* demonstrated a definite temperature gradient that was highest at the innermost site and lowest at the periphery (6). The maximum differences seen in the three experiments conducted were 0.5, 0.7, and 0.83 C (6). The same study also showed that the temperature of the external auditory canal responded with less sensitivity to small and rapid changes in arterial blood temperature than the tympanic membrane temperature (6).

Molnar and Read induced rapid changes in blood temperature through extracorporeal circulation (ECC) during open-heart surgery (33). Temperatures of the rectum, tympanic membrane, esophagus and the arterial blood in the ECC were measured for 7 patients. The temperature of the ECC was controlled at approximately 37 C during surgery. An initial cooling for three patients and the

rewarming of all patients provided rapid changes in core body temperature. During the changes in ECC temperature, esophageal temperature followed the changing temperature pattern more accurately than tympanic or rectal, but tympanic followed more closely than rectal. The data showed that the absolute temperatures of ECC, esophageal and tympanic were not equal, but that esophageal and tympanic temperatures did exhibit a similar pattern during the rise and fall of ECC temperature (33). In another study also conducted in a clinical setting, Shiraki *et al* looked at esophageal, rectal, tympanic, and pulmonary arterial temperatures in three patients during iatrogenic whole-body hyperthermia (7). The operating theater was maintained at 25 C, while hyperthermia was induced through ECC at a temperature range of 43 to 44 C. At steady state conditions, tympanic temperature was less than pulmonary arterial temperature by an average of 0.21 C, while esophageal temperature was different by an average of 0.12 C. During temperature changes, the absolute values of tympanic temperature did not reflect esophageal or pulmonary arterial temperatures, but followed the same patterns during both the rise and fall of ECC temperature. The data did show a difference in the lag time between esophageal, tympanic and pulmonary arterial temperatures. Esophageal temperature showed a shorter lag time than tympanic temperature. Thus, esophageal temperature followed pulmonary arterial temperature changes more closely than the somewhat slower and less accurate tympanic temperature (7).

Edwards *et al* and Gibson *et al* performed very similar studies in an attempt to derive a model that computes esophageal temperature from other sites commonly used to measure core body temperature (31,32). The sites measured in these studies were oral, external ear canal, rectal and gastrointestinal tract. Thermal transient conditions were elicited in both studies, passively, through immersion in a hot, then a cold bath while at rest in an ambient environment of 25 C, and actively, by exercise on a bicycle followed by a recovery period (31,32). Both studies showed that during thermal transients there was considerable site variation in response to the thermal stimuli. In using the prediction equation for determining esophageal temperature, external ear canal temperature provided the best estimate in both studies in terms of accuracy and time and amplitude of the response.

3.0 Purpose and Scope

The goal of all occupational health and safety programs is to eliminate or reduce occupational injuries and illnesses. A reliable and accurate assessment of heat stress is a crucial component of a successful heat stress program. The current methods used to characterize the heat stress potential of a given work situation rely on quantifying the environmental heat load and estimating the internal heat load. The combination of these two parameters is then used to predict heat strain for all individuals working in the heat stress conditions. It has been found that the current methods do not reliably and accurately predict heat strain for all individuals. Inherent limitations of current evaluation methods fail to account for unacclimatized, unfit workers; workers who are unhealthy or are taking medication that may interfere with their thermoregulatory system; healthy workers of different heat tolerance levels; and workers wearing clothing that inhibits the evaporation of sweat from the skin surface. The limitations of the current evaluation methods can be overcome through the determination of mean core body temperature. Mean core body temperature is a measure of the thermal state of the body and can provide a valid assessment of heat strain for all types of workers, in all types of clothing, and in all environmental conditions.

The Questemp^o II is a personal heat stress monitor that measures the temperature in the external aural canal. Electronics within the instrument applies an algorithm to the measured external ear canal temperature and displays an *adjusted-ear canal* temperature on the LCD readout. The instrument operates on the premise that the adjusted-ear canal temperature is a reliable surrogate for mean core body temperature.

This study evaluated the response of the Questemp^o II Personal Heat Stress Monitor in subjects exercising at two metabolic levels while wearing three different clothing ensembles. Each exercise level was followed by a rest period and the exercise/rest regime was conducted in one of three environmental heat loads. The combinations of exercise level, clothing ensemble and environmental load resulted in each subject performing 18 different tests. The adjusted-ear canal temperature measured by the Questemp^o II was compared to concomitantly measured esophageal temperature. The esophagus was chosen as the site to measure mean core body temperature.

The hypothesis was that the adjusted-ear canal temperature measured and recorded by the Questemp^o II would equal the esophageal temperature measured at the same time, and this equality would be maintained throughout all transient heat load conditions.

The objectives of the study were as follows:

1. Determine if the adjusted-ear canal temperature measured by the Questemp^o II tracks esophageal temperature over time.

2. Determine the equality of values for esophageal temperature and the adjusted-ear canal temperature measured by the Questemp II throughout all transient heat load conditions.
3. Determine if the calibration procedure of the Questemp^o II monitor via oral temperature compensates for the known difference between the external ear canal temperature and the mean core body temperature measured as esophageal temperature.
4. Determine if the algorithm used to calculate the Questemp^o II adjusted-ear canal temperature compensates for environmental influences on the external ear canal and the temperature differences between the external ear canal and the mean core body temperature measured as esophageal temperature.

4.0 Methods and Materials

4.1 Overview

The purpose of the present study was to determine the response of the Questemp[°] II Personal Heat Stress Monitor under controlled transient conditions of environmental heat and metabolic energy expenditure. In an environmentally controlled test chamber, subjects were exposed to an environmental heat load while exercising using a bicycle mounted on a resistance trainer. The combined environmental and internal heat loads led to an increase in mean core body temperature. The mean core body temperature was determined using an esophageal temperature probe. The Questemp[°] II adjusted-ear canal temperature measurements were then compared to concurrently measured esophageal temperatures for each test period. The tests differed in energy expenditure level, type of clothing worn, absence or presence of air movement over the body, and the environmental heat load during rest.

In order to provide heat stress conditions where an increase in mean core body temperature would be expected, energy expenditure levels and external heat loads chosen for the study placed the combined heat stress exposure levels in excess of the ACGIH TLVs for both acclimatized and unacclimatized workers. Figure 3 displays the exposure ranges relative to the TLVs (1). The

lower heat stress exposure range was designed to elicit a small increase in mean core body temperature during the test period, while the higher heat stress exposure range was expected to cause a large increase in mean core body temperature during the test period. Specific data displaying actual energy expenditure levels and environmental exposure values will be provided later in this section.

Additional data, such as oxygen consumption, relative humidity and WBGT index data, and heart rate was obtained during each test period. The collection of this data was used to monitor for exposure endpoints.

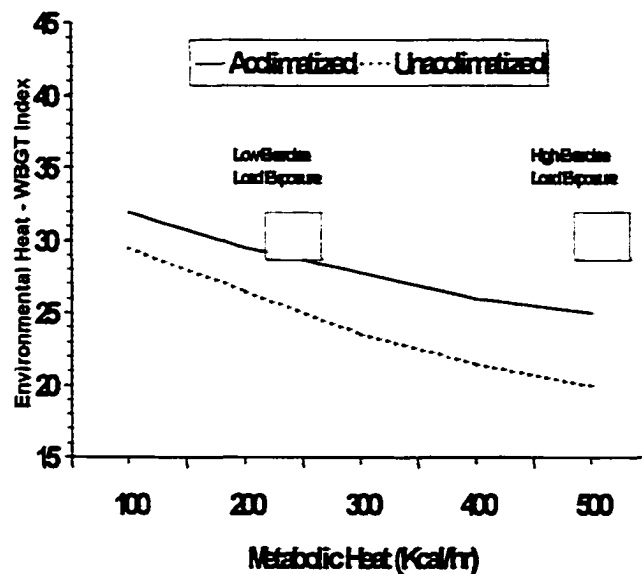


Figure 3: High and Low Exercise Load Exposures relative to the permissible heat exposure TLVs for heat acclimatized and unacclimatized workers (1).

4.2 Subject Selection

Ten individuals served as subjects for the study, eight males and two females. Eight of the subjects were graduate students, one was an undergraduate student, and one a faculty member. All subjects were associated with the Department of Environmental Health at Colorado State University. Subject ages ranged from 23 to 43 years during the data collection period of the study. Each subject was asked to determine his or her physical fitness level using a four-tiered scheme of unfit, slightly fit, moderately fit and highly fit. Self-determined physical fitness levels ranged from moderately fit to highly fit. Based on duration and degree of exposure to heat stress prior to study participation, only one of the 10 subjects was heat acclimatized to the environmental conditions at the beginning of the study. Prior to participation in the study, all subjects were required to 1) successfully complete an ear, nose, and throat examination conducted by a licensed physician at the Colorado State University Health Center; 2) demonstrate a lack of medical conditions that would inhibit study participation; and 3) be willing to participate for the entire study period. Immediately following participation in the study, each subject received an ear, nose, and throat examination to verify that no physical damage occurred during the study. Each subject attended two training sessions prior to beginning the study. The first training session provided a detailed description on all aspects of the study and explained investigator and subject responsibilities. It was explained that the Colorado State University Human Subjects Research

Committee had approved the study protocol. Following the first training session, all subjects were required to complete a written consent form agreeing to all study requirements which included a statement indicating the subjects were allowed to withdraw from the study at any time. The second training session was conducted to verify that each subject would be able to insert the esophageal temperature probe, and to collect preliminary study data. The second training session was conducted only after successful completion of the pre-study ear, nose, and throat examination.

4.3 Preliminary Study Data Collection

Several study variables needed to be determined before any tests were conducted. Preliminary study variables included 1) insertion depth of the esophageal temperature probe; 2) determination of each subject's basal metabolic rate; and 3) determination of the pedal resistance and revolutions per minute on the bicycle in order to achieve the desired energy expenditure level defined in the test protocol.

4.3.1 Esophageal Temperature Probe Placement.

The proper placement of an esophageal temperature probe was at the level of the left atrium, where the heart and esophagus are in contact. Above and below this level there is a decrease in esophageal temperature and dynamic temperature response times are altered. An estimate of the proper insertion depth can be determined through the anatomical measurement of one-fourth the subject's height (9).

A certified nurse anesthetist from Poudre Valley Hospital provided training to the researchers on the proper technique to insert the esophageal temperature probe. The researchers, in turn, provided the training to each subject prior to allowing the subject to proceed with self-insertion of the temperature probe. As discussed in the training and demonstrated by the researchers, the first step was to spray an over-the-counter nasal decongestant into the nostril. The nasal spray served to shrink the blood vessels of the nose and to decrease any swelling of the mucous membranes within the nasopharyngeal region. While the nasal spray was reacting, the end of the esophageal temperature probe was coated for a distance of approximately six inches with 2% Xylocaine Jelly. The jelly served as both a lubricant and a local anesthetic during the insertion of the probe. The probe then was carefully inserted into the nostril treated with the decongestant spray. When the tip of the probe was at the proper depth, the probe was secured to the bridge of the nose using 3M Transpore Clear Plastic Tape. The esophageal temperature probe was a copper-constantan thermocouple (type T) coated in flexible plastic. Physitemp Instruments, Inc., (Clifton, NJ) manufactured the ESO-1 Esophageal Temperature Sensor probe.

Following the probe insertion demonstration, the subject inserted the esophageal temperature probe using the same procedure. The initial insertion depth beyond the nares was one-fourth the subject's height. The subject then sat in the thermoneutral environment for 15 to 20 minutes to allow the temperature probe to reach equilibrium. During this time period, the temperature

probe was connected to an Omega Engineering Inc. Datalogger (Model OM272 Serial No. 9KK10759). The subject was instructed not to swallow, but to spit saliva into a cup, and instructed to nose breath with the mouth closed. Once equilibrium was reached, the temperature of the probe inserted at one-fourth the subject's height was noted and the probe was unsecured from the bridge of the nose. The probe was then inserted deeper at one-quarter inch intervals. The probe was stationed at each new depth for a minimum of 3 minutes or until a new probe temperature equilibrium was established and recorded. The procedure was conducted until several intervals showed a decrease in probe temperature. The procedure was then repeated while decreasing insertion depths of the esophageal probe. Examination of the temperature profile within the esophagus indicated the insertion depth beyond the nares that provided the location where the heart is in contact with the esophagus. The esophageal temperature probe was then marked with tape indicating the insertion depth beyond the nares for each subject. This procedure was repeated for each subject and each subject was furnished a personal probe.

4.3.2 Estimation of Basal Metabolic Rate (BMR)

Individual basal metabolic rates were estimated to establish equal energy expenditure levels for all subjects for the two exercise levels described in the testing protocol. The direct measurements of subject stature and mass were plotted on a nomogram to determine body surface area (m^2). Utilizing a graph where BMR was plotted as a function of age and gender, the BMR for each

subject was determined in units of kilocalories (Kcal) per m² per hour. Kcal per hour basal metabolic rates were then calculated by multiplying surface area by the Kcal per m² per hour values obtained from the graph. Basal metabolic rates were converted from Kcal per hour units to liters of oxygen per minute using the conversion value of 4.82 Kcal energy expended per liter of oxygen consumed. A person's basal metabolic rate estimated from this method is generally within 10% of the actual value determined from measurements utilizing strict laboratory procedures.

4.3.3 Determination of Workload Level

The testing protocol called for each subject to exercise at equal energy expenditure levels at two workload rates. A light workload rate was determined by multiplying the subject's BMR by four; and the heavy workload rate was nine times the subject's BMR. The subjects achieved the desired workload levels by riding a KHS Mountain Crest bicycle mounted on a Minoura Magturbo resistance trainer. Preliminary testing was needed to determine the pedal resistance and crankshaft revolutions per minute that resulted in the desired energy expenditure levels. Oxygen consumption in liters per minute was used as the indicator of energy expenditure.

The subjects arrived at the testing chamber rested and well hydrated at the same time of day they were assigned to participate in the heat stress tests. During preliminary data collection, the test chamber had a thermoneutral environment. The subjects mounted the bicycle and the bike seat was adjusted

and marked according to the subjects' acceptable level of comfort. The subjects were then fitted with headgear that held a one-way mouthpiece and respiratory valve manufactured by Hans Rudolph, Inc. The nose was clipped with a standard nose-clip. The exhalation port of the mouthpiece was connected to a plexiglass mixing chamber via 54 inches of 1 1/2 inch diameter flexible tubing. The mixing chamber was a three-stage chamber with each stage separated by perforated baffles. The chamber was 6 inches in diameter and 12 inches in length, with the middle segment 3.5 inches in length. Air was drawn from the middle stage via 1/8 inch diameter tygon tubing, through approximately 50 cubic centimeters of Drierite, anhydrous CaSO_4 desiccant (8 mesh size) and into an oxygen analyzer. The readout from the oxygen analyzer was percent oxygen. Complications with equipment availability resulted in the utilization of three different oxygen analyzers throughout the study period. The oxygen analyzers included: 1) Ametek, Single-Channel Oxygen Analyzer System (Model S-3A/I) consisting of an N-22M single-cell zirconia sensor, an S-3A/I Readout/Control Unit, and an R-1 Flow Control Unit; 2) Teem 100 oxygen analyzer utilizing a galvanic fuel cell as the oxygen sensor; and 3) Applied Technical Products, Inc. Oxygen Analyzer (Model 101) utilizing a zirconium oxide sensor. The inhalation port of the mouthpiece was fitted with a flow transducer with an integral breathswitch which was connected to a VMM 110 Series Ventilation Measurement Module. The ventilation measurement system recorded inhalation volume in liters. To calculate the oxygen consumption in liters per minute (V_{O_2}),

it was assumed that liters of air expired equaled liters of air inhaled after adjusting for temperature of the expired air. The following equation was used to equate volume inhaled to volume expired:

$$V_{ex} = V_{in} \left(\frac{273^{\circ} K + \text{ambient air temperature } ^{\circ} C}{273^{\circ} K + \text{mixing chamber air temperature } ^{\circ} C} \right)$$

where: V_{ex} = liters of air expired in one minute

V_{in} = liters of air inhaled in one minute

Ambient air temperature and mixing chamber air temperature were measured using 0.0200 Ga 36 inch copper-constantan (typeT) thermocouples. The thermocouples were connected to an Omega datalogger.

The liters of oxygen consumed in one minute by the subject assumed that the percent oxygen in the ambient air was 20.93% and determined from the following equation:

$$V_{O_2} = (V_{in} \times 20.93\%) - (V_{ex} \times \% O_{2\ ex})$$

where: $\%O_{2\ ex}$ = percent oxygen in the expired air

Once the headgear was fitted and the subject was comfortable, the subject was instructed to begin pedaling at a specific RPM and trainer resistance setting. Initial oxygen consumption measurements were recorded five minutes after the start of the pedaling at the desired RPM. Three one-minute measurements were collected and an arithmetic average was calculated. If the average oxygen consumption value reflected values higher or lower than the desired low exercise load rate, the subject was instructed to increase or

decrease the RPM rate. The procedure was repeated until the oxygen consumption value for each subject was within 5% of 4 times the BMR. Four times the BMR was the assigned energy expenditure rate for a low exercise load. The subject then rested for approximately 15 minutes. Once rested, the procedure was repeated in order to determine the RPM and resistance setting to achieve 9 times the BMR. Nine times the BMR was the assigned energy expenditure rate for a high exercise load. The trainer resistance setting and RPM value, which gave the desired energy expenditure for each subject, remained constant throughout the study period. A Cateye Micro Cyclocomputer (Model CC-6000) was used to determine the crankshaft RPM. Table 1 illustrates each subject's physical characteristics and energy expenditure levels expressed in liters oxygen per minute at 4 and 9 times the BMR.

Table 1: Physical characteristics, BMR and calculated energy expenditure values for all subjects.

Subject Number	Gender	Age (years)	Height (inches)	Weight (lbs)	SA (m ²)	BMR (V _{O2})	4 x BMR (V _{O2})	9 x BMR (V _{O2})
1	M	28	71	178	2.00	0.26	1.04	2.48
2	M	27	69.8	200	2.08	0.27	1.09	2.56
3	M	43	70	150	1.82	0.23	0.92	2.19
4	M	29	71	194	2.08	0.27	1.09	2.56
5	M	42	69.5	176	1.96	0.25	0.99	2.36
6	M	30	68	155	1.78	0.23	0.92	2.20
7	F	27	67	140	1.74	0.22	0.88	2.09
8	F	33	69	140	1.76	0.22	0.88	2.09
9	M	25	69	142	1.78	0.24	0.96	2.28
10	M	23	68	176	1.94	0.26	1.04	2.48

4.4 Test Chamber and Rest Area

The tests were performed in room 210 and in the hallway outside room 210 at the eastern end of the Physiology Building on the Colorado State University campus. The exercise/working portion and selected rest periods were conducted in Room 210, which was an insulated test chamber, while other selected rest periods were conducted in the hallway outside room 210. Room 210 had dimensions of 19 feet in length, 13 feet in width, and 8 feet from floor to ceiling. The walls of the insulated chamber were approximately 9 inches thick. The room was accessed through a large insulated door.

The heat load in the test chamber was generated using four Arvin Air radiant heaters manufactured by Adobe Air, Inc. The radiant heaters were operated at 1500 watts. Air movement was provided by a 3 speed Dayton box fan with a 20-inch diameter blade. The fan was operated on the medium speed setting for all tests that required air movement in the test protocol. Humidity levels were controlled in the room by adjusting the radiant heaters in conjunction with opening the test chamber door several inches. This procedure allowed cool air to enter the room, become heated and subsequently lower the relative humidity of the test chamber. The relative humidity in the test chamber ranged from 20% to 35%, with occasional, short-term, fluctuations reaching 45%. The WBGT index for the tests without air movement was maintained between 31 to 33 C. The WBGT index ranged from 29 to 31 C during tests where air movement was forced past the subject. Average dry bulb (ambient air) temperature ranged

from 40.3 to 40.9 C. Air movement at face level was 50 feet per minute (fpm) and 100 fpm at chest height for all subjects.

The environmental conditions in the hallway outside the test chamber were maintained by the Physiology building heating, ventilation, and air conditioning system. The WBGT index during the rest periods in the hallway ranged from 22 to 25 C. The dry bulb temperature ranged from 24 to 29 C and the relative humidity levels ranged from 30% to 50%. The hallway environmental conditions were consistent for all subjects across all tests.

4.5 Test Conditions

Eighteen different test conditions were used in this research project. All test periods consisted of a 5 minute warm-up period, followed by 45 minutes of work/exercise, followed by 15 minutes of rest. Three environmental heat load conditions were used throughout the 65 minute test period. The heat load conditions differed by the presence or absence of air movement, the location of the rest period (i.e., in the test chamber or in the hallway), and the low or high exercise load. Combining the environmental and internal heat loads, six testing conditions were created. The subjects were exposed to the six testing conditions three times, each while wearing a different clothing ensemble. The clothing ensembles were: 1) shorts, T-shirt, and shoes and socks (gym clothes); 2) a gold-lined face shield and gym clothes; and 3) a Tyvek whole body suit on top of the gym clothes (without the head, hands and feet covered by the suit).

The face shield was a Gold-lined face shield manufactured by Oberon Company, Model No. FF025. Table 2 illustrates the conditions for all 18 test conditions.

Table 2: Test conditions for all eighteen tests.

* GC = Gym Clothes; FS = Face Shield; Tyvek = Tyvek Whole Body Suit

Test Number	Energy Expenditure	Clothing*	Work WBGT Index (C)	Rest WBGT index (C)	Rest Location	Forced Air Movement
1	4x BMR	GC	31 - 33	31 - 33	Chamber	NO
2	4x BMR	GC	31 - 33	22 - 25	Halfway	NO
3	4x BMR	GC	29 - 31	29 - 31	Chamber	YES
4	4x BMR	GC + FS	31 - 33	31 - 33	Chamber	NO
5	4x BMR	GC + FS	31 - 33	22 - 25	Halfway	NO
6	4x BMR	GC + FS	29 - 31	29 - 31	Chamber	YES
7	4x BMR	GC + Tyvek	31 - 33	31 - 33	Chamber	NO
8	4x BMR	GC + Tyvek	31 - 33	22 - 25	Halfway	NO
9	4x BMR	GC + Tyvek	29 - 31	29 - 31	Chamber	YES
10	9 x BMR	GC	31 - 33	31 - 33	Chamber	NO
11	9 x BMR	GC	31 - 33	22 - 25	Halfway	NO
12	9 x BMR	GC	29 - 31	29 - 31	Chamber	YES
13	9 x BMR	GC + FS	31 - 33	31 - 33	Chamber	NO
14	9 x BMR	GC + FS	31 - 33	22 - 25	Halfway	NO
15	9 x BMR	GC + FS	29 - 31	29 - 31	Chamber	YES
16	9 x BMR	GC + Tyvek	31 - 33	31 - 33	Chamber	NO
17	9 x BMR	GC + Tyvek	31 - 33	22 - 25	Halfway	NO
18	9 x BMR	GC + Tyvek	29 - 31	29 - 31	Chamber	YES

4.6 Data Collection

The following data were collected for each test: esophageal temperature; Questemp^o II adjusted-ear temperature of the right ear; oral temperature; test

chamber and hallway WBGT index; test chamber and hallway relative humidity; oxygen consumption; heart rate; skin temperature around the right ear; air velocity; test chamber and hallway ambient air temperature; and mixing chamber temperature.

Esophageal temperature (T_{es}) was continuously measured but recorded at one-minute intervals. The skin temperature around the right ear (T_{sk}), the ambient air temperature (T_{db}), and the mixing chamber temperature (T_{mc}) were continuously measured but recorded at one-minute intervals using copper-constantan thermocouples. The values of T_{es} , T_{sk} , T_{db} , and T_{mc} were recorded using an Omega Datalogger. The thermocouple used to measure ambient air temperature was shielded from radiant loads by fitting it with an aluminum foil shield.

A Questemp[®] II Personal Heat Stress Monitor was used to measure and record the adjusted-ear canal temperature of the right ear at 1-minute intervals. Oral temperature was measured and recorded using the Questemp[®] Calprobe I thermometer during the calibration procedure of the Questemp[®] II Personal Heat Stress Monitor. The Questemp[®] Calprobe I thermometer was used to calibrate the Questemp[®] II prior to beginning each test. Specific information regarding its use is discussed in the Instrument Calibration section of this dissertation.

Oxygen consumption was measured and recorded at 10-minute intervals throughout the exercise portion of each test, and in 2 to 3 minute intervals during the rest period of each test. Oxygen consumption was used to verify that the

subject was exercising at a specified level of energy expenditure (i.e., 4 times BMR or 9 times BMR) and was determined by the procedure previously described. Heart rate was measured continuously using a Polar Favor Heart Rate Monitor and recorded at 2-minute intervals during the exercise phase and at 1-minute intervals for the resting phase of each test.

A Questemp^o 15 Area Heat Stress Monitor was used to measure and record the WBGT index at 1-minute intervals throughout all test periods. The Questemp^o 15 also recorded the globe, dry and wet bulb temperatures at one-minute intervals. Relative humidity (RH) was measured and recorded at 10-minute intervals during the exercise phase and at 5-minute intervals during the resting phase of each test. RH values were determined using a Bacharach Sling Psychrometer, Model 12-7011. WBGT index values and relative humidity levels were measured to ensure that the environmental heat load conditions remained constant throughout each test period.

For each test protocol that specified air movement, air velocity was measured and recorded at the beginning of each test. Air flow was determined using a Velocichck Air Velocity Meter, Model 8310/8315, manufactured by TSI, Inc.

4.7 instrument Calibration

4.7.1 Omega Datalogger and Temperature Probes

The Omega Datalogger converted the analog signals from all the copper constantan thermocouples to a digital output. The Physitemp esophageal

temperature probe, the temperature probes around the right ear, and the thermocouples measuring the test chamber and mixing chamber air temperatures were connected to the datalogger. Calibration was performed according to the manufacturer's instructions using a water bath and a primary standard mercury thermometer. The primary standard thermometer had a range of 0 - 100 C in 0.1 C increments.

4.7.2 Questemp° 15 Area Heat Stress Monitor

The area monitor was calibrated once per week using the calibration sensor module (Quest Model 056-937). The monitor was considered to be calibrated when the bulb temperature readings were within 0.5 C of the values on the calibration sensor module.

4.7.3 Ventilation Measurement Module

The module was calibrated before and after each test using a 3-liter calibration syringe manufactured by Hans Rudolph, Model No. 5530. The module was considered in calibration when the volume recorded by the instrument was within $\pm 3\%$ of the syringe volume.

4.7.4 Oxygen Analyzers

All three oxygen analyzers used during the study were calibrated before and after each test using medically certified calibration gas at 15% oxygen. The instruments were considered in calibration when the percent oxygen measured by the analyzers was within $\pm 5\%$ of the calibration gas concentration.

4.7.5 Questemp° II Personal Heat Stress Monitor

The operating manual for the monitor states that calibration is performed to compensate for the difference between an individual's ear canal and core body temperatures. Calibration of the instrument is performed by using the Questemp° Calprobe I thermometer to obtain an oral temperature. The oral temperature is applied to the instrument algorithm such that the oral and adjusted-ear temperatures are equal at calibration. The instrument algorithm will be presented and discussed in the Results and Discussion chapter of this dissertation.

Calibration of the instrument began upon immediate entry of the subject into the test chamber. The subject sat on the bicycle and inserted the oral temperature probe under the tongue and was instructed not to mouth breath. Calibration was complete when the oral temperature remained stable for at least two minutes. The time required to reach calibration ranged from 5 to 12 minutes. The operator's manual stated that recalibration should be performed when the user's environment changes by more than 10 C. Thus, recalibration took place for the rest periods conducted in the hallway. The ambient air temperature difference between the test chamber and hallway was an average of 13 C. Recalibration began upon immediate entry of the subject to the hallway. The calibration procedure used in the test chamber and the hallway were identical.

4.8 Subject Preparation

The subjects arrived at the Physiology building the same time of day each day they were scheduled for a test. A 2-hour time period for individual testing was assigned during the training sessions. Subjects were tested at their assigned time period in order to eliminate diurnal core body temperature variations. The test schedule included testing on both alternating and consecutive days. When subjects performed tests on consecutive days, heavy and light workload tests were alternated on those consecutive test days. No subjects performed heavy workload tests for two consecutive days.

Once the subject was dressed in his/her personal gym clothes, they were escorted to a surgical suite in the Physiology building. It was at this location that the subjects inserted the esophageal temperature probe using the protocol previously described. When the probe was at the proper insertion depth, it was attached to the bridge of the subject's nose using 3M Transpore™ plastic tape. The subject also donned the Polar Heart Rate Monitor while in the surgical suite. The subject was then led to the hallway outside the testing chamber. As the subject stood in the hallway, the thermocouples were attached to the skin surrounding the right ear using the same 3M tape described above. An E.A.R.® foam earplug was then inserted into the right ear canal by the subject. The foam earplug acted as a vehicle for inserting the ear canal temperature sensor from which the Questemp® II Personal Heat Stress Monitor obtained an adjusted-ear canal temperature. If the test protocol specified that the subject perform the test

while wearing a Tyvek suit, the suit was donned at this time; but remained unzipped until entry into the test chamber. The subject then sat in a comfortable position in the hallway and the esophageal temperature probe was connected to the Omega Datalogger in order to obtain a baseline core body temperature. The subject remained seated until the esophageal temperature stabilized, which took approximately 5 to 8 minutes. During this time period, the subject was instructed not swallow and was given a cup to spit saliva. At the end of this period, baseline values of esophageal temperature and heart rate were recorded, and the subject was led into the test chamber. The subject was immediately seated on the bicycle and the Questemp^o Calprobe I thermometer was placed under the tongue in order to begin the Questemp^oII monitor calibration procedure, as previously described. All subjects for all tests followed the same subject preparation procedure.

4.9 Test Protocol

The tests began when the Questemp^oII monitor calibration procedure was complete. As previously stated, each test was 65 minutes in length and comprised of the following sequence: 5-minute warm-up phase; 45-minute work/exercise phase; 15-minute rest phase. The 5-minute warm-up period allowed the subject to reach the desired work rate RPM at their own pace. The exercise phase lasted from minute 6 to minute 50 or until one of the following endpoints was reached:

1. an esophageal temperature of 39.5 C or a rise of 1.5 C above baseline;
2. a heart rate of $[(220-\text{age})0.9]$; or
3. subject chose to terminate the test because of fatigue, nausea or dizziness.

If the exercise phase ended early, the subject was asked whether he or she could continue with the rest phase. If the response was yes, then the rest period immediately began. If the response was no, the subject was taken out of the room and given cold water to drink and cool, wet towels were placed on the subject's head. Esophageal temperature and heart rate were continuously monitored during this cool down procedure. Only one of the 180 tests required this type of cool down procedure. The remaining 179 completed the entire exercise and rest sequences. For that test where the exercise phase ended prior to minute 50 (minute 45 of exercise) and the subject chose to continue, the rest period lasted 15 minutes. For tests where the exercise phase continued for the entire 45 minutes, the rest phase ran from minute 51 to minute 65. When the subjects reached 40 minutes of the prescribed 45 minute exercise phase, they were instructed to begin a 5 minute cool down period by reducing the bike RPM at their own discretion. The rest period was conducted in the location prescribed by the test conditions previously outlined. All tests were completed after the 15-minute rest period. At this time the subjects were given unlimited quantities of cool water, cool, wet towels and were provided assistance in

removing the monitoring devices and face shield or Tyvek suits. Subjects were released from the laboratory when their heart rate returned to baseline values.

5.0 Results and Discussion

The hypothesis of this study is the adjusted-ear canal temperature (T_{ac}) measured and recorded by the Questemp II[®] will equal the esophageal temperature (T_{es}) measured at the same time, and this equality will be maintained throughout all transient heat load conditions. In order to evaluate the relationship between the concomitant measurements of esophageal and adjusted-ear canal temperatures, four study objectives were determined. Discussion of these objectives follows in four sections: Section 5.1 focuses on the ability of the Questemp II[®] monitor to track concurrent measures of esophageal temperature; Section 5.2 presents analysis on the equality of adjusted-ear canal temperature measurements to esophageal temperature measurements throughout the test conditions; Section 5.3 involves a review and analysis of the calibration procedure of the Questemp[®] II in its attempt to compensate for the temperature differences between the external ear canal and core body temperature; and, Section 5.4 discusses the algorithm of the Questemp[®] II in its attempt to adjust for environmental influences on the external ear canal and the differences between the ear canal temperature and the core body temperature.

5.1 Questemp ° II Tracking Performance

Raw data plots were generated for the 180 tests conducted in this study. The graphs plotted esophageal and adjusted-ear canal temperatures on the y-axis and total test time on the x-axis. The time and both temperature measurements were collected and plotted on a per-minute basis. For discussion clarification, 3 distinct environments, 3 distinct clothing variables and 3 distinct time periods have been identified for the 18 test conditions. Environment 1 (E1) was the exercise and rest periods conducted in the test chamber. Environment 2 (E2) was the exercise period conducted in the test chamber and the rest conducted in the hallway. Environment 3 (E3) was the exercise and rest periods in the test chamber with forced air movement. Clothing 1 (C1) was gym clothes, socks and shoes; Clothing 2 (C2) was gym clothes, socks and shoes and a gold lined face shield; and Clothing 3 (C3) was gym clothes, socks and shoes and a vapor barrier (Tyvek) suit, with head, hands and feet not covered by the suit. Period 1 (P1) was minutes 1 to 5; Period 2 (P2) was minutes 6 to 50; and Period 3 (P3) was minutes 51 to 65. Each test was a total of 65 minutes in length. P1 was the warm-up period, P2 was the exercise period and P3 was the rest period. P1 and P2 were always conducted in the test chamber, while 6 of the 18 test conditions specified P3 to be conducted in the hallway. The remaining 12 tests had P3 conducted in the test chamber.

Careful observation of Table 2 shows that numerous tests provide the same heat stress conditions during the exercise phase. The following pairs of

tests had equal heat stress P2 conditions: 1 and 2; 4 and 5; 7 and 8; 10 and 11; 13 and 14; and 16 and 17.

Visual analysis of the graphs clearly demonstrated variations in temperature and time patterns between the high and low exercise loads, between the exercise and rest periods, and within and between subjects.

Figures 4 and 5 graphically display typical patterns of temperature changes over time for a low exercise load and a high exercise load under the same environmental test conditions (e.g. same environment, clothing, time period and subject). These graphs display the minor rise in T_{es} and T_{ac} throughout the low exercise load and the more dramatic increase in both temperatures during the high exercise load.

The majority of the research tests resulted in higher esophageal temperatures than adjusted-ear canal temperatures for both the low and high exercise loads. This pattern occurred for 89% of the low exercise loads and 96% of the high exercise loads. Those tests that had T_{ac} higher than T_{es} were from the same two subjects for both high and low exercise loads. Subject 3 had 8 tests with T_{ac} higher than T_{es} (6 low and 2 high exercise loads). Subject 5 had 5 tests with higher T_{ac} than T_{es} (3 low and 2 high exercise loads). Examples of these temperature relationships for Subject 3 and 5 are graphically displayed in Figures 6 and 7, respectively.

The raw data graphs displayed distinct temperature variations between the rest phases of E2 and E1 and E3. E2 required the rest period to be

conducted in the hallway, while E1 and E3 rest periods were conducted in the test chamber. The Questemp° II operations manual states that recalibration should take place if the ambient temperature changes more than ± 10 C. The recalibration procedure was carried out for each E2 test. The calibration procedure, however, took between 5 and 9 minutes to complete. During the calibration procedure, the Questemp° II monitor continued to collect and report Tac using the initial calibration offset value determined at the beginning of the test. Immediately upon entry into the hallway and prior to recalibration, Tac increased in value for nearly all E2 test conditions. Tac never

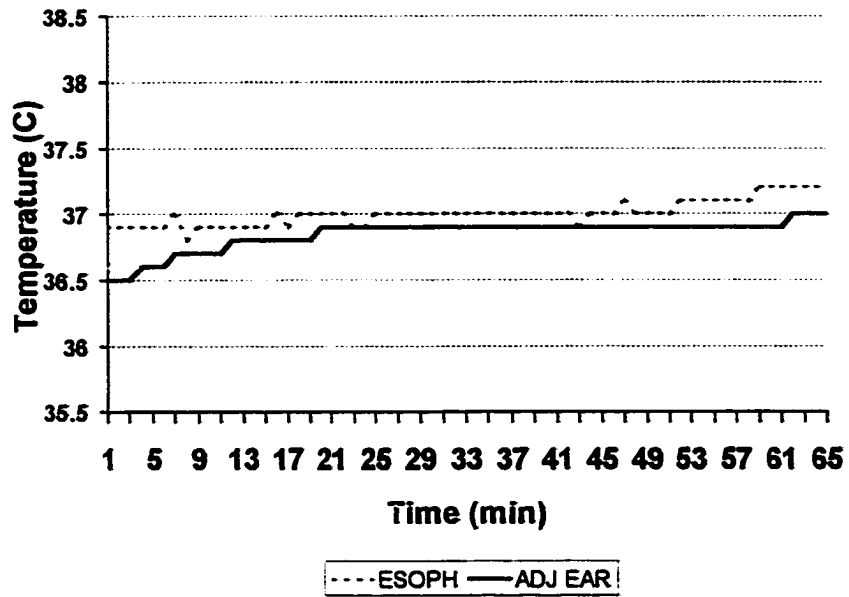


Figure 4: Representative of Low Exercise Load: Esophageal and Adjusted-ear temperature variation over time of Subject 10, Test 4.

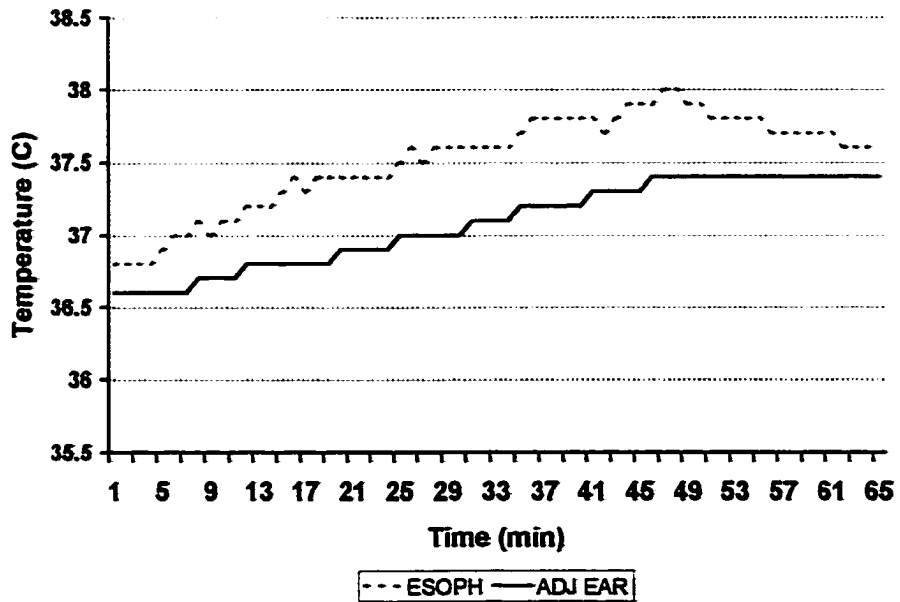


Figure 5: Representative of High Exercise Load: Esophageal and Adjusted-ear temperature variation over time of Subject 10, Test 13.

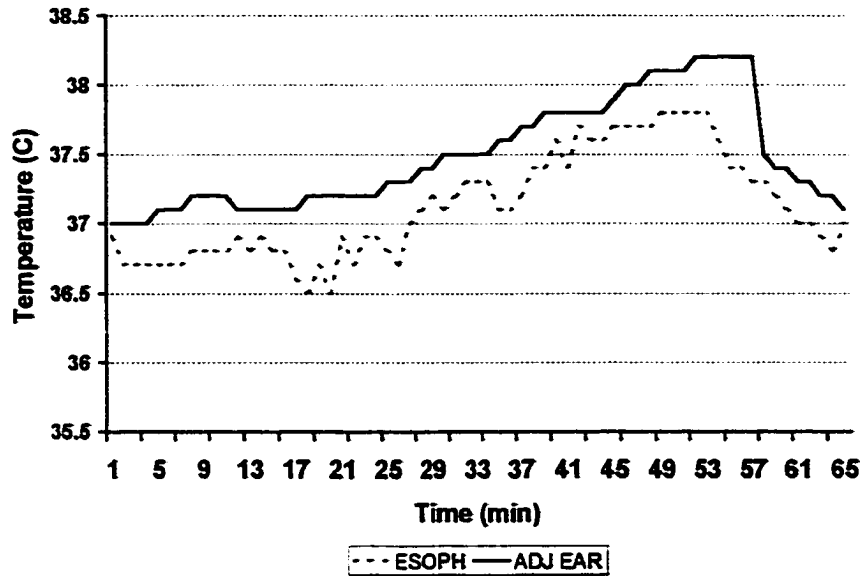


Figure 6: Representative of Adjusted-Ear greater than Esophageal Temperature over time for Subject 3, Test 17.

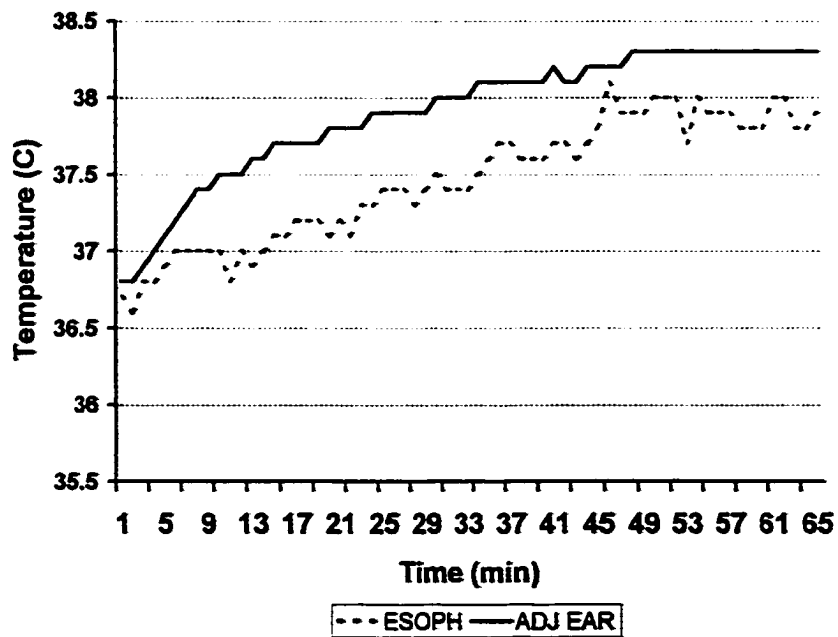


Figure 7: Representative of Adjusted-Ear greater than Esophageal temperature over time for Subject 5, Test 13

dropped in value, and for 6 occasions, remained the same. At the point of recalibration, Tac displayed a dramatic decrease in value in all but two tests. Those two tests were for the same subject, where pre- and post-calibration did not change the Tac value. Figures 8, 9 and 10 graphically display the different types of responses observed before and after recalibration. Figures 8 and 10 show an increase in Tac above Tes at the initiation of the rest period. Figure 9 also shows an increase in Tac, but the value does not rise above Tes. The pattern of Tac rising above Tes, as displayed in Figures 8 and 10, occurred in 70% of the low exercise load and 55% of the high exercise load tests. All other tests either had a pattern similar to Figure 9, where Tac did not rise above Tes, or Tac exceeded Tes at the termination of the exercise period, thus was already above Tes at the beginning of the rest period. The latter case occurred only twice and for the same subject.

Figures 8, 9 and 10 clearly illustrate the immediate decrease in Tac following recalibration. Figure 8 depicts recalibration which results in Tac matching Tes, where as Tac is adjusted far below Tes in Figure 9 and 10. The latter case occurred in 50% of the low exercise load and 81% of the high exercise load tests.

Variability of test results among subjects is presented in Figures 11 and 12. Both subjects completed Test 14 (E2, C2) with different Tac tracking patterns of Tes. Subject 5 had an increase of 0.8 C for Tes from the beginning of the work phase to its end, where as Subject 7 had only a 0.3 C

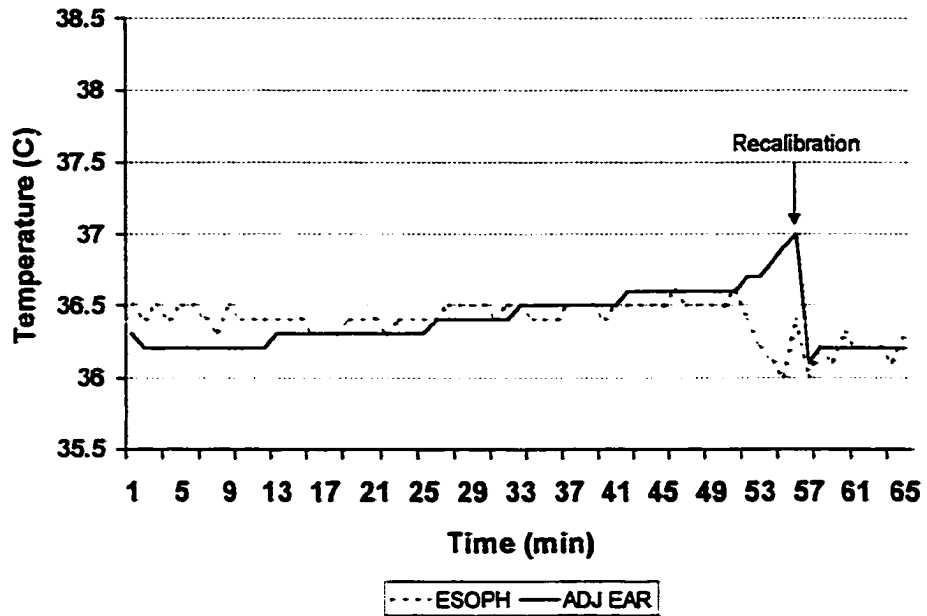


Figure 8: Effect of recalibration on adjusted-ear temperature and its relation to esophageal temperature for Subject 1, Test 8.

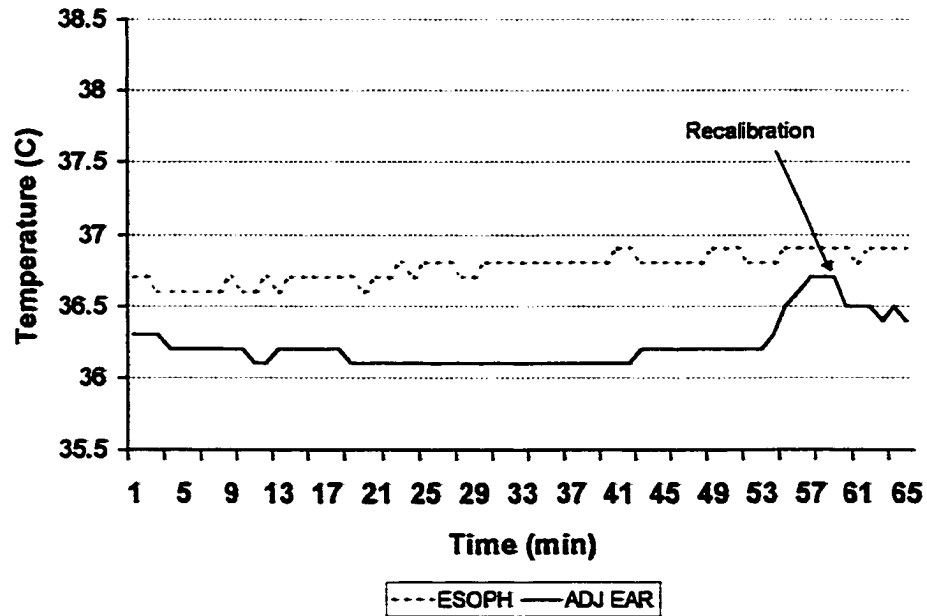


Figure 9: Effect of recalibration on adjusted-ear temperature and its relationship to esophageal temperature for Subject 3, Test 8.

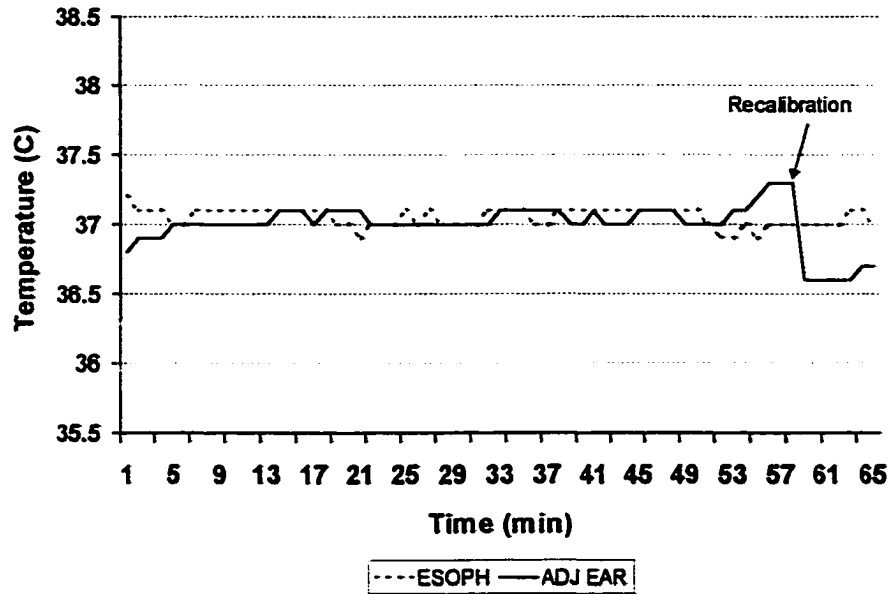


Figure 10: Effect of recalibration on adjusted-ear temperature and its relationship to esophageal temperature for Subject 2, Test 8.

rise in T_{es} . Both graphs display T_{ac} tracking of T_{es} , but with different offset values between the temperatures.

Intra-subject variability was also observed throughout numerous tests. Figures 13 and 14 illustrate this variability for Subject 2 in Tests 7 and 8. As previously introduced, the exercise phases of Tests 7 and 8 are equal in their environmental heat load, but have different heat loads during the rest phase. In the exercise phase of Test 7, Subject 2 response had a T_{ac} nearly equal to T_{es} throughout the entire period. The values differ by 0.1 C at the beginning of the exercise, minute 5, and by 0.2 C at the termination of exercise, minute 50. Test 8, however, differs by 0.4 C at the beginning of the exercise, minute 5, and 0.7 C at the termination of exercise, minute 50.

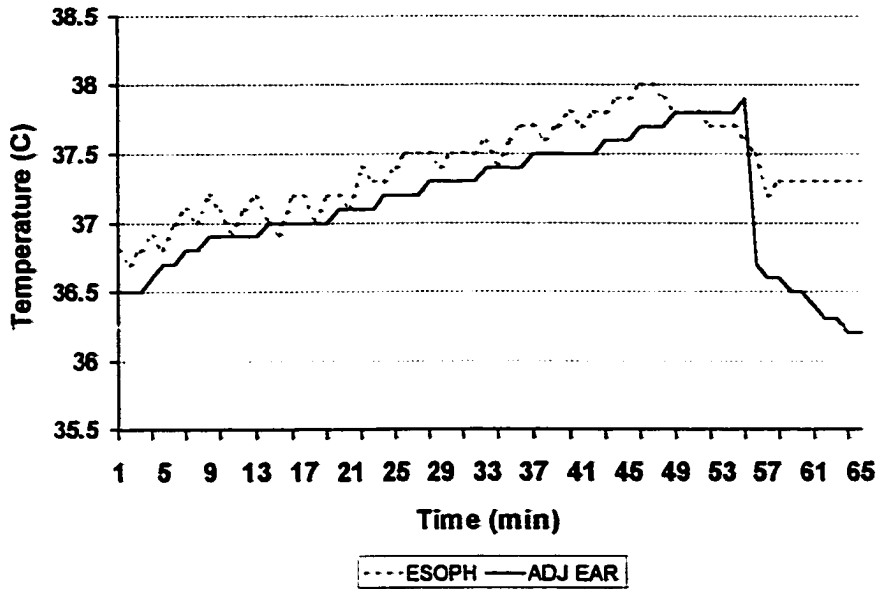


Figure 11: Compare to Figure 12 for illustration of variability between subjects conducting the same test. Subject 5, Test 14.

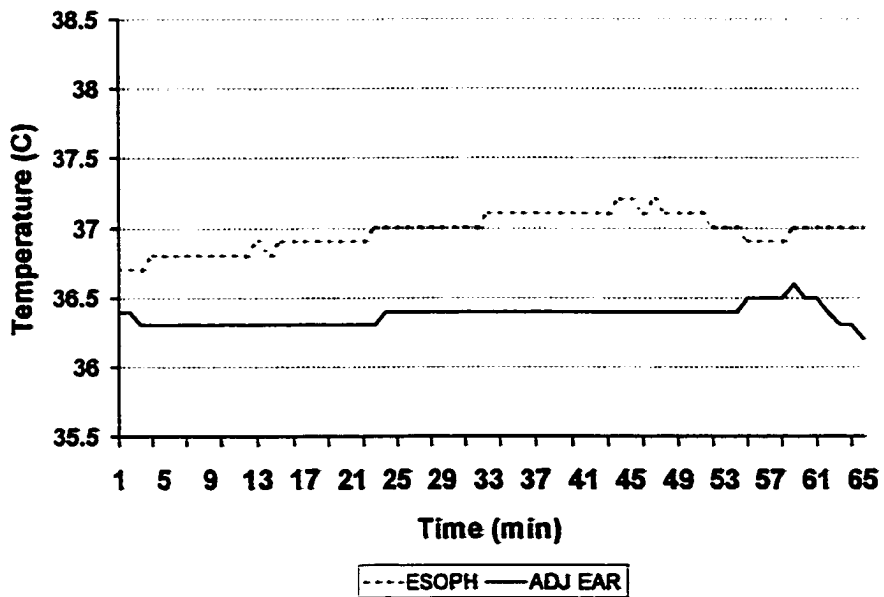


Figure 12: Compare to Figure 11 for illustration of variability between subjects conducting the same test. Subject 7, Test 14.

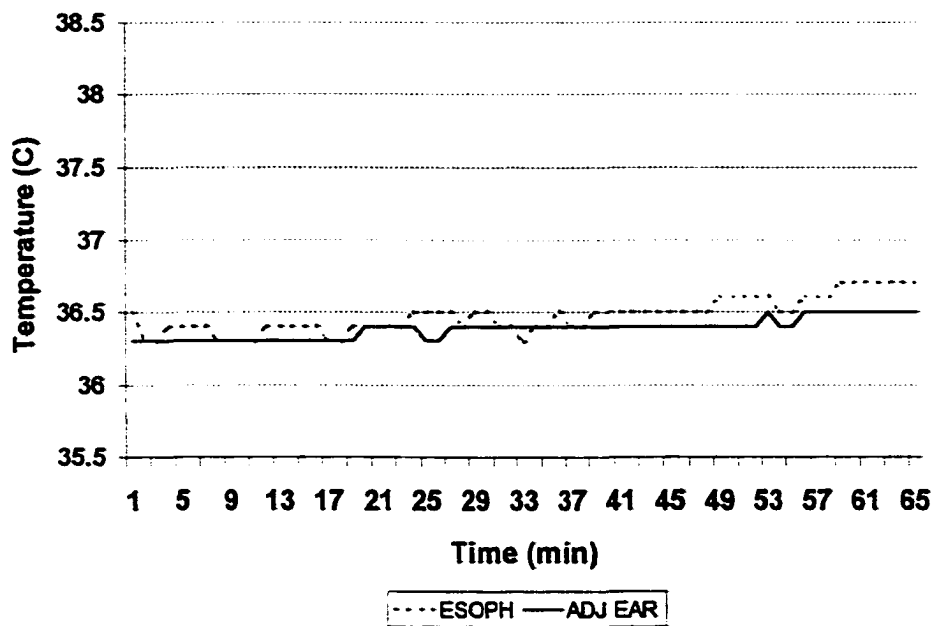


Figure 13: Compare to Figure 14 for illustration of intra-subject variability for same subject conducting same exercise phase of same test.. Subject 2, Test 7.

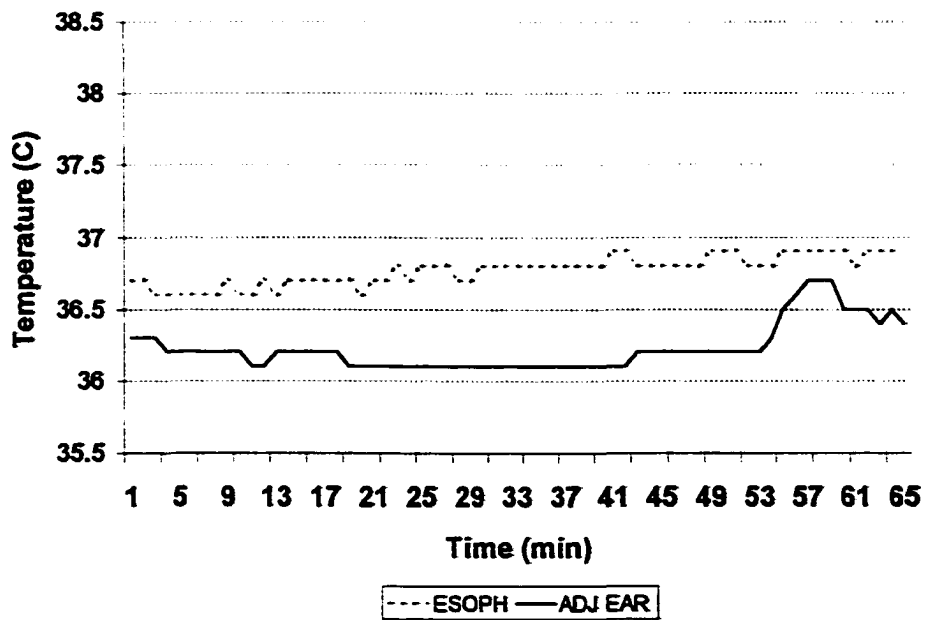


Figure 14: Compare to Figure 13 for illustration of intra-subject variability for same subject conducting same exercise phase of same test.. Subject 2, Test 8.

Tracking, as applied in this dissertation, means to follow the course of progress. Observation of the raw data graphically displayed through time indicates that Tac does track Tes, but with variations in tracking patterns. The most notable of these patterns is the variability in the absolute value difference between Tes and Tac between subjects and within subjects participating in the same test phase (i.e., exercise period, clothing worn and absence of forced air movement). A majority of tests, both low and high exercise loads, resulted in Tes higher than Tac throughout all test phases.

The instances where Tac exceeded Tes occurred for 8% of the tests and for only two subjects. The oral temperature value at calibration exceeded or was equal to Tes for 85% of these tests. Because of the Questemp° II algorithm and how the oral temperature interacts with this algorithm at calibration, an oral temperature exceeding Tes at calibration would place Tac higher than Tes at the start of these tests. Section 5.3 discusses this interaction in much greater detail.

The pattern where Tac immediately increases upon entering a cooler rest environment can be explained by examining the Questemp° II algorithm. The algorithm is as follows:

Equation 1

$$\mathbf{ADJUSTED-EAR = EAR\ CANAL - 0.1(M-37) + CALIBRATION\ OFFSET}$$

ADJUSTED-EAR = the adjusted-ear temperature on the LCD readout of the instrument. It is this temperature which the instrument interprets as the surrogate for core body temperature.

EAR CANAL = the actual temperature in the ear canal as measured by the thermistor inserted into the ear canal.

M = the mold temperature. It is the temperature measured by a thermistor in a plastic housing assembly, which is located directly outside the pinna.

CALIBRATION OFFSET = the oral temperature minus uncorrected-adjusted-ear temperature. The uncorrected-adjusted-ear temperature is the stabilized ear-adjusted temperature just prior to calibration.

The algorithm temperature variables are applied in degrees centigrade.

The purpose of the mold temperature is to sense and then compensate for non-drastic changes of the thermal environment. Non-drastic changes are defined as temperature changes less than ± 10 C. The instrument manufacturer indicates that thermal environmental changes affect the temperatures of the body's outer tissues, including the ear canal.

Studying the algorithm, if the mold temperature (M) is greater than 37 C, then the entire ADJUSTED-EAR value would equal some factor less than the EAR canal temperature (ignoring the calibration offset value). If the mold temperature were less than 37 C, then the ADJUSTED-EAR value would equal some factor greater than the EAR canal temperature. All test conditions where the rest phase was conducted in the hallway, the mold temperature was less than 37 C. The increase in Tac observed in the raw data plots can be explained by the lower mold temperature. Additionally, the continued increase in Tac up until the point of re-calibration can be explained by the continuous decrease in mold temperature. Mold temperature was decreasing in value towards the ambient temperature.

5.2 Equality of Concomitant Measures of Esophageal and Questemp® II Temperatures

Regression analysis was used to assess the extent of agreement between concomitant measures of Tac and Tes. The regression analysis examined the behavior of absolute temperature values over time of all subjects and clothing ensembles for low and high exercise loads, and warm and cool rest locations. The dependent variable assigned in the analyses was the difference between Tes and Tac, hereafter referred as Tes-ac. The independent variable was time. Equality between esophageal and adjusted-ear temperatures in time would create a regression line with a zero y-intercept and slope.

Figure 15 illustrates the format upon which the data analyses will be presented. If the analyses place the regression line, with 95% confidence intervals, within the zero-intercept/zero-slope line, then Tac was an accurate predictor of Tes. If the regression line is above the zero-intercept/zero-slope line, then Tac under-predicted Tes. If the regression line is below the zero-intercept/zero-slope line, then Tac over-predicted Tes.

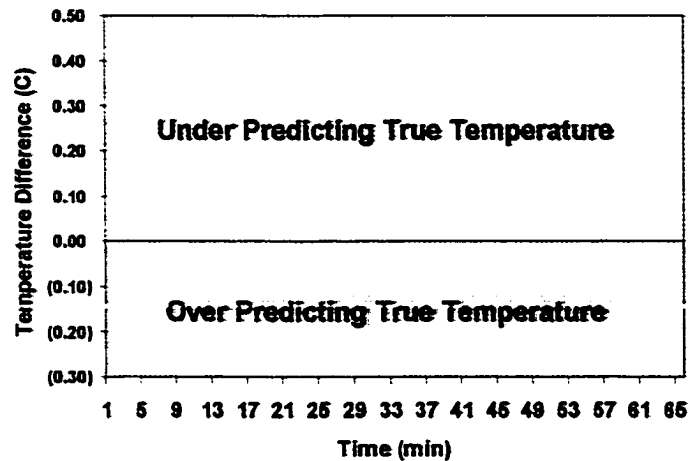


Figure 15: Format graph for presentation of regression analysis of esophageal temperature minus adjusted-ear temperature over time

As previously discussed in Section 5.1, visual analysis of the data indicated very different temperature/time patterns between T_{ac} and T_{es} for a) high and low exercise loads, b) exercise and rest periods, and c) warm and cool rest locations. To eliminate these known effects on the relationship between T_{es} and T_{ac} over time, six (6) regression analyses of $T_{es}-ac$ in time were conducted for the following test periods:

1. Low Exercise Load – Exercise period only (*low exercise*)
2. High Exercise Load – Exercise period only (*high exercise*)
3. Low Exercise Load – Rest period in test chamber (*warm low rest*)
4. High Exercise Load – Rest period in test chamber (*warm high rest*)
5. Low Exercise Load – Rest period in hallway (*cool low rest*)
6. High Exercise Load – Rest period in hallway (*cool high rest*)

In order to eliminate the dramatic Tac fluctuations observed during the cool low and high rest periods resulting from recalibration of the Questemp° II (see Figures 8, 9, and 10), the recalibration offset value was used to manipulate the Tac data for these periods. Corrected Tac values were established for the minutes from the beginning of the rest phase to the time of recalibration using the recalibration offset value. The Tes-ac temperature differences in the regression analyses for these cool rest periods used the corrected Tac temperature values.

Figures 16 through 21 graphically illustrate the regression lines for each of the above test periods 1 through 6, respectively. The analyses for all the test conditions indicate that the adjusted-ear temperature consistently under-predicts esophageal temperature. The graphs for *Low Exercise*, *High Exercise*, and *Warm Low Rest* illustrate that the temperature difference between Tes and Tac increases in time. The *Cool Low Rest*, and *Cool High Rest* graphs illustrate that the Tes-ac decreases in time. Tes-ac does not appear to change during the rest period for *Warm High Rest*. Comparing the pairs of Figures 16 and 17; 18 and 19; and 20 and 21 with each other, the Tes-ac differences between the low exercise load conditions are consistently smaller than the Tes-ac differences of the high exercise load conditions.

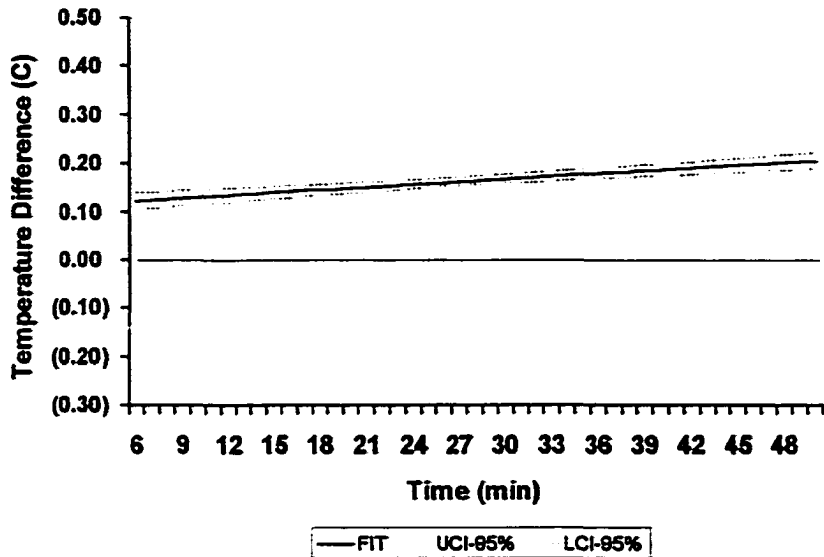


Figure 16: Regression line of Tes-ac temperature difference over time for Low Exercise Load – Exercise Period Only.

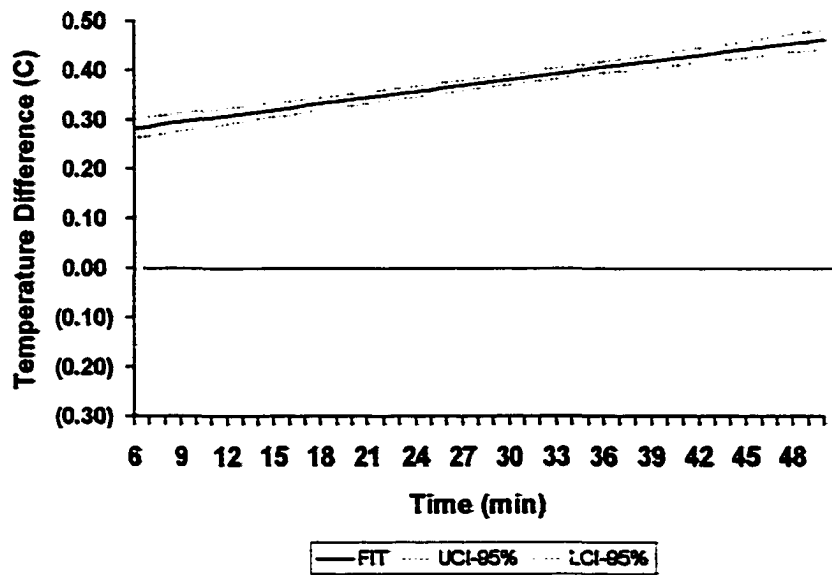


Figure 17: Regression line of Tes-ac temperature difference over time for High Exercise Load Exercise Period Only.

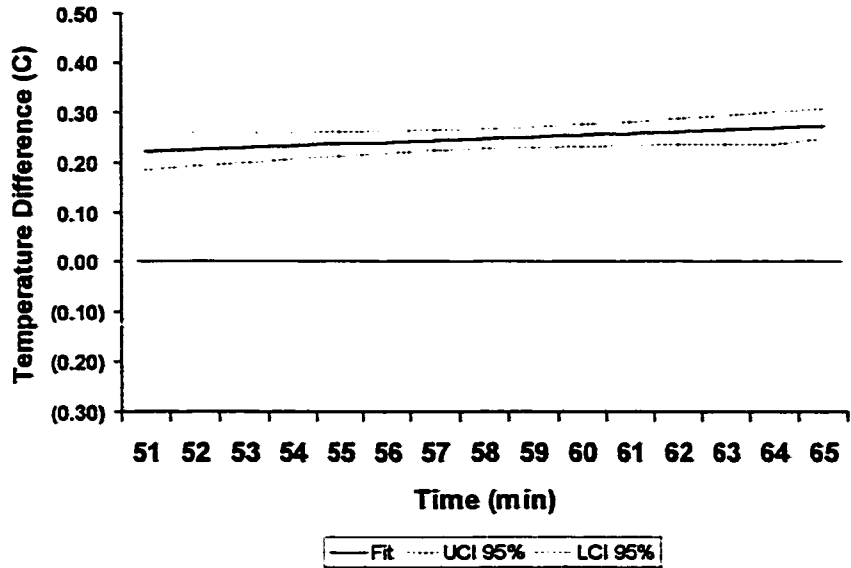


Figure 18: Regression line of Tes-ac temperature difference over time for Low Exercise Load – Rest Period in Test Chamber.

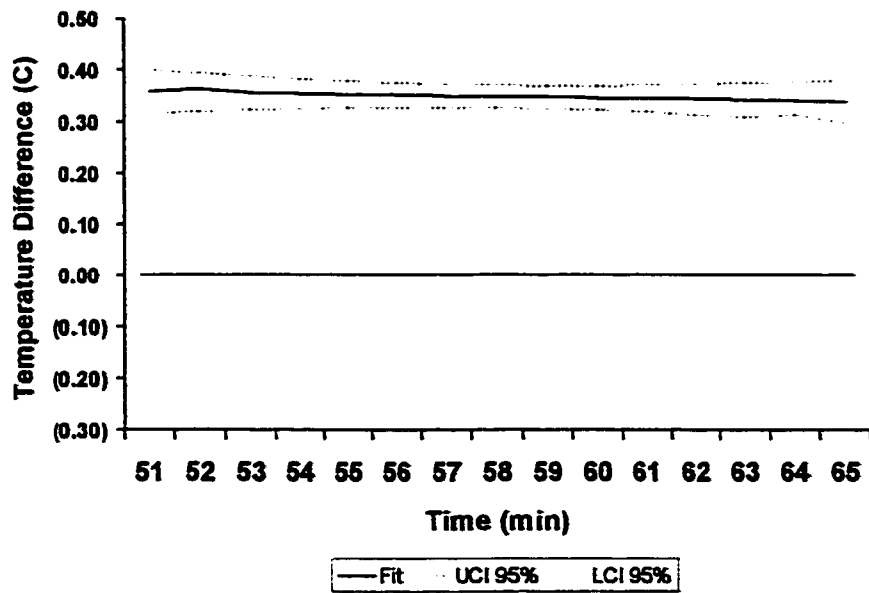


Figure 19: Regression line of Tes-ac temperature difference over time for High Exercise Load – Rest Period in Test Chamber.

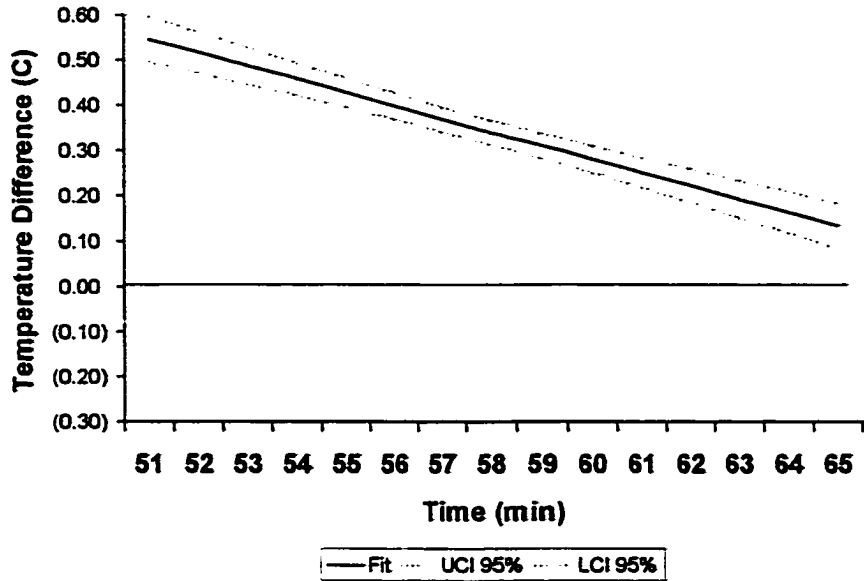


Figure 20: Regression line of Tes-ac temperature difference over time for Low Exercise Load – Rest Period in Hallway.

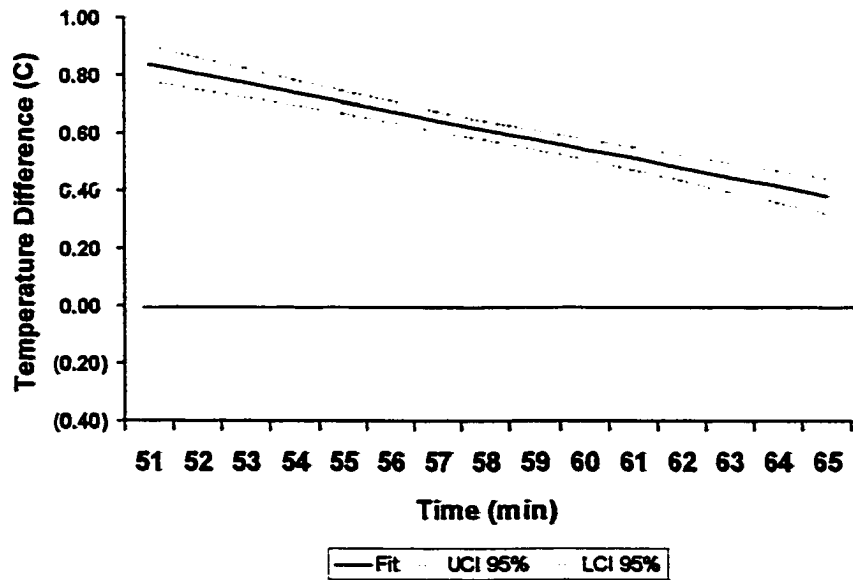


Figure 21: Regression line of Tes-ac temperature difference over time for High Exercise Load – Rest Period in Hallway.

Figures 16 to 21 indicate that the Questemp° II does not provide an equal measure of T_{es} for the conditions evaluated in this study. Based upon Figures 16 and 17, it appears that the ability of the Questemp° II to accurately predict esophageal temperature is worse for higher exercise conditions with continual degradation of prediction over time. This relationship is most unfortunate, in that as heat stress conditions rise, the ability of the Questemp° II to predict ensuing heat strain is degraded.

Figures 20 and 21 illustrate a point previously discussed in Section 5.1. Recalibration upon entering a cooler environment resets T_{ac} values far below T_{es} , thus indicating a dramatic under-prediction of esophageal temperature. As a result, one must question the need for recalibration as the Questemp° II operation manual instructs. Algebraic manipulation of the Questemp° II algorithm enabled the researcher to address this issue. Using the initial calibration offset value and the recalibration offset value, the researcher was able to calculate a corrected-recalibration T_{ac} value. The corrected-recalibration T_{ac} value represented T_{ac} as if no recalibration took place upon entering the cooler rest environment. The corrected-recalibration T_{ac} , hereafter, is referred to as $T_{ac}/ncaI$.

In addressing the need to recalibrate upon entering a cooler environment, regression analyses were conducted using the calculated $T_{ac}/ncaI$ data. The temperature differences between concurrent measures of T_{es} and $T_{ac}/ncaI$ were

assigned as the dependent variable and time as the independent variable. The regression lines for *Cool Low Rest-Tac/ncal* and *Cool High Rest-Tac/ncal* are illustrated in Figures 22 and 23, respectively.

Examination of Figures 22 and 23 indicates that recalibration does impair the ability of the Questemp[®] II to accurately predict esophageal temperature. Eliminating recalibration, however, does not correct for the under-prediction of *Tes* at the start of the rest period. This may pose a problem in that the wearer of this instrument may not take a rest period when one is needed. As in Figures 16 and 17, the ability for *Tac/ncal* to accurately predict *Tes* also degrades with time. Although at mid-rest, *Tac/ncal* equates to *Tes*, as the rest period progresses, *Tac/ncal* over-predicts *Tes*. An over-prediction of *Tes* during a rest period may lead to an unnecessary extended rest period.

Based upon previous research, external ear canal temperature is more affected by the environment and would be expected to cool faster and be lower in absolute value than esophageal temperature when subjects are placed in a cool environment. Examination of the actual ear canal temperature averaged by subject across time for both the low and high cool rest periods does show a marked decrease in value. Figures 24 and 25 illustrate averaged external ear canal, esophageal, *Tac/ncal*, and mold temperatures for the low and high cool rest periods. These figures also explain why *Tac/ncal* increases in value relative to *Tes* as the rest period progresses. As presented in Section 5.1, an

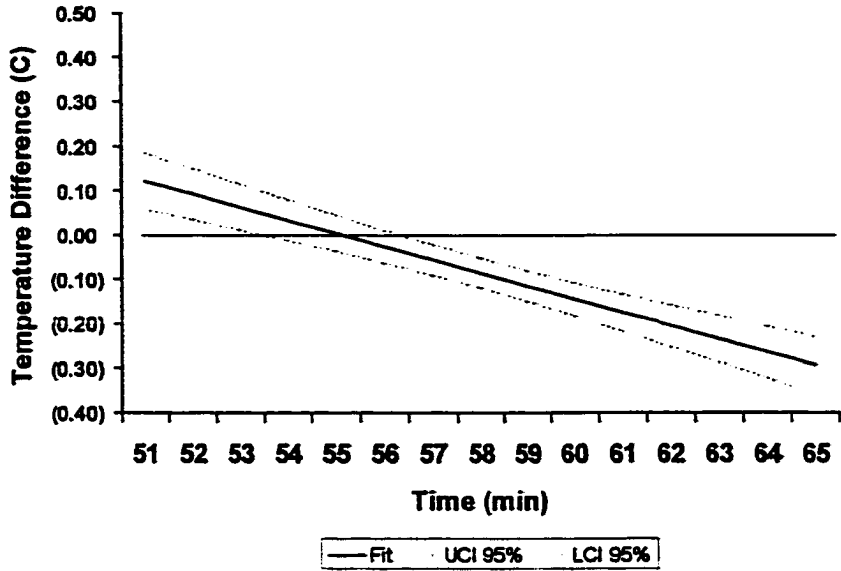


Figure 22: Regression line of Tes minus Tac/ncal temperature difference over time for Low Exercise Load – Rest Period in Hallway.

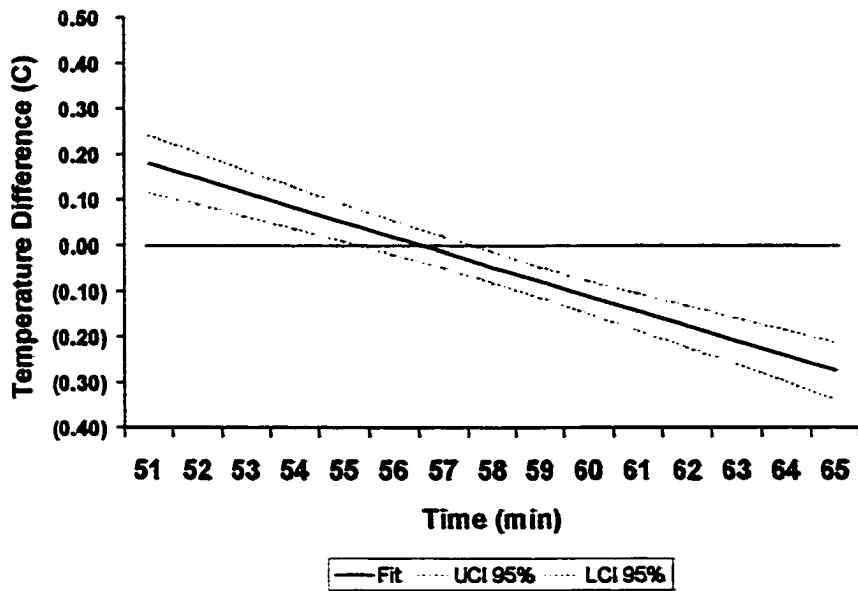


Figure 23: Regression line of Tes minus Tac/ncal temperature difference over time for High Exercise Load – Rest Period in Hallway.

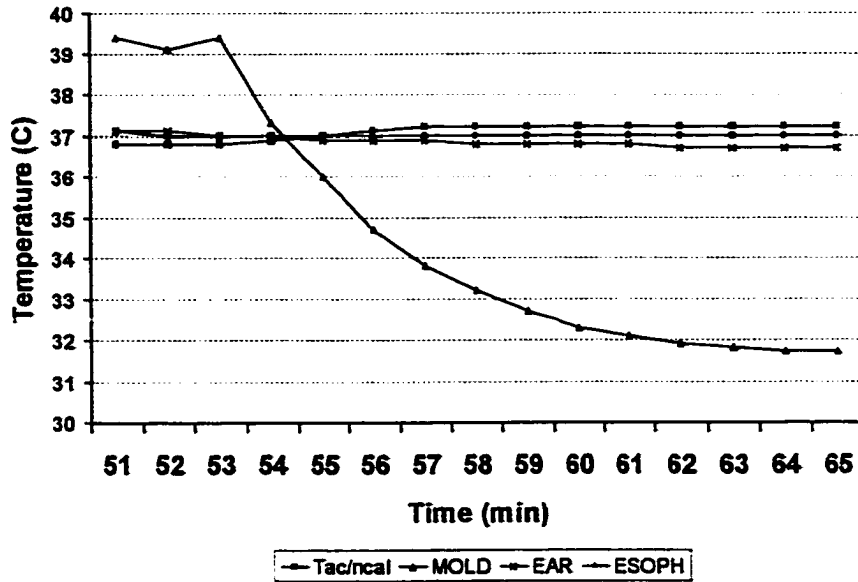


Figure 24: External ear canal, esophageal, mold and Tac/ncal temperatures through time for Low Exercise Load – Rest Period in Hallway.

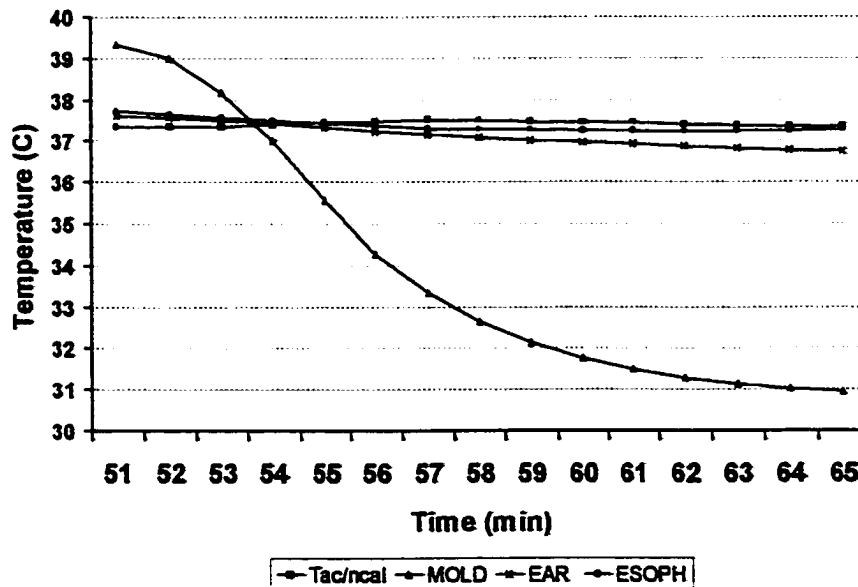


Figure 25: External ear canal, esophageal, mold and Tac/ncal temperatures through time for High Exercise Load – Rest Period in Hallway.

explanation lies with the mold temperature and its function in the adjusted-ear temperature algorithm. Referring to Equation 1, if the mold temperature was less than 37 C, then the ADJUSTED-EAR value would equal some factor greater than the actual EAR canal temperature. All test conditions where the rest phase was conducted in the hallway, the mold temperature was less than 37 C, and as the graphs illustrate, the mold temperature continually decreased throughout the entire rest periods. Also presented in the graphs, at the point in time when average mold temperature was equal to 37 C, the average esophageal, and Tac/ncal merged.

5.3 Calibration of the Questemp° II

The Questemp° II operation manual states the “purpose of calibration is to compensate for the difference between an individual’s ear and body temperatures” (53). Calibration is accomplished, by first, obtaining an oral temperature with the Questemp° Calprobe I thermometer. The thermometer is connected to the instrument via an external jack. Once the thermometer is placed under the tongue and the unit is in the *RUN* mode, the instrument is recording the oral temperature. At the time of calibration, the difference between the oral temperature and the adjusted-ear temperature is determined. This difference is termed the *calibration offset* and this value is used to equate the adjusted-ear temperature to the oral temperature. Thus, at the time of calibration, the adjusted-ear temperature equals the oral temperature

determined by the Questemp[®] Calprobe I thermometer. The first minute after calibration, the adjusted-ear temperature is recalculated based upon the algorithm, which includes the calibration offset value. The calibration offset value remains in effect until it is modified by the next calibration or if the instrument is reset.

As previously stated, the purpose for calibration is to compensate for the difference between an individual's ear canal and body temperatures. The calibration procedure equates the adjusted-ear temperature to the individual's oral temperature. Based upon the information presented in the Questemp[®] II operation manual and the algebraic deduction of the calibration procedure, calibration of the instrument assumes an individual's oral temperature is equal to the core body temperature.

Determining the effectiveness of the Questemp[®] II calibration procedure begins by evaluating the differences between oral and esophageal temperatures at the time of calibration. The values for esophageal and oral temperatures were recorded at the start of all tests. The mean difference, across all subjects and tests, of esophageal minus oral temperature was 0.16 C, with a 95% confidence interval of 0.13 to 0.18 C. Analysis of variance (ANOVA) showed the difference between esophageal and oral temperature was significantly influenced by subject ($P < 0.0001$) and environment ($P < 0.0001$). The influencing environment variable was the forced air movement.

The mean difference for the tests with forced air movement, across all subjects, of esophageal minus oral temperature was 0.06 C (0.006 – 0.12C). Eliminating the tests with forced air movement, the mean difference for all remaining tests, across all subjects, for esophageal minus oral temperature was 0.20 C (0.17 – 0.23C). It is obvious that the forced air movement induces some change in esophageal and/or oral temperatures. ANOVA showed that only subject (P<0.0001) influenced oral temperature, while subject (P<0.0001) and environment (P<0.0001) influenced esophageal temperature. The mean esophageal temperature at calibration for the tests with forced air movement was 36.8 C. The mean esophageal temperature for the tests without forced air movement was 37.0 C. A Student's T-test showed that the mean esophageal temperatures, with and without air movement, are significantly different ($\alpha = 0.005$). Analysis of the data indicates that the forced air movement caused esophageal temperature to be lower than the tests without forced air movement. In addition, there was no difference in oral temperature between these tests. The mean oral temperatures for forced air movement were 36.79 C and 36.81 C without air movement. Analysis showed those oral temperatures for these tests were not significantly different.

This finding is interesting, in that one would assume the oral temperature of an individual would decrease if placed in an environment with forced air movement compared to no air movement. Under these test conditions, this was clearly not the case. Rather, at the time of calibration, the oral temperature was

the same between the test environments and esophageal temperature was lower in the environment with air movement. The calibration procedure took between 4 and 7 minutes to complete. During this time, the subjects sat still on the bicycle with the Questemp^o Calprobe I thermometer under the tongue. The subjects were instructed only to nose breath during the procedure. The average range of the ambient air temperature for the test environments was 40.3 to 40.9 C. In the 7 to 9 minutes of exposure to the environment prior to calibration, one would expect the skin temperature to rise without a concomitant rise in core temperature. An increase in skin temperature would lead to active vasodilation of the skin arterioles and passive vasodilation of superficial veins, thus flooding the skin with blood previously flowing through the deep veins of the muscles. The increase in skin blood flow would enhance convective and radiative (sensible) heat loss. Additionally, initiation of the sweat response would be expected with subsequent evaporative heat loss, which would be enhanced with the air movement. Thus, an increase in skin blood flow and initiation of the sweating response without a concomitant rise in core temperature may introduce a slight decrease in core body temperature in preparation for potential heat strain.

At first glance, forced air movement appeared to improve the agreement between oral and esophageal temperatures relative to the tests without air movement. Examination of the data has shown that oral temperature did not change to accurately reflect an esophageal temperature change. Rather,

esophageal temperature changed in response to thermoregulatory physiological adjustments. Therefore, oral temperature did not show numerical agreement to esophageal temperature or physiological adaptability to reflect changes in esophageal temperature at the time of initial calibration.

The operation manual of the Questemp^o II indicates that recalibration should occur when the wearer of the instrument moves to an environment with a dry bulb temperature difference of $\pm 10\text{C}$. The dry bulb temperature in the test chamber ranged from 40 to 41 C, and the average hallway temperature was 27.7 C. Recalibration upon entering the hallway followed the same procedures as initial calibration. The time required for recalibration was slightly longer than initial calibration, 7 to 9 minutes compared to 4 to 7 minutes for initial calibration. The mean difference between esophageal minus oral temperature at the time of recalibration was 0.24 C (0.16 – 0.31 C). ANOVA showed significant influences on the temperature difference due to subject ($P<0.0001$) and exercise load ($P<0.001$). The exercise loads were low and high loads which, respectively, reflected 4 and 9 times each subject's basal metabolic rate. The mean difference between esophageal and oral temperatures for the low exercise load was 0.11 C. The mean difference between esophageal and oral temperatures for the high exercise load was 0.36 C. Once again, the question to be answered was "which temperature, esophageal or oral, was different as a result of the exercise loads?" It was found that only subject influences was a significant variable on the oral temperature. The subject and exercise load was shown to

influence the esophageal temperature. The mean esophageal temperature at the time of recalibration for the low exercise load was 36.9 C, and for the high exercise load was 37.3 C. A Student's T-test showed these two temperatures to be significantly different at $\alpha = 0.005$. The oral temperatures between the two exercise loads were not significantly different.

These findings indicate that esophageal temperature is lower in value at recalibration for the low exercise load compared to the high exercise load, whereas oral temperature remains the same for each exercise load. Under both circumstances, the mean esophageal temperature was higher than the mean oral temperature. The mean difference for the low load was 0.11 C, whereas the difference for the high load was 0.36 C. It appears that oral temperature is much lower than esophageal temperature under greater heat strain conditions. Recalibration under these conditions would reset the adjusted-ear temperature at a much lower value than the core body temperature. During heat strain conditions, where the actual body temperature is between 38 and 39 C, recalibration may drop the adjusted-ear temperature to below 38 C. An unfortunate outcome may be that the wearer of the instrument interprets this recalibration adjusted-ear temperature as a "safe" condition and continues to work.

5.4 Questemp^o II Algorithm Adjustment for Environmental Influences

Quest Electronics, the manufacturer of the Questemp^o II, accepts that environmental and individual parameters and changes in those parameters

influence the external ear canal temperature and its relationship to the core body temperature. An algorithm was made part of the instrument electronics to manipulate the external ear canal temperature in an attempt to compensate for these influences. As presented in Equation 1, the algorithm variables include the external ear canal temperature, a calibration offset value which stems from the oral temperature, and the mold temperature. Thus, the algorithm uses the numeric values of external ear canal temperature, oral temperature, and mold temperature to account for variations in the relationship between the ear canal temperature and the core body temperature. ANOVA was used to determine which test characteristics could explain the total variance in esophageal temperature. Since preliminary analysis indicated that the relationship between external ear canal temperature and esophageal temperature was different in the low and high exercise load tests, ANOVA was conducted separately for these conditions. Figures 26 and 27 illustrate the percent mean square error (%MSE) for each significant test parameter ($P < 0.0001$) that could explain the variance in esophageal temperature. The graphs show ear temperature has the largest influence for both the high and low exercise loads. Time has a much greater influence in the high exercise load, whereas the environmental condition (air movement) is more important in the low exercise load. Analysis presented in Section 5.3 of this chapter discussed the influence of forced air movement on the behavior of esophageal temperature. In conditions of lower heat strain (low exercise load), air movement appeared to influence esophageal temperature.

Under conditions of severe heat strain as in the high exercise load tests, the role of air movement in explaining the variance in esophageal temperature was lessened. Time, however, could explain nearly 30% of the variance in esophageal temperature for the high exercise loads. Further examination found that the rate of change in esophageal temperature was much greater for the high exercise loads than for the low exercise loads.

An important finding is that the mold temperature explains very little variance in esophageal temperature for both exercise loads. The clothing variable also has little influence on the variance of esophageal temperature. This is important in that it indicates that there is little influence on esophageal temperature between wearing a vapor barrier coverall versus wearing gym clothes for high and low exercise loads.

Based upon the analyses, it appears the emphasis placed on the mold temperature in the Questemp^o II algorithm does little to compensate for environmental and subject influences on the differences between ear canal and esophageal temperatures. If ear temperature, time and air movement could be accounted for in an algorithm, then 85% of the variance in esophageal temperature could be accounted for during high exercise loads, and 81% for low exercise loads. As it currently stands, only 53% is accounted for during high exercise loads, and 61% for low exercise loads. A toggle switch placed in the instrument that would designate workload and air movement would enable an

assortment of algorithms to be used for various combinations of work environments and workload level.

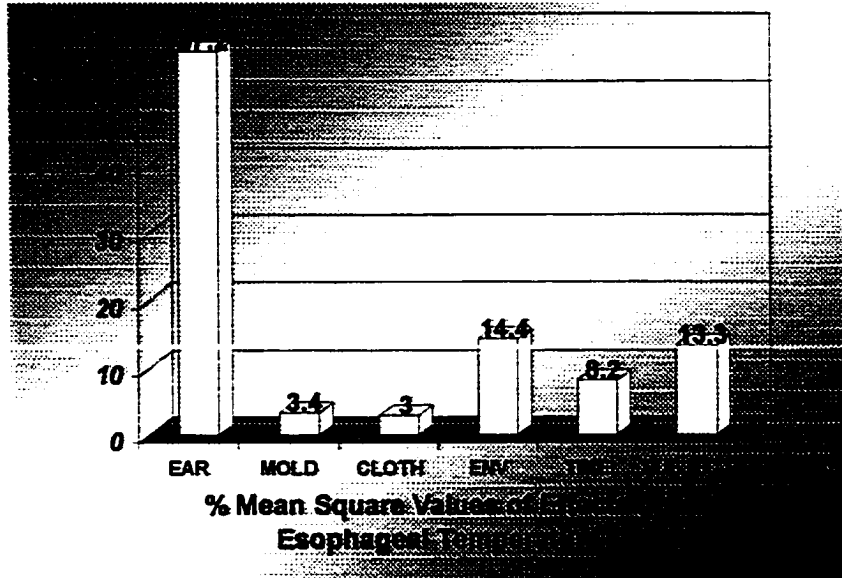


Figure 26: Low Exercise Loads: ANOVA % Mean Square Values of Effects on Esophageal Temperature.

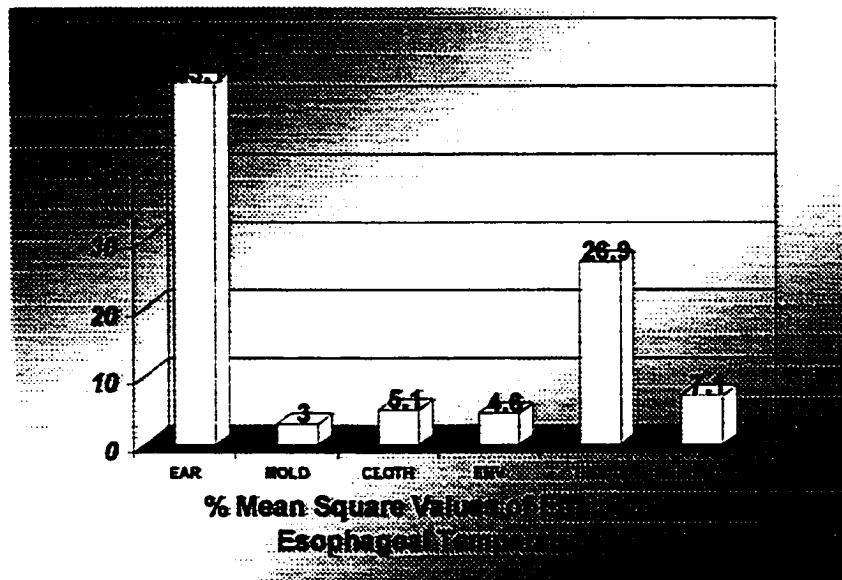


Figure 27: High Exercise Loads: ANOVA % Mean Square Values of Effects on Esophageal Temperature.

6.0 Conclusions

The first objective of this study was to determine if the adjusted-ear canal temperature tracked esophageal temperature over time. The data demonstrated numerous types of tracking patterns for different exercise loads and between the exercise and resting phases. Visual analysis indicated that the low exercise load induced very little heat strain on the subjects, whereas the high exercise loads imparted measurable heat strain. Within both exercise loads, various inter- and intra-subject variability was observed for the same test conditions. This variability suggests that the instrument will have difficulty accounting for variations in the physical and physiological make-up of the working population.

Major pattern variations were observed for the test conditions that involved moving the subjects from the hot exercise phase to the cool rest phase. Reasons for the variations were two-fold. First, the immediate rise in T_{ac} resulted from the mold temperature influence on the instrument's algorithm. Secondly, recalibration of the instrument decreased T_{ac} values below T_{es} in 65% of the tests. The combined influence of the mold temperature and recalibration drastically alter the instrument's ability to track esophageal temperature.

The second objective was to determine the equality of the adjusted-ear canal temperature to the esophageal temperature. Throughout all test conditions, adjusted-ear canal temperature under-predicted esophageal temperature. The degree of inaccuracy is greater for the high exercise loads. Since the high exercise loads resulted in greater heat strain, an under-prediction of up to 0.46 C introduces a significant health risk for the instrument's wearer.

Algebraic manipulation of the cool rest data indicated that eliminating recalibration upon entering a cooler environment would improve the instrument's ability to predict esophageal temperature. The instrument, though, would still include the influence of mold temperature. This influence causes T_{ac} to rise above T_{es} at mid-rest. A worker wearing the instrument could interpret this as a "safe" condition and return to work while still in a state of thermal imbalance.

The third objective was to evaluate the calibration procedure of the Questemp[®]II. It was found that using the oral temperature as a surrogate for esophageal temperature lead to a calibration error of 0.2 C. Therefore, at the start of each test, T_{ac} was not equivalent to T_{es} . The calibration procedure did not meet its objective, which was to equate the two temperatures at the initiation of personal heat stress monitoring.

The fourth and final objective was to determine if the instrument algorithm compensated for the environmental influences on the external ear canal and the temperature differences between the external ear canal and esophageal temperatures. The ear canal and mold temperatures only accounted for 53% to

58%, and 3%, respectively, of the total variance on esophageal temperature. It seems that dependence on the mold temperature to compensate for environmental influences on the ability of the external ear temperature to predict esophageal temperature produces error in the prediction. Involving workload variables, air movement qualifiers and ear canal temperature in the algorithm should provide a more accurate measure of the thermal state of the body.

The instrument manufacturer states that the Questemp[®]II should be used in conjunction with an effective heat stress management program. The instrument is not intended as a definitive measure of physiological heat strain. Additionally, the monitor should act as an aid and not replace a worker's own feelings and judgement. The instrument, however, is also marketed as an alerting device that warns the wearer that their body temperature has risen above safe levels. The instrument alarm is capable of sounding between 38C and 39C. The data has shown there may be circumstances where the instrument alarm will not sound even though the core body temperature has exceeded the safe level of 38C. This study has shown that the instrument, when used as an alerting device, can be improved by altering the calibration method and algorithm variables used to determine its prediction of core body temperature.

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Abbreviations

ACGIH	American Conference of Governmental Industrial Hygienists
BMR	Basal Metabolic Rate
C	Degrees Celsius
CET	Corrected Effective Temperature
db	Dry Bulb
ECC	Extracorporeal Circulation
EDZ	Environmental Driven Zone
ET	Effective Temperature
F	Degrees Fahrenheit
gt	Globe Temperature
HSI	Heat Stress Index
Kcal	Kilocalories
NIOSH	National Institute for Occupational Safety and Health
nwb	Natural Wet Bulb
OSHA	Occupational Safety and Health Administration
P4SR	Predicted 4-Hour Sweat Rate
PZ	Prescription Zone
RH	Relative Humidity
RPM	Revolutions Per Minute
Tac	Adjusted-ear Temperature
Tac/ncal	Adjusted-ear Temperature without Calibration
Tc	Core Body Temperature
Tes	Esophageal Temperature
Tes-ac	Esophageal minus Adjusted-ear Temperature
TLV	Threshold Limit Value
Tmc	Mixing Chamber Temperature
Tsk	Skin Temperature
ULPZ	Upper Limit of Prescription Zone
Vex	Exhalation Volume
Vin	Inhalation Volume
V02	Oxygen Consumption in Liters Per Minute
WBGT	Wet Bulb Globe Temperature
WGT	Wet Globe Temperature

Appendix A

Esophageal and Adjusted-Ear Temperature Data for all Subjects and Tests

Test 1, Subject 1 to 5

TIME (min)	SUBJECT 1		SUBJECT 2		SUBJECT 3		SUBJECT 4		SUBJECT 5	
	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR
1	36.9	36.6	36	35.9	37.3	36.8	37.2	37	37.1	36.5
2	36.9	36.6	36	35.9	37.3	36.9	37.2	37	37.2	36.5
3	36.8	36.6	36	35.9	37.2	36.9	37.3	36.9	37	36.5
4	36.8	36.5	36	35.9	37.2	36.9	37.2	36.9	37.1	36.5
5	36.9	36.5	35.8	35.9	37.2	37	37.2	36.9	37	36.5
6	36.9	36.5	35.9	35.9	37.2	37	37.2	36.9	37.1	36.6
7	36.8	36.6	35.9	35.9	37.2	37	37.2	36.8	36.9	36.6
8	36.8	36.6	35.9	35.9	37.2	37	37.1	36.8	37	36.6
9	36.9	36.6	35.9	35.9	37.2	37	37	36.8	37.1	36.6
10	36.8	36.6	36	35.9	37.1	37	37	36.8	37	36.6
11	36.8	36.6	35.9	35.9	37.1	37	37	36.9	37.1	36.6
12	36.8	36.6	36	35.9	37.1	37	37	36.9	37	36.6
13	36.8	36.6	36	35.9	37.1	37	37	36.9	37.1	36.6
14	36.8	36.6	36	35.9	37.1	37.1	37	36.9	37	36.6
15	36.9	36.6	36	35.9	37.1	37.1	37.1	36.8	37.1	36.6
16	36.9	36.6	35.9	35.9	37.1	37.1	37.1	36.8	37.1	36.6
17	36.8	36.6	36	36	37.1	37.1	37.1	36.8	37	36.6
18	36.9	36.5	36	36	37.1	37.1	37	36.8	37	36.6
19	36.9	36.5		36	37.1	37.1	37	36.8	37.1	36.7
20	36.9	36.5	35.9	36	37.1	37.1	37	36.8	37.2	36.7
21	36.9	36.5	36	36	37.1	37.1	37	36.8	36.9	36.7
22	36.9	36.5	36	36	37.1	37.1	36.9	36.8	37	36.8
23	36.8	36.5	36	36	37.1	37.1	37	36.8	37	36.8
24	36.9	36.5	36.1	36	37.1	37.1	36.9	36.8	37	36.8
25	36.9	36.5	36	36	37	37.1	37	36.8	37	36.8
26	36.9	36.6	36	36	37	37.1	37.1	36.8	37.1	36.8
27	36.9	36.6	36	36.1	37	37.1	37	36.8	37.1	36.8
28	37	36.6	36	36.1	37.1	37.1	37	36.8	37.1	36.8
29	37	36.7	36	36.1	37.1	37.1	37	36.8	37.1	36.8
30	37	36.7	36	36.1	37.1	37.1	36.9	36.8	37	36.8
31	37	36.7	36	36.1	37.1	37.1	37	36.8	37.1	36.8
32	37	36.7	36	36.1	37	37.1	37	36.8	37.1	36.8
33	37	36.7	35.9	36	37.1	37.1	37	36.8	37.2	36.8
34	37	36.7	36	36.1	37.1	37.1	37	36.8	37	36.8
35	37	36.7	35.9	36.1	37	37.1	37.1	36.8	37.1	36.8
36	37	36.7	35.9	36	37.1	37.1	37.1	36.9	37.1	36.8
37	36.9	36.7	36	36.1	37.1	37.1	37.1	36.9	37	36.8
38	37	36.7	36	36.1	37.1	37.1	37	36.9	37.2	36.8
39	37	36.7	36.1	36.1	37.1	37.1	37.1	36.9	37.1	36.8
40	37	36.7	36	36.1	37.1	37.1	37.1	36.9	37.1	36.8
41	37	36.7	36	36.1	37.1	37.1	37	36.8	37.1	36.8
42	36.9	36.7	36	36.1	37.1	37.1	37	36.8	37.1	36.8
43	36.9	36.7	36	36.1	37.1	37.1	37	36.8	37.1	36.9
44	37	36.7	36	36.1	37.2	37.1	37.1	36.8	37.2	36.8
45	36.9	36.7	36.1	36.1	37.1	37.1	37.1	36.8	37.2	36.8
46	36.9	36.7	36	36.1	37.1	37.1	37.2	36.9	37.2	36.8
47	37	36.7	36	36.1	37.1	37.1	37.2	36.9	37	36.8
48	37	36.7	36.1	36.1	37.2	37.1	37.1	36.9	37.1	36.8
49	37	36.7	36.1	36.1	37.2	37.1	37.2	36.9	37	36.9
50	37	36.8	36.1	36	37.2	37.1	37.2	36.9	37.1	36.9
51	37	36.7	36.1	36	37.2	37.1	37.2	36.9	37.1	36.9
52	37	36.7	36.1	36	37.2	37.1	37.2	36.9	37.1	36.9
53	37	36.7	36.1	36	37.2	37.1	37.2	36.9	37.1	36.9
54	37	36.7	36.1	36	37.2	37.2	37.3	36.9	37.1	36.9
55	37	36.7	36.1	36.1	37.2	37.2	37.3	36.9	37.1	36.9
56	37	36.7	36.1	36.1	37.2	37.2	37.3	36.9	37.2	36.9
57	37	36.7	36.2	36.1	37.2	37.2	37.3	36.9	37.2	36.9
58	37	36.6	36.2	36.2	37.2	37.1	37.3	36.9	37.2	36.9
59	37	36.6	36.2	36.2	37.2	37.1	37.3	36.9	37.2	36.9
60	37	36.6	36.2	36.2	37.2	37.1	37.3	37	37.2	36.9
61	37	36.6	36.3	36.2	37.2	37.1	37.3	37	37.2	37
62	37	36.6	36.2	36.3	37.2	37.1	37.3	37	37.3	37
63	37	36.7	36.2	36.3	37.2	37.1	37.4	37	37.2	37
64	37	36.7	36.2	36.3	37.2	37.1	37.4	37	37.2	37
65	37	36.6	36.2	36.3	37.2	37.1	37.4	37	37.2	37

Test 1, Subjects 6 to 10

TIME (min)	SUBJECT 6		SUBJECT 7		SUBJECT 8		SUBJECT 9		SUBJECT 10	
	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR
1	37	36.9	37.1	36.8	37.1	36.6	37.2	36.7	37.1	36.6
2	36.9	36.9	37	36.9	37.1	36.6	37.2	36.7	37.1	36.6
3	36.9	36.9	36.9	36.9	37.1	36.6	37.2	36.8	37.1	36.6
4	36.9	36.9	36.9	36.9	37.1	36.6	37.1	36.8	37.1	36.6
5	36.9	36.9	36.9	36.9	37.1	36.6	37.2	36.8	37.2	36.6
6	36.9	36.9	36.9	36.9	37.1	36.6	37.2	36.8	37.2	36.7
7	36.9	36.9	36.8	36.8	37.1	36.7	37.1	36.7	37.1	36.7
8	36.8	36.8	36.9	36.9	37.1	36.7	37.2	36.7	37.2	36.7
9	36.8	36.8	36.9	36.8	37	36.7	37.2	36.7	37.1	36.7
10	36.8	36.8	36.9	36.8	37.1	36.7	37.2	36.7	37.1	36.7
11	36.8	36.8	36.9	36.8	37.1	36.7	37.2	36.7	37.1	36.8
12	36.9	36.8	36.9	36.8	37.1	36.7	37.2	36.7	37.2	36.8
13	36.8	36.8	36.8	36.8	37.1	36.8	37.2	36.7	37.1	36.8
14	36.9	36.8	36.9	36.8	37.1	36.8	37.2	36.7	37.2	36.8
15	36.9	36.8	36.9	36.8	37.2	36.8	37.2	36.7	37.1	36.8
16	36.9	36.8	36.9	36.8	37.2	36.8	37.2	36.7	37.2	36.8
17	37	36.8	36.9	36.8	37.2	36.8	37.1	36.7	37.2	36.8
18	36.8	36.8	36.9	36.8	37.2	36.8	37.2	36.8	37.2	36.8
19	36.8	36.9	36.9	36.8	37.2	36.9	37.2	36.8	37.2	36.8
20	36.9	36.9	36.9	36.8	37.2	36.9	37.2	36.8	37.2	36.8
21	36.9	36.9	36.9	36.8	37.2	36.9	37.2	36.8	37.2	36.8
22	36.9	36.9	36.9	36.9	37.2	36.9	37.2	36.8	37.2	36.8
23	37	36.9	36.9	36.9	37.2	36.9	37.3	36.7	37.2	36.8
24	36.9	36.9	36.9	36.9	37.2	36.9	37.2	36.7	37.2	36.8
25	36.9	36.9	37	36.9	37.2	36.9	37.2	36.7	37.2	36.8
26	37	36.9	37	36.9	37.3	36.9	37.3	36.7	37.3	36.8
27	37	36.9	37	36.9	37.3	36.9	37.2	36.7	37.2	36.9
28	36.9	36.9	36.9	36.9	37.3	36.9	37.3	36.7	37.2	36.9
29	36.9	36.9	37	36.9	37.3	36.9	37.2	36.7	37.3	36.9
30	36.9	36.9	36.9	36.9	37.3	36.9	37.2	36.7	37.3	36.9
31	37	36.9	37	36.9	37.3	36.9	37.2	36.6	37.3	36.9
32	37	36.9	37	36.9	37.2	36.9	37.3	36.6	37.3	36.9
33	37	36.9	36.9	36.9	37.3	36.9	37.3	36.6	37.3	36.9
34	37	36.9	37	36.9	37.3	36.9	37.2	36.6	37.3	36.9
35	37	36.9	37	36.9	37.3	36.9	37.3	36.6	37.3	36.9
36	37	36.9	37	36.9	37.3	36.9	37.3	36.6	37.3	36.9
37	37	37	37	36.9	37.3	36.9	37.3	36.6	37.3	36.9
38	36.9	37	37	37	37.4	36.9	37.3	36.6	37.4	37
39	37	37	37	37	37.4	36.9	37.3	36.6	37.4	37
40	37	37	37	37	37.3	36.9	37.3	36.7	37.4	37
41	36.9	37	37	37	37.3	36.9	37.3	36.7	37.4	37
42	36.9	36.9	37	37	37.4	36.9	37.3	36.6	37.4	37.1
43	36.9	36.9	37	37	37.4	36.9	37.3	36.6	37.4	37.1
44	37	36.9	37	37	37.3	36.9	37.3	36.6	37.4	37.1
45	36.9	37	37	37	37.3	36.9	37.3	36.6	37.3	37.1
46	37	37	37	37	37.4	36.9	37.3	36.6	37.4	37.1
47	36.9	37	37	37	37.3	36.9	37.3	36.6	37.3	37.1
48	36.9	37	37	37	37.3	36.9	37.2	36.6	37.3	37.1
49	37	37	37	37	37.4	36.9	37.3	36.6	37.3	37.1
50	37	37	37	37	37.4	36.9	37.3	36.6	37.3	37.1
51	37	37	37	37	37.4	37	37.4	36.7	37.4	37.1
52	37	37	37	37	37.4	37	37.3	36.7	37.4	37.1
53	37.1	37	37	37	37.4	37	37.4	36.7	37.4	37.1
54	37.1	37	37	37	37.4	37	37.4	36.7	37.4	37.1
55	37	36.9	37.1	37	37.4	37	37.4	36.7	37.4	37.1
56	37	37	37	37	37.5	37	37.5	36.7	37.4	37.1
57	37.1	37	37.1	37	37.4	37	37.5	36.7	37.4	37.1
58	37.1	37	37	37	37.5	37	37.5	36.7	37.4	37.1
59	37	37	37.1	37	37.4	37	37.5	36.6	37.5	37.1
60	37.1	37	37.1	37	37.4	37	37.5	36.8	37.5	37.1
61	37.1	37	37.1	37	37.5	37	37.5	36.7	37.5	37.1
62	37.1	37	37.1	37	37.5	37	37.5	36.7	37.5	37.1
63	37.1	37	37.1	36.9	37.5	37	37.5	36.7	37.5	37
64	37.2	37	37.1	36.9	37.5	37	37.5	36.8	37.5	37
65	37.1	37	37.1	36.9	37.5	37	37.5	36.8	37.5	37

Test 2, Subjects 1 to 5

TIME (min)	SUBJECT 1		SUBJECT 2		SUBJECT 3		SUBJECT 4		SUBJECT 5	
	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR
1	36.8	36.6	36.6	36.3	36.4	36.8	37.1	36.9	37.4	37
2	36.8	36.6	36.6	36.3	36.3	36.8	37	36.9	37.4	37
3	36.8	36.6	36.6	36.2	36.3	36.8	37	36.9	37.4	37
4	36.8	36.6	36.7	36.2	36.3	36.9	36.9	36.9	37.2	37
5	36.8	36.6	36.7	36.1	36.4	36.9	37	36.9	37.4	37
6	36.8	36.6	36.6	36.2	36.3	36.9	36.9	36.9	37.4	37
7	36.8	36.5	36.6	36.2	36.3	36.9	36.9	36.8	37.3	37
8	36.8	36.5	36.7	36.2	36.2	37	36.8	36.8	37.4	37
9	36.8	36.5	36.7	36.2	36.2	37	36.9	36.8	37.4	37.1
10	36.7	36.5	36.8	36.2	36.1	37	36.9	36.8	37.4	37.1
11	36.7	36.5	36.7	36.2	36.2	37	36.9	36.8	37.4	37.1
12	36.7	36.5	36.6	36.2	36.2	37	36.8	36.8	37.4	37.1
13	36.7	36.5	36.7	36.2	36.3	37	36.8	36.8	37.5	37.1
14	36.7	36.5	36.7	36.2	36.3	37	36.9	36.8	37.4	37.1
15	36.8	36.5	36.7	36.2	36.4	37	36.9	36.8	37.5	37.1
16	36.7	36.5	36.7	36.2	36.4	37	36.9	36.8	37.5	37.1
17	36.7	36.5	36.7	36.3	36.3	37	36.8	36.8	37.4	37.1
18	36.8	36.5	36.7	36.3	36.3	37.1	36.9	36.8	37.4	37.1
19	36.8	36.5	36.7	36.3	36.3	37.1	36.8	36.8	37.5	37.1
20	36.8	36.5	36.7	36.3	36.4	37.1	36.9	36.8	37.5	37.2
21	36.8	36.5	36.7	36.3	36.4	37.1	36.8	36.8	37.4	37.2
22	36.9	36.5	36.8	36.3	36.4	37.1	36.9	36.8	37.5	37.2
23	36.9	36.5	36.7	36.3	36.4	37.1	36.8	36.8	37.5	37.2
24	36.9	36.5	36.8	36.3	36.4	37.1	36.9	36.8	37.5	37.3
25	36.9	36.5	36.7	36.3	36.5	37.1	37	36.7	37.5	37.3
26	36.9	36.6	36.8	36.3	36.5	37.1	36.9	36.7	37.6	37.3
27	36.9	36.6	36.8	36.3	36.4	37.1	36.9	36.7	37.6	37.3
28	36.9	36.6	36.7	36.3	36.4	37.1	36.9	36.7	37.4	37.3
29	36.9	36.6	36.7	36.3	36.4	37.1	36.8	36.7	37.6	37.3
30	36.9	36.6	36.7	36.3	36.5	37.1	36.9	36.7	37.6	37.3
31	36.9	36.6	36.8	36.3	36.5	37.1	36.9	36.8	37.6	37.4
32	37	36.6	36.8	36.3	36.5	37.1	37	36.7	37.5	37.4
33	37	36.6	36.8	36.3	36.5	37.1	37	36.7	37.6	37.4
34	36.9	36.6	36.9	36.3	36.5	37.1	36.9	36.7	37.7	37.4
35	37	36.6	36.8	36.3	36.5	37.1	37	36.7	37.7	37.4
36	36.9	36.6	36.8	36.3	36.5	37.1	37	36.7	37.7	37.4
37	36.9	36.6	36.8	36.3	36.4	37.2	37	36.8	37.5	37.4
38	37	36.6	36.9	36.3	36.4	37.2	37	36.8	37.7	37.4
39	37	36.6	36.8	36.3	36.4	37.2	37	36.9	37.6	37.4
40	37	36.6	36.9	36.3	36.4	37.2	37	36.9	37.7	37.4
41	37	36.6	36.9	36.3	36.4	37.2	37	36.8	37.6	37.4
42	37	36.6	36.9	36.3	36.4	37.2	37	36.8	37.6	37.4
43	36.9	36.6	36.9	36.4	36.4	37.2	37	36.8	37.7	37.4
44	36.9	36.6	36.9	36.4	36.5	37.2	37	36.9	37.6	37.4
45	37	36.6	36.9	36.4	36.5	37.2	37.1	36.9	37.7	37.4
46	36.9	36.6	36.8	36.4	36.5	37.2	37.1	36.9	37.7	37.4
47	36.9	36.6	36.8	36.4	36.4	37.2	37.1	36.9	37.7	37.4
48	36.9	36.6	36.8	36.4	36.5	37.1	37.1	36.9	37.7	37.4
49	37	36.6	36.9	36.4	36.5	37.1	37.2	37	37.6	37.4
50	37	36.6	36.9	36.4	36.5	37.1	37.2	37	37.7	37.4
51	36.9	36.6	36.9	36.4	36.5	37.1	37.2	37	37.7	37.4
52	36.9	36.6	36.7	36.4	36.4	37.2	37.1	37	37.6	37.4
53	36.9	36.7	36.7	36.4	36.3	37.2	36.9	37	37.5	37.4
54	36.9	36.8	36.6	36.5	36.3	37.3	36.9	37.1	37.5	37.5
55	36.8	36.9	36.6	36.6	36.3	37.3	37	37.2	37.4	37.6
56	36.8	37	36.6	36.7	36.4	37.4	37.1	37.3	37.4	37.7
57	36.9	37	36.6	36.8	36.4	37.5	37.1	37.4	37.4	37.8
58	36.8	36.7	36.6	36.8	36.4	36.8	37.2	37.4	37.3	37.8
59	36.8	36.7	36.6	36.8	36.4	36.8	37.2	36.9	37.3	37.3
60	36.8	36.7	36.6	36.8	36.5	36.8	37.2	36.9	37.3	37.3
61	36.8	36.7	36.7	36.8	36.4	36.7	37.3	36.9	37.3	37.3
62	36.9	36.7	36.7	36.7	36.5	36.7	37.2	36.9	37.3	37.3
63	36.9	36.7	36.7	36.7	36.5	36.7	37.3	36.9	37.3	37.3
64	36.9	36.7	36.6	36.7	36.5	36.7	37.3	36.9	37.3	37.3
65	36.9	36.7	36.7	36.7	36.5	36.7	37.3	36.9	37.3	37.3

Test 2, Subjects 6 to 10

TIME (min)	SUBJECT 6		SUBJECT 7		SUBJECT 8		SUBJECT 9		SUBJECT 10	
	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR
1	37	36.7	36.9	36.6	37.6	37.3	37	36.8	36.9	36.2
2	37	36.7	36.8	36.6	37.5	37.3	37.1	36.8	37	36.2
3	36.9	36.7	36.8	36.6	37.6	37.2	37.1	36.8	36.9	36.2
4	36.9	36.7	36.8	36.6	37.6	37.2	37.1	36.8	37	36.2
5	36.9	36.7	36.8	36.6	37.5	37.2	37.1	36.8	36.9	36.3
6	36.9	36.8	36.8	36.6	37.5	37.2	37.1	36.8	36.9	36.3
7	36.9	36.8	36.8	36.5	37.5	37.3	37	36.8	36.9	36.3
8	36.9	36.8	36.8	36.5	37.5	37.3	37	36.8	36.9	36.4
9	36.8	36.8	36.9	36.5	37.5	37.3	37	36.8	36.9	36.4
10	36.9	36.8	36.9	36.5	37.4	37.3	37.1	36.8	36.8	36.5
11	36.9	36.8	36.9	36.5	37.4	37.3	37.1	36.8	36.9	36.5
12	36.9	36.8	36.8	36.5	37.5	37.3	37.1	36.8	36.9	36.5
13	37	36.8	36.9	36.5	37.5	37.3	37.1	36.8	36.9	36.5
14	36.8	36.8	36.9	36.5	37.4	37.3	37.1	36.8	36.9	36.5
15	36.9	36.8	36.9	36.5	37.5	37.3	37.1	36.8	36.9	36.5
16	36.9	36.8	36.9	36.5	37.5	37.3	37.1	36.8	37	36.4
17	37	36.8	37	36.4	37.5	37.3	37	36.8	36.8	36.4
18	36.9	36.8	36.9	36.5	37.4	37.3	37.2	36.8	36.9	36.4
19	36.9	36.8	36.9	36.5	37.5	37.3	37.2	36.8	36.9	36.4
20	37	36.8	36.9	36.5	37.5	37.3	37.2	36.9	36.8	36.4
21	37	36.8	37	36.5	37.4	37.3	37.1	36.9	36.8	36.4
22	37	36.8	36.9	36.6	37.5	37.3	37.2	36.9	36.8	36.5
23	37	36.8	37	36.6	37.5	37.3	37.2	36.9	36.9	36.5
24	37	36.8	37	36.6	37.5	37.3	37.2	36.9	36.9	36.5
25	37	36.8	37	36.6	37.5	37.3	37.3	37	36.9	36.5
26	37.1	36.8	37.1	36.5	37.5	37.3	37.3	36.9	37	36.5
27	37.1	36.9	37.1	36.5	37.5	37.3	37.2	36.9	36.9	36.5
28	37.1	36.9	37	36.5	37.5	37.3	37.3	36.9	37	36.5
29	37.1	36.9	37	36.5	37.6	37.3	37.3	36.9	37	36.5
30	37	36.9	37.1	36.5	37.4	37.3	37.2	36.9	37	36.5
31	37	36.9	37	36.5	37.5	37.3	37.3	36.9	37	36.5
32	37.1	36.9	37	36.5	37.6	37.3	37.2	36.9	37	36.5
33	37	36.9	37	36.6	37.5	37.3	37.3	36.9	37	36.5
34	37.1	36.9	37	36.6	37.5	37.3	37.3	36.9	37	36.5
35	37.1	36.9	37.1	36.6	37.5	37.3	37.3	36.9	37.1	36.5
36	37.1	36.9	37	36.5	37.5	37.3	37.3	36.9	37.1	36.5
37	37.1	36.9	37	36.5	37.5	37.3	37.3	36.9	37	36.5
38	36.5	36.9	37	36.5	37.4	37.3	37.3	37	37	36.5
39	36.9	36.9	37	36.5	37.5	37.3	37.3	37	37	36.5
40	37	37	37.1	36.5	37.6	37.3	37.3	37	37	36.5
41	37.1	37	37.1	36.5	37.5	37.3	37.4	37	37	36.6
42	37.2	37	37.1	36.5	37.6	37.3	37.2	36.9	37	36.6
43	37.1	37	37.1	36.5	37.5	37.3	37.3	36.9	37	36.5
44	37.1	37	37.1	36.5	37.5	37.3	37.3	36.9	37	36.5
45	37.2	37	37.1	36.5	37.6	37.3	37.3	36.9	37.1	36.5
46	37.2	37	37.1	36.5	37.7	37.4	37.4	36.9	37	36.5
47	37.2	37	37.1	36.5	37.7	37.4	37.2	37	37	36.5
48	37.2	37	37.1	36.5	37.6	37.4	37.4	37	37	36.5
49	37.2	37	37.1	36.5	37.7	37.4	37.4	36.9	37	36.5
50	37.2	37	37.1	36.4	37.7	37.4	37.4	36.9	37	36.5
51	37.2	37	37.1	36.4	37.7	37.4	37.4	36.9	37.1	36.5
52	37.1	37	37.1	36.4	37.6	37.5	37.3	36.9	37	36.5
53	37.1	37.1	37.1	36.5	37.7	37.5	37.3	36.9	36.9	36.6
54	37	37.1	37.1	36.5	37.6	37.5	37.3	37	36.9	36.7
55	37	37.1	37.1	36.6	37.7	37.6	37.3	37.1	36.9	36.8
56	37	37.2	37.1	36.7	37.6	37.7	37.3	37.2	36.9	37
57	37.1	37.3	37.1	36.7	37.6	37.7	37.3	37.2	36.9	37.1
58	37	37.3	37.1	36.7	37.5	37.8	37.3	37.3	36.9	37.1
59	37.1	37.3	37.1	36.7	37.5	37.8	37.2	37.2	37	36.6
60	37.1	37.1	37.1	36.6	37.6	37.1	37.2	37	36.9	36.4
61	37.1	37.2	37.1	36.6	37.6	37.1	37.3	37	36.9	36.4
62	37.1	37.1	37.1	36.6	37.6	37.1	37.3	36.9	37	36.4
63	37.1	37.1	37.1	36.5	37.6	37.1	37.3	36.9	37	36.4
64	37.1	37.1	37.1	36.5	37.6	37.1	37.3	36.9	37	36.4
65	37.2	37.1	37.1	36.4	37.6	37.1	37.3	36.9	37	36.4

Test 3, Subjects 1 to 5

TIME (min)	SUBJECT 1		SUBJECT 2		SUBJECT 3		SUBJECT 4		SUBJECT 5	
	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR
1	36.7	36.5	36.4	36.3	36.8	36.8	37.3	36.9	36.6	
2	36.7	36.5	36.4	36.3	36.8	36.9	37.2	36.9	36.5	
3	36.7	36.6	36.3	36.3	36.8	36.9	37.2	36.9	36.4	36.6
4	36.7	36.6	36.3	36.3	36.8	37	37.2	36.9	36.6	36.7
5	36.6	36.6	36.3	36.3	36.8	37	37.2	36.9	36.6	36.7
6	36.6	36.5	36.3	36.3	36.8	37.1	37.2	36.9	36.5	36.7
7	36.6	36.5	36.3	36.3	36.7	37.1	37.1	36.9	36.3	
8	36.6	36.5	36.2	36.3	36.8	37.1	37.2	37	36.3	36.7
9	36.6	36.5	36.3	36.3	36.8	37.1	37.1	37	36.3	36.7
10	36.6	36.5	36.2	36.3	36.8	37.1	37.1	37	36.4	36.7
11	36.6	36.6	36.3	36.3	36.8	37.1	37.1	37	36.3	36.7
12	36.6	36.6	36.3	36.3	36.8	37.1	37.1	37	36.5	
13	36.6	36.6	36.3	36.3	36.8	37.1	37	36.9	36.4	36.7
14	36.5	36.6	36.3	36.3	36.8	37.1	37.1	36.9	36.5	36.7
15	36.6	36.6	36.3	36.3	36.8	37.1	37.1	36.9	36.5	36.7
16	36.6	36.6	36.3	36.3	36.9	37.1	37.1	36.9	36.5	36.7
17	36.6	36.6	36.3	36.3	36.9	37.1	37.1	36.9	36.5	
18	36.6	36.6	36.3	36.3	36.9	37.2	37	36.9	36.5	36.7
19	36.6	36.6	36.3	36.3	36.9	37.2	37.1	36.9	36.5	36.7
20	36.6	36.6	36.3	36.3	36.9	37.1	37.1	36.9	36.5	36.7
21	36.6	36.6	36.3	36.3	36.8	37.1	37	36.9	36.4	36.8
22	36.6	36.6	36.3	36.4	36.9	37.2	37	36.9	36.5	36.8
23	36.6	36.6	36.3	36.3	36.9	37.2	37.1	36.9	36.5	
24	36.5	36.6	36.3	36.6	36.9	37.2	37.1	36.9	36.5	36.8
25	36.6	36.6	36.3	36.5	36.9	37.2	37.2	36.9	36.4	36.8
26	36.6	36.6	36.4	36.4	36.9	37.2	37.1	36.9	36.5	36.8
27	36.7	36.6	36.4	36.3	36.8	37.2	37.1	36.9	36.6	36.8
28	36.6	36.6	36.4	36.3	36.9	37.2	37	36.9	36.6	
29	36.7	36.6	36.3	36.3	36.9	37.2	37	36.9	36.5	36.8
30	36.7	36.6	36.4	36.3	36.9	37.2	37.1	36.9	36.6	36.8
31	36.7	36.6	36.3	36.2	36.8	37.2	37.1	36.9	36.6	36.8
32	36.7	36.6	36.3	36.3	36.9	37.2	37.1	36.9	36.5	36.8
33	36.7	36.6	36.4	36.3	36.9	37.2	37	36.9	36.5	
34	36.7	36.6	36.4	36.3	36.9	37.2	37.1	36.9	36.5	36.8
35	36.6	36.6	36.4	36.3	36.9	37.2	37.2	36.9	36.6	36.8
36	36.6	36.6	36.4	36.3	36.8	37.2	37.2	36.9	36.6	36.8
37	36.6	36.6	36.4	36.3	36.8	37.1	37.2	36.9	36.7	36.8
38	36.7	36.6	36.4	36.3	36.8	37.1	37.1	36.9	36.7	
39	36.7	36.6	36.4	36.2	36.8	37.1	37.1	36.9	36.6	36.8
40	36.7	36.6	36.4	36.2	36.8	37.1	37.1	36.9	36.6	36.8
41	36.8	36.6	36.4	36.2	36.9	37.1	37.1	36.9	36.6	36.8
42	36.8	36.6	36.4	36.2	36.9	37.1	37	36.9	36.6	36.8
43	36.8	36.6	36.4	36.2	36.9	37.1	37.1	36.9	36.6	
44	36.8	36.7	36.4	36.2	36.9	37.1	37.1	37	36.5	36.8
45	36.8	36.7	36.4	36.3	36.9	37.1	37.2	37	36.6	36.8
46	36.8	36.7	36.4	36.3	36.8	37.1	37.3	37	36.6	36.8
47	36.8	36.7	36.5	36.2	36.8	37.2	37.1	37	36.7	36.8
48	36.7	36.6	36.5	36.2	36.9	37.2	37.2	37	36.7	36.8
49	36.7	36.6	36.5	36.2	36.9	37.1	37.2	37	36.7	36.8
50	36.8	36.6	36.5	36.2	36.8	37.1	37.3	37	36.7	36.8
51	36.8	36.6	36.5	36.2	36.9	37.1	37.3	37	36.9	
52	36.8	36.6	36.5	36.2	36.9	37.1	37.3	37	36.6	
53	36.8	36.6	36.5	36.2	36.9	37.1	37.3	37	36.8	36.8
54	36.8	36.6	36.5	36.2	36.9	37.1	37.3	37	36.8	36.8
55	36.7	36.6	36.5	36.2	36.9	37.1	37.3	37	36.9	36.8
56	36.8	36.6	36.5	36.2	36.9	37.1	37.3	37	36.9	36.8
57	36.8	36.6	36.6	36.2	36.9	37.1	37.3	37	36.9	
58	36.8	36.6	36.6	36.2	36.9	37.1	37.3	37	36.9	36.8
59	36.8	36.6	36.6	36.2	36.9	37.1	37.3	37	36.9	36.9
60	36.8	36.6	36.6	36.2	36.9	37.1	37.3	37.1	36.9	36.9
61	36.8	36.7	36.6	36.2	36.9	37.1	37.4	37.1	37	36.9
62	36.8	36.7	36.6	36.2	36.9	37.1	37.4	37.1	36.9	36.9
63	36.8	36.7	36.6	36.2	36.9	37.1	37.4	37.1	37	
64	36.8	36.7	36.5	36.2	36.9	37.1	37.4	37.1	36.9	37
65	36.8	36.7	36.6	36.3	37	37.1	37.4	37.1	37	37

Test 3, Subjects 6 to 10

TIME (min)	SUBJECT 6		SUBJECT 7		SUBJECT 8		SUBJECT 9		SUBJECT 10	
	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR
1	36.9	36.9	36.6	36.5	36.9	36.6	37.2	36.8	36.9	36.3
2	36.8	36.9	36.6	36.6	36.8	36.6	37.2	36.8	36.9	36.3
3	36.8	36.9	36.6	36.6	36.9	36.6	37.1	36.9	37	36.3
4	36.8	36.9	36.5	36.6	36.8	36.6	37.2	36.9	37	36.4
5	36.8	36.9	36.6	36.6	36.9	36.6	37.2	37	36.9	36.4
6	36.8	36.8	36.6	36.6	36.9	36.6	37.2	37	36.9	36.4
7	36.8	36.8	36.6	36.6	36.9	36.6	37.2	37	36.8	36.5
8	36.7	36.8	36.5	36.6	36.9	36.6	37.2	37	36.9	36.5
9	36.8	36.8	36.6	36.6	36.9	36.7	37.2	37	36.9	36.5
10	36.7	36.8	36.5	36.6	36.9	36.7	37.1	37	36.9	36.6
11	36.8	36.8	36.5	36.7	36.9	36.7	37.2	37	36.9	36.6
12	36.8	36.9	36.6	36.7	36.9	36.7	37.2	37	36.9	36.6
13	36.9	36.9	36.6	36.7	36.9	36.7	37.2	37	36.9	36.6
14	36.9	36.9	36.6	36.7	36.9	36.7	37.2	37	36.9	36.6
15	36.9	36.9	36.6	36.6	37	36.7	37.3	37	36.9	36.6
16	36.9	36.9	36.6	36.6	37	36.7	37.3	37	36.9	36.6
17	36.9	36.9	36.7	36.6	37	36.8	37.3	37	36.9	36.5
18	36.9	37	36.6	36.6	37	36.8	37.3	37	36.9	36.5
19	36.9	37	36.6	36.6	37.1	36.8	37.3	37	36.9	36.5
20	37	37	36.6	36.6	37	36.8	37.3	37	36.9	36.5
21	36.9	37	36.6	36.6	37	36.8	37.2	37	36.9	36.5
22	37	37	36.6	36.6	37.1	36.8	37.3	37	36.9	36.5
23	37	37	36.7	36.6	37.1	36.8	37.3	37	36.9	36.5
24	37	37	36.6	36.6	37.1	36.8	37.3	37	37	36.6
25	37	37	36.6	36.6	37.1	36.8	37.3	37	37	36.6
26	37.1	37	36.7	36.6	37.1	36.8	37.3	37	36.9	36.6
27	37.1	37	36.6	36.6	37.1	36.8	37.3	37	37	36.6
28	37.1	37	36.6	36.5	37.1	36.8	37.4	37	36.9	36.6
29	37	37.1	36.7	36.5	37.1	36.8	37.3	37	36.9	36.6
30	37	37.1	36.7	36.5	37.2	36.9	37.4	37	37	36.6
31	37	37.1	36.6	36.5	37.2	36.9	37.3	37	36.9	36.5
32	36.9	37.1	36.7	36.5	37.2	36.9	37.4	37	37	36.5
33	37.1	37.1	36.7	36.5	37.2	36.9	37.4	37	37	36.5
34	37.1	37.1	36.7	36.5	37.2	36.9	37.3	37	37	36.6
35	37	37.1	36.7	36.5	37.2	36.9	37.4	37	36.9	36.6
36	37	37.1	36.7	36.6	37.2	36.9	37.4	37	36.9	36.5
37	37.1	37.1	36.8	36.6	37.3	36.9	37.4	36.9	36.9	36.5
38	37	37.1	36.8	36.6	37.2	36.9	37.3	36.9	37	36.5
39	36.9	37.1	36.7	36.6	37.2	36.9	37.4	36.9	37	36.5
40	37.1	37.1	36.8	36.6	37.2	36.9	37.4	36.9	36.9	36.5
41	37.1	37.1	36.8	36.6	37.2	36.9	37.4	36.9	36.9	36.5
42	37	37.1	36.8	36.6	37.2	36.9	37.4	36.9	37	36.5
43	37.1	37.1	36.8	36.6	37.2	36.9	37.4	36.9	36.9	36.5
44	37.1	37.1	36.8	36.6	37.2	36.9	37.4	36.9	37	36.5
45	37.1	37.1	36.8	36.6	37.2	36.9	37.5	36.9	36.9	36.5
46	37	37.1	36.8	36.6	37.2	36.9	37.5	36.9	36.9	36.5
47	37.1	37.1	36.8	36.6	37.2	36.9	37.5	36.9	37	36.5
48	37	37.1	36.8	36.6	37.2	36.9	37.5	36.9	36.9	36.5
49	37.1	37.1	36.8	36.6	37.2	36.9	37.5	37	36.9	36.5
50	37.1	37.1	36.8	36.6	37.2	36.9	37.5	37	36.9	36.5
51	37.1	37.1	36.8	36.6	37.2	36.9	37.5	37	37	36.5
52	37.2	37.1	36.8	36.6	37.3	36.9	37.5	37	37	36.5
53	37.1	37.1	36.8	36.6	37.3	36.9	37.5	37	37	36.5
54	37.2	37.1	36.8	36.6	37.3	36.9	37.6	37	37	36.5
55	37.2	37.1	36.8	36.6	37.3	36.9	37.6	37	36.9	36.5
56	37.2	37.2	36.8	36.5	37.3	36.9	37.6	37	37	36.5
57	37.2	37.2	36.9	36.5	37.3	36.9	37.6	37	37	36.5
58	37.3	37.2	36.9	36.5	37.3	36.9	37.6	37	36.9	36.5
59	37.2	37.2	36.9	36.5	37.3	36.9	37.6	37	37	36.5
60	37.2	37.2	36.9	36.5	37.3	36.9	37.6	37	37	36.5
61	37.2	37.2	36.9	36.5	37.3	36.9	37.6	37	37	36.5
62	37.2	37.2	36.9	36.5	37.3	36.9	37.6	37	36.9	36.5
63	37.3	37.2	37	36.5	37.3	37	37.6	37	36.9	36.5
64	37.3	37.2	37	36.5	37.3	37	37.6	37	36.9	36.5
65	37.2	37.2	37	36.5	37.2	37	37.6	37	36.9	36.5

Test 4, Subjects 1 to 5

TIME (min)	SUBJECT 1		SUBJECT 2		SUBJECT 3		SUBJECT 4		SUBJECT 5	
	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR
1	36.6	36.4	36.9	36.5	37.2	36.7	37.2	36.7	37	36.5
2	36.6	36.4	36.8	36.5	37.1	36.8	37.1	36.7	37	36.5
3	36.6	36.3	36.8	36.5	37.2	36.8	37.1	36.7	37	36.5
4	36.6	36.3	36.8	36.5	37.1	36.8	37.1	36.7	37	36.5
5	36.6	36.3	36.8	36.5	37.1	36.9	37.1	36.7	37	36.5
6	36.6	36.3	36.8	36.5	37.1	36.9	37.1	36.7	36.8	36.5
7	36.6	36.3	36.7	36.5	37.1	36.9	37	36.7	37	36.5
8	36.6	36.3	36.7	36.5	37.1	36.9	37	36.7	37	36.6
9	36.6	36.2	36.7	36.5	37.1	37	37.1	36.7	36.9	36.5
10	36.5	36.2	36.7	36.5	37.1	37	37	36.7	37	36.5
11	36.5	36.2	36.7	36.5	37.1	37	37.1	36.8	36.8	36.5
12	36.6	36.2	36.7	36.5	37.1	37	37.1	36.8		36.6
13	36.5	36.2	36.7	36.5	37.1	37	37.1	36.8	36.7	36.6
14	36.6	36.2	36.7	36.5	37.1	37	37.1	36.8	36.8	36.6
15	36.5	36.2	36.7	36.5	37.1	37	37.2	36.8	36.9	36.6
16	36.6	36.2	36.8	36.5	37.1	37	37.2	36.8	36.9	36.7
17	36.5	36.2	36.7	36.5	37.1	37	37.2	36.8	37	36.7
18	36.5	36.2	36.7	36.5	37.1	37	37.1	36.8	36.9	36.7
19	36.6	36.2	36.7	36.4	37.1	37	37.1	36.8	36.8	36.7
20	36.6	36.2	36.7	36.4	37.1	37	37.2	36.8	36.8	36.7
21	36.6	36.3	36.7	36.4	37.1	37	37.2	36.8	36.8	36.7
22	36.6	36.3	36.7	36.4	37.1	37	37.1	36.8	36.8	36.7
23	36.6	36.3	36.8	36.5	37.1	37	37.1	36.8	36.9	36.7
24	36.6	36.3	36.7	36.5	37	37	37.1	36.8	36.9	36.7
25	36.6	36.3	36.8	36.5	37	37	37.1	36.8	36.8	36.7
26	36.6	36.3	36.8	36.5	37	37	37.2	36.8	36.8	36.7
27	36.5	36.3	36.7	36.5	37	36.9	37.2	36.8	36.9	36.7
28	36.6	36.2	36.7	36.5	37	36.9	37.1	36.8	36.9	36.7
29	36.6	36.2	36.8	36.5	37	36.9	37.1	36.8	36.7	36.7
30	36.6	36.2	36.8	36.5	37.1	36.9	37.1	36.8	36.9	36.7
31	36.6	36.3	36.8	36.5	37.1	36.9	37.1	36.8	36.7	36.8
32	36.6	36.3	36.8	36.5	37.1	36.9	37.1	36.8	36.8	36.8
33	36.6	36.3	36.8	36.5	37	37	37.1	36.8		36.7
34	36.6	36.3	36.8	36.5	37	37	37.1	36.8	36.8	36.7
35	36.6	36.3	36.8	36.5	37	37	37.1	36.8	36.8	36.7
36	36.6	36.4	36.8	36.5	37	36.9	37.2	36.8	36.8	36.7
37	36.6	36.4	36.8	36.5	36.9	36.9	37.1	36.8	36.6	36.7
38	36.7	36.3	36.8	36.5	37	36.9	37.1	36.8	36.8	36.7
39	36.7	36.3	36.8	36.5	37	36.9	37.1	36.8	36.8	36.7
40	36.7	36.3	36.8	36.5	37	36.9	37.1	36.8	36.8	36.8
41	36.7	36.3	36.7	36.5	37	36.9	37.2	36.8	36.8	36.7
42	36.6	36.3	36.7	36.5	37.1	36.9	37.2	36.8	36.8	36.7
43	36.7	36.3	36.7	36.5	37	36.9	37.2	36.8	37	36.7
44	36.7	36.3	36.7	36.4	37	36.9	37.1	36.8	36.8	36.7
45	36.7	36.3	36.7	36.5	37	36.9	37.2	36.8	36.8	36.7
46	36.7	36.3	36.7	36.4	37	36.9	37.2	36.8	37	36.8
47	36.6	36.3	36.8	36.4	37	36.9	37.2	36.8	37	36.8
48	36.7	36.3	36.7	36.4	37	36.9	37.2	36.8	36.8	36.8
49	36.7	36.3	36.8	36.4	37	36.9	37.2	36.8	36.7	36.8
50	36.7	36.3	36.8	36.4	37	36.9	37.2	36.8	36.7	36.8
51	36.7	36.3	36.8	36.4	37	36.9	37.3	36.8	36.9	36.8
52	36.7	36.3	36.8	36.4	37	36.9	37.3	36.8	37	36.8
53	36.8	36.3	36.8	36.4	37	36.9	37.2	36.8	36.7	36.8
54	36.8	36.3	36.8	36.4	37	36.9	37.3	36.8		36.9
55	36.7	36.3	36.7	36.4	37	36.9	37.3	36.8		36.9
56	36.7	36.3	36.8	36.4	37.1	36.9	37.3	36.8	37	36.9
57	36.8	36.3	36.8	36.5	37.1	36.9	37.3	36.9	36.7	36.9
58	36.7	36.3	36.8	36.5	37.1	36.9	37.3	36.9	37	36.9
59	36.7	36.4	36.8	36.5	37.1	36.9	37.3	36.9	36.7	36.9
60	36.7	36.4	36.9	36.5	37.1	36.9	37.3	36.9	36.7	36.9
61	36.8	36.4	36.8	36.5	37.1	37	37.3	36.9	37	36.9
62	36.8	36.4	36.9	36.5	37.1	37	37.3	36.9	37	36.9
63	36.8	36.4	36.8	36.6	37.1	37	37.4	36.9	37	36.9
64	36.8	36.4	36.9		37.1	37	37.4	36.9	36.7	37
65	36.8	36.4	36.9		37.1	37	37.4	36.9	36.8	37

Test 4, Subjects 6 to 10

TIME (min)	SUBJECT 6		SUBJECT 7		SUBJECT 8		SUBJECT 9		SUBJECT 10	
	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR
1	37.2	37	37.1	36.6	37.6	37.3	37.2	36.7	36.9	36.5
2	37.1	37	37.1	36.5	37.6	37.3	37.1	36.7	36.9	36.5
3	37.1	37	37	36.5	37.6	37.3	37.2	36.8	36.9	36.5
4	37.1	37	37	36.5	37.6	37.3	37.1	36.8	36.9	36.6
5	37.1	37	37	36.5	37.6	37.3	37.1	36.8	36.9	36.6
6	37	37	37	36.4	37.6	37.3	37.1	36.8	36.9	36.6
7	37	37	37	36.4	37.6	37.3	37.1	36.8	37	36.7
8	37.1	37	37	36.4	37.6	37.3	37.1	36.8	36.8	36.7
9	37	37	37	36.4	37.6	37.3	37.1	36.8	36.9	36.7
10	37	37	37	36.4	37.6	37.3	37.1	36.8	36.9	36.7
11	37	37	37	36.4	37.5	37.3	37	36.9	36.9	36.7
12	37.1	37	37	36.4	37.5	37.3	37	36.9	36.9	36.8
13	37	37	37	36.4	37.4	37.3	37.1	36.9	36.9	36.8
14	37	37	37.1	36.4	37.5	37.3	37.1	36.9	36.9	36.8
15	37.1	37.1	37	36.4	37.5	37.3	37.1	36.9	36.9	36.8
16	37.1	37.1	37.1	36.4	37.5	37.4	37	36.9	37	36.8
17	37.1	37.1	37.1	36.4	37.5	37.4	37	36.9	36.9	36.8
18	37.1	37.1	37.1	36.5	37.5	37.4	37.1	36.9	37	36.8
19	37.1	37.1	37.1	36.5	37.6	37.4	37.1	36.9	37	36.8
20	37.1	37.1	37.1	36.4	37.5	37.4	37.1	36.9	37	36.9
21	37.2	37.2	37.1	36.5	37.5	37.4	37.1	36.9	37	36.9
22	37.2	37.2	37.1	36.5	37.6	37.4	37.1	36.9	37	36.9
23	37.1	37.1	37.1	36.5	37.6	37.4	37.1	36.9	36.9	36.9
24	37.1	37.1	37.1	36.5	37.6	37.3	37.1	36.9	36.9	36.9
25	37.2	37.1	37.2	36.5	37.6	37.3	37.1	36.9	37	36.9
26	37.2	37.1	37.2	36.5	37.6	37.4	37.1	36.8	37	36.9
27	37.2	37.1	37.2	36.5	37.5	37.4	37.1	36.8	37	36.9
28	37.2	37.1	37.2	36.5	37.6	37.4	37.1	36.8	37	36.9
29	37.3	37.1	37.2	36.5	37.6	37.4	37.1	36.9	37	36.9
30	37.1	37.1	37.2	36.5	37.6	37.4	37.1	36.9	37	36.9
31	37.2	37.1	37.2	36.5	37.6	37.4	37.1	36.9	37	36.9
32	37.2	37.1	37.3	36.5	37.6	37.4	37.1	36.9	37	36.9
33	37.2	37.2	37.3	36.5	37.7	37.4	37.2	36.9	37	36.9
34	37.2	37.2	37.3	36.5	37.7	37.4	37.2	36.9	37	36.9
35	37.3	37.2	37.3	36.6	37.7	37.4	37.2	36.9	37	36.9
36	37.3	37.2	37.3	36.5	37.7	37.4	37.2	36.9	37	36.9
37	37.3	37.2	37.3	36.5	37.7	37.4	37.1	36.9	37	36.9
38	37.3	37.2	37.3	36.5	37.7	37.4	37.2	36.8	37	36.9
39	37.3	37.2	37.3	36.5	37.7	37.4	37.2	36.8	37	36.9
40	37.3	37.2	37.3	36.5	37.7	37.4	37.2	36.9	37	36.9
41	37.3	37.2	37.3	36.5	37.7	37.4	37.2	36.9	37	36.9
42	37.3	37.2	37.3	36.5	37.7	37.4	37.1	36.9	37	36.9
43	37.3	37.2	37.3	36.5	37.7	37.4	37.2	36.9	36.9	36.9
44	37.3	37.2	37.3	36.5	37.7	37.4	37.2	36.9	37	36.9
45	37.3	37.2	37.3	36.6	37.7	37.4	37.2	36.9	37	36.9
46	37.3	37.2	37.3	36.5	37.7	37.4	37.2	36.9	37	36.9
47	37.3	37.2	37.3	36.5	37.7	37.4	37.2	36.9	37.1	36.9
48	37.3	37.2	37.3	36.5	37.7	37.4	37.2	36.9	37	36.9
49	37.3	37.2	37.3	36.5	37.7	37.4	37.2	36.9	37	36.9
50	37.3	37.2	37.3	36.5	37.7	37.3	37.2	36.9	37	36.9
51	37.3	37.3	37.3	36.5	37.7	37.3	37.2	36.9	37	36.9
52	37.3	37.3	37.3	36.5	37.8	37.3	37.2	36.9	37.1	36.9
53	37.3	37.2	37.3	36.5	37.8	37.4	37.2	36.9	37.1	36.9
54	37.3	37.2	37.3	36.5	37.7	37.4	37.2	36.9	37.1	36.9
55	37.3	37.2	37.2	36.4	37.7	37.4	37.2	36.8	37.1	36.9
56	37.4	37.2	37.3	36.4	37.8	37.4	37.2	36.8	37.1	36.9
57	37.3	37.2	37.3	36.4	37.8	37.5	37.3	36.8	37.1	36.9
58	37.4	37.2	37.3	36.4	37.8	37.5	37.3	36.8	37.1	36.9
59	37.4	37.2	37.3	36.4	37.8	37.5	37.3	36.9	37.2	36.9
60	37.4	37.2	37.3	36.4	37.9	37.5	37.3	36.9	37.2	36.9
61	37.4	37.2	37.3	36.4	37.9	37.5	37.3	36.9	37.2	36.9
62	37.4	37.2	37.3	36.4	37.9	37.5	37.3	36.9	37.2	37
63	37.4	37.2	37.3	36.4	37.9	37.4	37.3	36.9	37.2	37
64	37.4	37.3	37.3	36.4	37.8	37.4	37.3	36.9	37.2	37
65	37.4	37.3	37.3	36.4	37.8	37.4	37.3	36.9	37.2	37

Test 5, Subjects 1, 3 to 5

TIME (min)	SUBJECT 1		SUBJECT 3		SUBJECT 4		SUBJECT 5	
	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR
1	36.6	36.4	36.9	36.8	37.1	36.7	36.9	36.6
2	36.6	36.4	36.9	36.9	37	36.7	37	36.6
3	36.6	36.5	36.9	36.9	37	36.7	37	36.6
4	36.6	36.5	36.8	36.9	37	36.7	36.9	36.6
5	36.8	36.5	36.8	37	37.1	36.7	37	36.6
6	36.8	36.5	36.8	37	37.1	36.7	37	36.6
7	36.6	36.5	36.8	37	37	36.7	36.9	36.6
8	36.6	36.6	36.8	37	36.9	36.7	37	36.6
9	36.6	36.8	36.8	37.1	36.9	36.7	37.1	36.6
10	36.6	36.5	36.8	37.1	36.9	36.7	37	36.7
11	36.6	36.5	36.8	37.1	37	36.7	37	36.7
12	36.6	36.5	36.8	37.1	36.9	36.7	37	36.7
13	36.5	36.5	36.8	37.1	37	36.7	37.1	36.7
14	36.5	36.5	36.8	37.1	37	36.7	37	36.7
15	36.5	36.5	36.8	37.1	37	36.7	37.1	36.7
16	36.8	36.5	36.8	37.1	37	36.7	37.1	36.7
17	36.5	36.5	36.8	37.1	36.9	36.7	37	36.7
18	36.5	36.5	36.8	37.1	36.9	36.7	37.1	36.8
19	36.5	36.5	36.8	37.1	37	36.7	37.1	36.8
20	36.5	36.5	36.8	37.1	37	36.7	37.1	36.8
21	36.8	36.5	36.8	37.1	37	36.7	37.1	36.8
22	36.5	36.5	36.8	37.1	36.9	36.7	37	36.9
23	36.5	36.5	36.9	37.1	37	36.7	37.1	36.9
24	36.5	36.5	36.9	37.1	37	36.7	37.1	36.9
25	36.5	36.5	36.8	37.1	37	36.7	37.1	36.9
26	36.5	36.5	36.8	37.1	37	36.7	37.1	36.9
27	36.5	36.5	36.8	37.1	37	36.7	37	36.9
28	36.6	36.5	36.9	37.1	37	36.7	37.2	36.9
29	36.6	36.5	36.9	37.1	37	36.7	37.1	36.9
30	36.6	36.5	36.9	37.1	36.9	36.7	37.2	36.9
31	36.5	36.5	36.9	37.1	37	36.7	37.2	37
32	36.6	36.5	36.9	37.1	36.9	36.7	37.1	37
33	36.6	36.5	36.9	37.1	37	36.7	37.2	36.9
34	36.6	36.5	36.9	37.1	37	36.8	37.2	36.9
35	36.6	36.5	36.9	37.1	37.1	36.8	37.1	36.9
36	36.6	36.5	36.9	37.1	37.1	36.7	37.2	36.9
37	36.8	36.5	36.8	37.1	37.1	36.7	37.2	36.9
38	36.7	36.5	36.9	37.1	37.1	36.7	37.2	36.9
39	36.7	36.5	36.9	37.1	37.1	36.7	37.2	36.9
40	36.7	36.6	36.8	37.1	37.1	36.7	37.2	36.9
41	36.7	36.8	36.9	37.1	37.1	36.7	37.3	36.9
42	36.6	36.6	36.8	37.1	37	36.7	37.3	36.9
43	36.6	36.8	36.9	37.1	37	36.7	37.2	36.9
44	36.6	36.6	36.9	37.1	37	36.7	37.3	36.8
45	36.7	36.7	36.9	37.1	37.1	36.7	37.2	36.8
46	36.6	36.7	36.8	37.1	37.1	36.7	37.2	36.9
47	36.7	36.7	36.8	37	37.1	36.8	37.2	36.9
48	36.7	36.7	36.8	37	37	36.8	37.3	36.9
49	36.7	36.7	36.8	37	37.1	36.8	37.2	36.9
50	36.7	36.7	36.8	37	37.1	36.8	37.2	36.9
51	36.7	36.7	36.8	37	37.1	36.8		
52	36.6	36.7	36.7	37	37	36.8		
53	36.5	36.7	36.7	37.1	37	36.9		
54	36.5	36.8	36.7	37.1	37	36.9		
55	36.5	36.9	36.7	37.2	37	37		
56	36.5	37	36.7	36.9	37	37.1		
57	36.5	37	36.7	36.7	37	37.2		
58	36.5	36.5	36.7	36.7	37.1	37.2		
59	36.6	36.6	36.7	36.7	37.1	37.3		
60	36.6	36.6	36.7	36.7	37.1	37.3		
61	36.6	36.6	36.7	36.7	37.1			
62	36.6	36.6	36.8	36.7	37.1	37		
63	36.7	36.6	36.7	36.7	37.1	37		
64	36.7	36.6	36.7	36.7	37.2	37		
65	36.7	36.6	36.7	36.7	37.2	37		

Test 5, Subjects 6 to 10

TIME (min)	SUBJECT 6		SUBJECT 7		SUBJECT 8		SUBJECT 9		SUBJECT 10	
	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR
1	37.1	37	36.9	36.6	36.9	36.7	37.1	36.7	37	36.5
2	37.1	36.9	36.8	36.6	36.9	36.7	37.1	36.7	37	36.5
3	37	36.9	36.8	36.6	36.9	36.7	37.1	36.7	37	36.5
4	36.9	36.9	36.8	36.6	36.9	36.7	37.1	36.7	36.9	36.6
5	37	36.9	36.8	36.6	36.9	36.7	37.1	36.7	37	36.6
6	37	36.9	36.8	36.6	36.9	36.7	37.1	36.7	37	36.6
7	37	36.9	36.7	36.6	36.9	36.7	37.1	36.7	36.9	36.6
8	36.9	36.9	36.7	36.6	36.9	36.7	37.1	36.7	37	36.6
9	37	36.9	36.7	36.6	36.9	36.7	37.1	36.7	36.9	36.6
10	36.9	36.9	36.7	36.6	36.9	36.7	37.1	36.7	37	36.6
11	36.9	36.9	36.7	36.6	37	36.8	37.1	36.8	37	36.6
12	36.9	36.9	36.7	36.6	37	36.8	37.1	36.8	37	36.6
13	37	36.9	36.7	36.6	37	36.8	37.2	36.8	36.9	36.6
14	36.9	36.9	36.7	36.6	37	36.8	37.2	36.8	37	36.6
15	37	36.9	36.7	36.6	37.1	36.8	37.2	36.8	37	36.6
16	37	36.9	36.7	36.5	37.1	36.8	37.2	36.7	37	36.6
17	37	36.9	36.7	36.5	37.1	36.8	37.2	36.7	37	36.6
18	36.9	36.9	36.7	36.6	37.1	36.8	37.2	36.7	37	36.6
19	37	36.9	36.7	36.6	37.1	36.8	37.2	36.8	37	36.6
20	37	36.9	36.7	36.6	37	36.8	37.2	36.8	37	36.6
21	37	36.9	36.7	36.6	37.1	36.8	37.2	36.8	37	36.6
22	37	36.9	36.7	36.6	37.1	36.9	37.3	36.8	37	36.6
23	36.9	36.9	36.7	36.6	37.1	36.9	37.2	36.7	36.9	36.6
24	36.9	36.9	36.8	36.6	37.2	36.9	37.2	36.7	37	36.6
25	37	36.9	36.8	36.6	37.2	36.9	37.3	36.7	36.9	36.6
26	37.1	36.9	36.8	36.6	37.2	36.9	37.3	36.7	36.9	36.6
27	37.1	36.9	36.7	36.6	37.2	36.9	37.2	36.7	37	36.6
28	37	36.9	36.8	36.6	37.2	36.9	37.3	36.8	36.9	36.6
29	37.1	36.9	36.8	36.7	37.2	36.9	37.3	36.8	36.9	36.6
30	37.1	36.9	36.8	36.7	37.1	36.9	37.3	36.8	37	36.6
31	37	36.9	36.8	36.7	37.2	36.9	37.3	36.8	37	36.6
32	37.1	36.8	36.8	36.7	37.2	36.9	37.3	36.8	37	36.6
33	37.1	36.8	36.8	36.7	37.2	36.9	37.3	36.8	37	36.6
34	37	36.8	36.8	36.7	37.2	36.9	37.3	36.9	36.9	36.6
35	37.1	36.8	36.8	36.7	37.2	36.9	37.3	36.9	37	36.6
36	37.1	36.9	36.8	36.7	37.2	36.9	37.3	36.8	37	36.6
37	37.1	36.9	36.8	36.7	37.2	36.9	37.3	36.8	37	36.6
38	37.2	36.9	36.8	36.7	37.1	36.9	37.3	36.8	37	36.6
39	37	37	36.8	36.7	37.2	36.9	37.3	36.8	37	36.6
40	37.1	37	36.9	36.7	37.1	36.9	37.3	36.8	37	36.6
41	37.1	37	36.9	36.7	37.1	36.9	37.3	36.9	37	36.6
42	37.1	37.1	36.9	36.8	37.1	36.9	37.3	36.9	37	36.6
43	37.1	37	36.9	36.8	37.2	36.9	37.3	36.8	37	36.6
44	37.1	37	36.9	36.8	37.2	36.9	37.3	36.8	37	36.6
45	37.2	37	36.9	36.8	37.1	36.9	37.3	36.8	37	36.6
46	37.2	36.9	36.9	36.7	37.2	36.9	37.3	36.8	37	36.6
47	37.2	36.9	36.9	36.7	37.2	36.9	37.3	36.8	37	36.6
48	37.2	36.9	36.9	36.7	37.1	37	37.3	36.7	37	36.6
49	37.1	36.9	36.9	36.7	37.2	37	37.3	36.8	37	36.6
50	37.2	36.9	36.9	36.7	37.1	37	37.3	36.7	37.1	36.6
51	37.2	36.9	36.9	36.7	37.2	37	37.3	36.7	37	36.6
52	37.1	36.9	36.9	36.7	37.1	37	37.2	36.7	37	36.6
53	37.1	36.9	36.8	36.7	37.2	37	37.2	36.8	36.9	36.6
54	37.2	37	36.8	36.8	37.1	37.1	37.2	36.8	36.9	36.7
55	37.2	37.1	36.8	36.8	37.2	37.2	37.1	36.9	36.9	36.8
56	37.2	37.2	36.8	36.9	37.2	37.3	37.1	37	36.9	36.9
57	37.2	37.3	36.9	36.9	37.2	36.8	37.2	36.9	37	36.9
58	37.2	37.3	36.9	36.8	37.2	36.8	37.2	36.9	36.9	37
59	37.2	36.9	36.8	36.7	37.2	36.8	37.2	36.9	36.9	37
60	37.1	36.9	36.9	36.7	37.2	36.8	37.2	36.9	37	37
61	37.1	36.9	36.9	36.6	37.2	36.8	37.2	36.9	37	36.7
62	37.1	36.9	36.9	36.6	37.2	36.8	37.3	36.9	37	36.7
63	37.1	36.9	36.9	36.6	37.2	36.8	37.3	36.9	37	36.7
64	37.1	36.9	36.9	36.6	37.3	36.8	37.3	36.9	37	36.7
65	37.1	36.9	37	36.5	37.3	36.8	37.3	36.9	37	36.7

Test 6, Subjects 1 to 5

TIME (min)	SUBJECT 1		SUBJECT 2		SUBJECT 3		SUBJECT 4		SUBJECT 5	
	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR
1	36.7	36.6	36.6	36.2	36.5	36.9	36.9	36.6	36.9	36.5
2	36.7	36.7	36.5	36.2	36.6	36.9	36.8	36.6	36.8	36.6
3	36.7	36.7	36.5	36.2	36.6	37	36.8	36.7	36.9	36.6
4	36.6	36.7	36.4	36.2	36.6	37	36.8	36.7	36.9	36.6
5	36.7	36.7	36.5	36.2	36.6	37.1	36.9	36.7	37	36.6
6	36.7	36.7	36.4	36.2	36.6	37.1	36.9	36.7	37	36.6
7	36.6	36.7	36.4	36.2	36.5	37.1	36.9	36.7	36.8	36.6
8	36.6	36.7	36.4	36.2	36.4	37.1	36.9	36.7	36.8	36.6
9	36.6	36.7	36.4	36.2	36.5	37.1	36.9	36.7	36.9	36.6
10	36.6	36.7	36.4	36.2	36.5	37.2	36.9	36.7	37	36.6
11	36.6	36.7	36.4	36.2	36.6	37.2	36.9	36.7	36.8	36.6
12	36.5	36.7	36.3	36.2	36.6	37.2	36.8	36.7	36.9	36.6
13	36.6	36.7	36.3	36.2	36.6	37.2	36.8	36.7	36.9	36.6
14	36.6	36.7	36.4	36.2	36.6	37.2	36.8	36.7	37	36.6
15	36.6	36.7	36.4	36.2	36.6	37.2	36.8	36.7	37	36.6
16	36.6	36.7	36.4	36.2	36.5	37.2	36.9	36.7	37	36.6
17	36.6	36.7	36.3	36.2	36.4	37.2	36.9	36.7	37	36.6
18	36.6	36.7	36.4	36.2	36.4	37.2	36.8	36.7	36.9	36.6
19	36.6	36.7	36.4	36.2	36.4	37.2	36.8	36.7	37	36.6
20	36.6	36.7	36.4	36.2	36.5	37.2	36.8	36.7	36.9	36.6
21	36.6	36.7	36.4	36.2	36.6	37.2	36.9	36.7	37	36.6
22	36.6	36.7	36.4	36.1	36.6	37.2	36.8	36.7	37	36.6
23	36.6	36.7	36.4	36.2	36.6	37.2	36.9	36.7	37.1	36.6
24	36.6	36.7	36.4	36.2	36.6	37.2	36.9	36.7	37.1	36.6
25	36.7	36.7	36.4	36.2	36.6	37.2	36.9	36.7	36.9	36.6
26	36.7	36.7	36.4	36.2	36.6	37.2	37	36.7	37	36.6
27	36.7	36.7	36.4	36.2	36.5	37.2	37	36.8	37.1	36.6
28	36.7	36.7	36.4	36.2	36.5	37.2	36.9	36.8	37.1	36.7
29	36.7	36.8	36.4	36.1	36.5	37.2	36.9	36.8	37	36.7
30	36.6	36.8	36.4	36.2	36.6	37.2	37	36.8	37.1	36.7
31	36.7	36.8	36.4	36.2	36.6	37.2	37	36.8	37.2	36.7
32	36.6	36.8	36.4	36.2	36.6	37.2	37	36.8	37.1	36.7
33	36.6	36.8	36.4	36.2	36.6	37.2	37	36.8	37.1	36.7
34	36.6	36.8	36.4	36.2	36.5	37.2	36.9	36.8	37.1	36.7
35	36.7	36.8	36.4	36.2	36.6	37.2	37	36.8	37.1	36.7
36	36.7	36.8	36.5	36.2	36.5	37.2	37	36.8	37.1	36.7
37	36.6	36.8	36.4	36.2	36.4	37.2	37	36.8	37.1	36.7
38	36.6	36.8	36.5	36.2	36.5	37.2	37	36.8	37.1	36.7
39	36.7	36.8	36.5	36.2	36.5	37.2	37	36.8	37.1	36.8
40	36.7	36.8	36.5	36.2	36.6	37.2	37	36.8	37.1	36.8
41	36.7	36.8	36.5	36.2	36.6	37.2	37	36.8	37.1	36.8
42	36.7	36.8	36.5	36.2	36.6	37.2	37	36.8	37.2	36.8
43	36.7	36.8	36.6	36.2	36.6	37.2	37	36.8	37	36.8
44	36.7	36.8	36.5	36.2	36.6	37.2	37	36.8	37.1	36.8
45	36.8	36.8	36.5	36.2	36.7	37.2	37.1	36.8	37.1	36.8
46	36.8	36.8	36.6	36.2	36.6	37.2	37.1	36.8	37.2	36.8
47	36.6	36.8	36.6	36.2	36.5	37.2	37.1	36.8	37.1	36.8
48	36.7	36.8	36.6	36.2	36.5	37.2	37.1	36.8	37.1	36.8
49	36.7	36.8	36.6	36.2	36.6	37.2	37.1	36.8	37.1	36.8
50	36.8	36.8	36.6	36.2	36.7	37.2	37.1	36.9	37.2	36.8
51	36.8	36.9	36.6	36.2	36.6	37.2	37.1	36.8	37.2	36.8
52	36.8	36.9	36.6	36.2	36.6	37.2	37.1	36.9	37.2	36.8
53	36.8	36.8	36.6	36.2	36.6	37.2	37.1	36.9	37.2	36.8
54	36.8	36.8	36.6	36.2	36.6	37.2	37.1	36.9	37.2	36.8
55	36.8	36.8	36.6	36.2	36.6	37.2	37.1	36.9	37.2	36.8
56	36.8	36.8	36.6	36.2	36.6	37.2	37.1	36.9	37.2	36.8
57	36.8	36.8	36.6	36.2	36.7	37.2	37.1	36.9	37.2	36.8
58	36.8	36.8	36.6	36.2	36.7	37.2	37.2	36.9	37.2	36.8
59	36.8	36.8	36.7	36.2	36.7	37.2	37.2	36.9	37.3	36.8
60	36.8	36.8	36.7	36.2	36.7	37.2	37.2	36.9	37.2	36.8
61	36.8	36.8	36.7	36.2	36.7	37.2	37.2	36.9	37.3	36.9
62	36.8	36.8	36.7	36.2	36.7	37.2	37.2	36.9	37.3	36.9
63	36.8	36.8	36.7	36.2	36.7	37.2	37.2	36.9	37.3	36.9
64	36.8	36.7	36.7	36.2	36.7	37.2	37.2	36.9	37.3	36.9
65	36.8	36.7	36.7	36.2	36.8	37.2	37.2	36.9	37.3	36.9

Test 6, Subjects 6 to 10

TIME (min)	SUBJECT 6		SUBJECT 7		SUBJECT 8		SUBJECT 9		SUBJECT 10	
	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR
1	36.8	36.9	36.9	36.8	36.8	36.5	37.2	36.9	36.9	36.5
2	36.9	37	37	36.7	36.8	36.5	37.2	36.9	36.9	36.5
3	36.7	37	36.9	36.7	36.8	36.5	37.2	37	36.9	36.6
4	36.6	37	37	36.7	36.7	36.5	37.2	37	36.9	36.6
5	36.7	37	36.9	36.7	36.7	36.5	37.2	36.9	36.9	36.6
6	36.7	37	36.9	36.7	36.8	36.6	37.2	36.9	36.9	36.6
7	36.7	36.9	37	36.7	36.8	36.6	37.2	36.8	36.9	36.6
8	36.7	37	36.9	36.7	36.8	36.6	37.2	36.8	36.9	36.6
9	36.8	37	37	36.7	36.8	36.6	37.2	36.8	36.9	36.6
10	36.7	37	36.9	36.7	36.8	36.6	37.2	36.8	36.9	36.6
11	36.8	37	37	36.7	36.8	36.6	37.2	36.8	36.9	36.6
12	36.8	37	37	36.7	36.8	36.6	37.2	36.9	36.9	36.6
13	36.9	37	37	36.8	36.8	36.6	37.2	36.9	36.9	36.6
14	36.9	37	37	36.8	36.9	36.7	37.2	36.9	36.9	36.6
15	36.9	37	37	36.7	36.9	36.7	37.2	36.9	36.9	36.6
16	36.9	37	37	36.7	36.9	36.7	37.2	36.8	36.9	36.6
17	36.9	37	37.1	36.7	36.9	36.7	37.3	36.8	37	36.6
18	36.8	37	37	36.7	37	36.7	37.3	36.8	37	36.6
19	36.9	37	37	36.7	37	36.7	37.3	36.8	37	36.6
20	36.9	37	37.1	36.7	37	36.7	37.3	36.8	37	36.6
21	36.7	37	37.1	36.8	37	36.7	37.3	36.8	37	36.6
22	36.8	37	37	36.8	37	36.8	37.3	36.9	37	36.6
23	36.9	37	37.1	36.8	37	36.8	37.3	36.9	37	36.6
24	36.8	37	37.1	36.8	37	36.8	37.3	36.9	37	36.6
25	36.9	37	37.1	36.8	37	36.8	37.3	36.9	37	36.6
26	37	37	37.1	36.7	37.1	36.8	37.3	36.9	37	36.6
27	37	37	37.1	36.7	37	36.8	37.3	36.8	37	36.6
28	36.9	37	37.1	36.7	37	36.8	37.3	36.8	37	36.6
29	37	37.1	37.1	36.7	37.1	36.8	37.3	36.9	37	36.6
30	37	37.1	37.1	36.7	37.1	36.8	37.4	36.9	37	36.6
31	37.1	37.1	37.1	36.7	37.1	36.8	37.4	36.9	37	36.6
32	37.1	37.1	37.1	36.7	37.1	36.8	37.4	36.9	37	36.6
33	37.1	37.1	37.1	36.8	37.1	36.9	37.4	36.9	37	36.6
34	37.1	37.1	37.1	36.7	37.1	36.9	37.4	37	37	36.6
35	37	37.1	37.2	36.7	37.2	36.9	37.4	36.9	37	36.6
36	37.1	37.1	37.2	36.7	37.2	36.9	37.4	36.9	37.1	36.6
37	37.1	37.1	37.2	36.7	37.2	36.9	37.4	36.8	37.1	36.6
38	37	37.1	37.2	36.7	37.2	36.9	37.4	36.8	37.1	36.6
39	37.1	37.1	37.2	36.7	37.2	36.9	37.4	36.8	37.1	36.7
40	37.1	37.1	37.2	36.7	37.2	36.9	37.4	36.8	37.1	36.7
41	37	37.1	37.2	36.7	37.2	36.9	37.4	36.8	37.1	36.7
42	37.2	37.1	37.1	36.8	37.2	36.9	37.4	36.8	37.1	36.7
43	37.1	37.2	37.2	36.7	37.2	36.9	37.4	36.8	37.1	36.7
44	37.1	37.2	37.2	36.7	37.2	36.9	37.4	36.8	37.1	36.7
45	37.2	37.2	37.2	36.7	37.2	36.9	37.4	36.8	37.1	36.7
46	37.2	37.2	37.2	36.6	37.2	36.9	37.4	36.8	37.1	36.7
47	37.2	37.2	37.2	36.6	37.2	37	37.4	36.8	37.1	36.7
48	37.2	37.2	37.2	36.6	37.2	37	37.4	36.8	37.2	36.7
49	37.2	37.2	37.2	36.6	37.3	37	37.4	36.8	37.2	36.7
50	37.2	37.2	37.2	36.6	37.3	37	37.4	36.8	37.2	36.7
51	37.1	37.2	37.2	36.5	37.3	37	37.4	36.8	37.2	36.7
52	37.2	37.2	37.2	36.5	37.3	37	37.4	36.8	37.2	36.7
53	37.2	37.2	37.2	36.5	37.3	37	37.4	36.8	37.2	36.8
54	37.1	37.2	37.2	36.5	37.3	37	37.4	36.8	37.2	36.8
55	37.2	37.2	37.2	36.5	37.3	37	37.4	36.8	37.2	36.8
56	37.2	37.2	37.2	36.5	37.3	37	37.5	36.8	37.3	36.8
57	37.2	37.2	37.2	36.6	37.3	37	37.5	36.8	37.3	36.8
58	37.3	37.2	37.2	36.6	37.3	37	37.4	36.8	37.3	36.8
59	37.2	37.2	37.2	36.6	37.3	37	37.5	36.8	37.3	36.8
60	37.3	37.2	37.3	36.6	37.3	36.9	37.5	36.8	37.4	36.9
61	37.3	37.2	37.3	36.6	37.3	36.9	37.5	36.8	37.4	36.9
62	37.2	37.2	37.3	36.6	37.3	37	37.4	36.8	37.4	36.9
63	37.3	37.2	37.3	36.6	37.3	37	37.4	36.8	37.4	36.9
64	37.3	37.2	37.3	36.6	37.3	36.9	37.4	36.8	37.4	36.9
65	37.3	37.2	37.3	36.6	37.2	37	37.4	36.8	37.4	36.9

Test 7, Subjects 1 to 5

TIME (min)	SUBJECT 1		SUBJECT 2		SUBJECT 3		SUBJECT 4		SUBJECT 5	
	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR
1	36.9	36.5	36.5	36.3	36.7	36.7	37.3	36.8	36.7	36.7
2		36.5	36.3	36.3	36.6	36.8	37.3	36.8	36.8	36.7
3	36.6	36.5	36.3	36.3	36.6	36.8	37.3	36.8	36.8	36.7
4	36.5	36.5	36.4	36.3	36.6	36.9	37.2	36.7	36.6	36.8
5	36.5	36.5	36.4	36.3	36.6	37	37.2	36.7	36.7	36.8
6	36.5	36.5	36.4	36.3	36.5	37	37.2	36.7	36.7	36.8
7	36.5	36.5	36.4	36.3	36.4	37	37.2	36.7	36.7	36.8
8		36.5	36.3	36.3	36.4	37	37.2	36.7	36.7	36.8
9		36.5	36.3	36.3	36.5	37.1	37.2	36.7	36.7	36.8
10	36.4	36.5	36.3	36.3	36.6	37.1	37.2	36.7	36.5	36.8
11	36.5	36.5	36.3	36.3	36.6	37.1	37.2	36.7	36.6	36.8
12	36.3	36.5	36.4	36.3	36.6	37.1	37.1	36.7	36.8	36.8
13	36.3	36.5	36.4	36.3	36.6	37.1	37.2	36.8	36.6	36.8
14	36.4	36.5	36.4	36.3	36.6	37.1	37.1	36.8	36.6	36.8
15	36.3	36.5	36.4	36.3	36.6	37.1	37.2	36.8	36.5	36.8
16	36.4	36.5	36.4	36.3	36.5	37.1	37.2	36.8	36.6	36.8
17	36.4	36.5	36.3	36.3	36.4	37.1	37.2	36.8	36.6	36.8
18	36.3	36.5	36.3	36.3	36.4	37.1	37.1	36.8	36.7	36.8
19	36.3	36.5	36.4	36.3	36.5	37.1	37.2	36.8	36.7	36.8
20	36.5	36.5	36.4	36.4	36.5	37.1	37.1	36.8	36.7	36.8
21	36.3	36.5	36.4	36.4	36.6	37.1	37.1	36.8	36.7	36.9
22	36.3	36.5	36.4	36.4	36.6	37.1	37.2	36.7	36.6	36.9
23	36.3	36.5	36.4	36.4	36.6	37.1	37.2	36.7	36.7	36.8
24	36.3	36.5	36.5	36.4	36.6	37.1	37.1	36.7	36.6	36.9
25	36.5	36.6	36.5	36.3	36.6	37.1	37.2	36.7	36.7	36.9
26	36.4	36.6	36.5	36.3	36.6	37.1	37.2	36.8	36.8	36.9
27	36.3	36.6	36.5	36.4	36.5	37.1	37.2	36.8	36.9	36.9
28	36.5	36.6	36.4	36.4	36.6	37.1	37.2	36.8	36.8	36.8
29	36.4	36.6	36.5	36.4	36.6	37.1	37.2	36.7	36.5	36.9
30	36.5	36.6	36.5	36.4	36.6	37.2	37.1	36.7	36.6	36.9
31	36.3	36.6	36.4	36.4	36.7	37.2	37.2	36.7	36.7	36.9
32	36.3	36.7	36.4	36.4	36.7	37.2	37.2	36.7	36.7	36.9
33	36.4	36.7	36.3	36.4	36.7	37.2	37.1	36.7	36.7	36.9
34	36.4	36.7	36.4	36.4	36.7	37.2	37.2	36.7	36.8	36.9
35	36.4	36.7	36.4	36.4	36.7	37.1	37.2	36.8	36.7	36.9
36	36.3	36.7	36.5	36.4	36.6	37.1	37.2	36.8	36.7	36.9
37	36.5	36.7	36.4	36.4	36.6	37.1	37.2	36.8		37
38	36.5	36.7	36.4	36.4	36.5	37.1	37.1	36.8	36.6	37
39	36.5	36.7	36.5	36.4	36.6	37.1	37.2	36.8	36.7	37
40	36.4	36.7	36.5	36.4	36.7	37.1	37.2	36.8	36.8	37
41	36.6	36.6	36.5	36.4	36.7	37.1	37.1	36.8	36.9	37
42	36.5	36.7	36.5	36.4	36.7	37.1	37.2	36.8	36.9	37
43	36.4	36.7	36.5	36.4	36.7	37.1	37.2	36.8	36.7	37
44	36.5	36.7	36.5	36.4	36.7	37.1	37.2	36.7		37
45	36.5	36.7	36.5	36.4	36.7	37.1	37.3	36.7		37
46	36.5	36.7	36.5	36.4	36.6	37.1	37.3	36.7	36.9	37
47	36.5	36.7	36.5	36.4	36.6	37.1	37.3	36.8	36.9	37
48	36.5	36.8	36.5	36.4	36.5	37.1	37.2	36.8	36.8	37
49	36.6	36.8	36.6	36.4	36.6	37.1	37.3	36.8		37
50	36.6	36.8	36.6	36.4	36.6	37.1	37.2	36.8	36.9	37
51		36.8	36.6	36.4	36.6	37.1	37.3	36.8	37	37
52	36.7	36.8	36.6	36.4	36.6	37.1	37.3	36.8		37
53	36.6	36.7	36.6	36.5	36.6	37.1	37.3	36.8		37
54	36.7	36.7	36.5	36.4	36.5	37.1	37.3	36.8		37
55	36.7	36.7	36.5	36.4	36.5	37.1	37.3	36.8	36.9	37
56	36.6	36.7	36.6	36.5	36.6	37.1	37.3	36.8		37
57	36.7	36.7	36.6	36.5	36.6	37.1	37.3	36.8	37	37
58	36.6	36.7	36.6	36.5	36.6	37.1	37.3	36.8	37.1	37
59	36.7	36.7	36.7	36.5	36.6	37.1	37.4	36.8	37.1	37
60	36.6	36.8	36.7	36.5	36.6	37.1	37.4	36.8	37.1	37
61	36.7	36.7	36.7	36.5	36.6	37.1	37.4	36.8	37.1	37
62	36.7	36.8	36.7	36.5	36.6	37.1	37.4	36.8	36.9	37
63	36.7	36.8	36.7	36.5	36.6	37.1	37.4	36.8	36.9	37.1
64	36.8	36.8	36.7	36.5	36.7	37.1	37.4	36.8	37.2	37.1
65	36.6	36.8	36.7	36.5	36.7	37.1	37.4	36.8		37.1

Test 7, Subjects 6 to 10

TIME (min)	SUBJECT 6		SUBJECT 7		SUBJECT 8		SUBJECT 9		SUBJECT 10	
	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR
1	37.3	37.3	37.1	36.9	37.3	36.8	37.1	36.6	37	36.7
2	37.4	37.3	37	36.9	37.3	36.8	37.1	36.6	37	36.7
3	37.5	37.3	37	36.9	37.2	36.7	37.1	36.6	37	36.8
4	37.4	37.2	37.1	36.9	37.2	36.8	37.1	36.7	37	36.8
5	37.4	37.2	37	36.9	37.2	36.8	37.1	36.7	36.9	36.9
6	37.4	37.2	37	36.8	37.2	36.8	37.1	36.7	37	36.9
7	37.4	37.2	37	36.8	37.2	36.8	37.1	36.7	37	36.9
8	37.3	37.2	37	36.8	37.2	36.8	37.1	36.7	37	36.9
9	37.3	37.2	37	36.8	37.2	36.8	37.1	36.7	36.9	36.9
10	37.3	37.2	37	36.8	37.2	36.8	37.1	36.7	36.9	37
11	37.4	37.2	37	36.8	37.2	36.8	37	36.8	37	37
12	37.4	37.3	37	36.8	37.2	36.9	37.1	36.8	36.9	37
13	37.4	37.3	37	36.8	37.2	36.9	37.1	36.8	36.9	37
14	37.4	37.3	37	36.8	37.2	36.9	37.1	36.8	37	37
15	37.4	37.3	37.1	36.8	37.2	36.9	37.2	36.8	37	37
16	37.4	37.3	37.1	36.8	37.3	37	37.2	36.8	37	37
17	37.4	37.3	37.1	36.8	37.3	37	37.1	36.8	36.9	37
18	37.4	37.3	37.1	36.8	37.3	37	37.2	36.8	36.9	37
19	37.5	37.4	37.1	36.8	37.3	37	37.2	36.8	37	37
20	37.4	37.4	37.1	36.8	37.3	37	37.2	36.8	36.9	37
21	37.5	37.4	37.1	36.8	37.3	37	37.2	36.8	36.9	37
22	37.5	37.4	37.1	36.9	37.3	37	37.2	36.9	37	37
23	37.5	37.4	37.1	36.8	37.3	37	37.2	36.9	37	37
24	37.4	37.4	37.1	36.8	37.3	37	37.3	36.9	37	37
25	37.5	37.4	37.1	36.8	37.3	37	37.3	36.9	37	37
26	37.5	37.4	37.2	36.8	37.3	37.1	37.3	36.9	37	37
27	37.5	37.4	37.2	36.8	37.4	37.1	37.3	36.9	37	37
28	37.5	37.4	37.1	36.8	37.3	37.2	37.3	36.9	37	37
29	37.5	37.4	37.1	36.8	37.3	37.2	37.2	36.9	37	37
30	37.5	37.4	37.2	36.8	37.4	37.2	37.3	36.8	37	37
31	37.3	37.4	37.2	36.8	37.4	37.1	37.3	36.8	37	37
32	37.5	37.4	37.2	36.8	37.4	37.1	37.3	36.8	37	37
33	37.5	37.4	37.2	36.8	37.4	37.1	37.4	36.8	36.9	37
34	37.4	37.4	37.2	36.8	37.4	37.1	37.4	36.8	36.9	37
35	37.5	37.4	37.2	36.8	37.4	37.1	37.3	36.8	37	37
36	37.5	37.4	37.2	36.8	37.4	37.1	37.4	36.8	37	37
37	37.6	37.4	37.1	36.8	37.4	37.1	37.3	36.8	37	37
38	37.6	37.4	37.1	36.8	37.4	37.1	37.3	36.8	37	37
39	37.5	37.4	37.2	36.8	37.5	37.1	37.3	36.8	37	37
40	37.4	37.4	37.2	36.8	37.5	37.1	37.3	36.8	37	37
41	37.6	37.4	37.2	36.8	37.4	37.1	37.3	36.8	37	37
42	37.6	37.3	37.2	36.8	37.4	37.1	37.3	36.8	37	37
43	37.5	37.3	37.1	36.8	37.4	37.1	37.3	36.8	37	37
44	37.6	37.3	37.2	36.8	37.4	37.1	37.2	36.8	37	37
45	37.6	37.3	37.2	36.8	37.4	37.1	37.3	36.8	37	37
46	37.6	37.3	37.2	36.8	37.4	37.1	37.3	36.8	37.1	37
47	37.6	37.3	37.2	36.7	37.5	37.1	37.3	36.8	37	37
48	37.6	37.3	37.2	36.7	37.4	37.1	37.4	36.8	37	37
49	37.6	37.3	37.2	36.7	37.5	37.1	37.3	36.8	37	37
50	37.6	37.4	37.2	36.7	37.5	37.1	37.3	36.8	37.1	37
51	37.6	37.4	37.3	36.7	37.5	37.1	37.3	36.8	37.1	37
52	37.5	37.4	37.2	36.7	37.5	37.1	37.3	36.8	37.1	37
53	37.5	37.4	37.2	36.7	37.5	37.1	37.3	36.8	37.1	37
54	37.5	37.4	37.2	36.7	37.4	37.1	37.3	36.7	37.1	37
55	37.5	37.3	37.2	36.6	37.4	37.1	37.4	36.7	37.1	37
56	37.6	37.3	37.2	36.6	37.4	37.1	37.3	36.7	37.1	37
57	37.6	37.3	37.2	36.6	37.4	37.1	37	36.7	37.2	37
58	37.6	37.3	37.2	36.6	37.4	37.1	37.4	36.7	37.2	37
59	37.6	37.4	37.3	36.6	37.5	37.1	37.4	36.7	37.2	37
60	37.6	37.4	37.2	36.7	37.4	37.1	37.4	36.7	37.2	37
61	37.7	37.4	37.3	36.7	37.4	37.1	37.4	36.7	37.2	37.1
62	37.7	37.4	37.3	36.7	37.5	37.1	37.4	36.7	37.2	37.1
63	37.7	37.4	37.3	36.7	37.5	37.1	37.5	36.7	37.2	37.1
64	37.7	37.4	37.3	36.7	37.5	37.1	37.5	36.7	37.3	37.1
65	37.7	37.4	37.3	36.7	37.5	37.1	37.4	36.7	37.2	37.1

Test 8, Subjects 1 to 5

TIME (min)	SUBJECT 1		SUBJECT 2		SUBJECT 3		SUBJECT 4		SUBJECT 5	
	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR
1	36.5	36.3	36.7	36.3	37.2	36.8	37.1	36.7	37	36.7
2	36.4	36.2	36.7	36.3	37.1	36.9	37.1	36.7	36.9	36.6
3	36.5	36.2	36.6	36.3	37.1	36.9	37.1	36.7	37	36.6
4	36.4	36.2	36.6	36.2	37.1	36.9	37.1	36.7	37.1	36.6
5	36.5	36.2	36.6	36.2	37	37	37.1	36.7	37	36.6
6	36.5	36.2	36.6	36.2	37	37	37.1	36.7	37.1	36.6
7	36.4	36.2	36.6	36.2	37.1	37	37.1	36.7	37	36.6
8	36.3	36.2	36.6	36.2	37.1	37	37	36.7	37.1	36.6
9	36.5	36.2	36.7	36.2	37.1	37	37	36.7	37.1	36.6
10	36.4	36.2	36.6	36.2	37.1	37	37	36.7	37.1	36.6
11	36.4	36.2	36.6	36.1	37.1	37	37	36.7	37.1	36.7
12	36.4	36.2	36.7	36.1	37.1	37	37.1	36.7	37.1	36.7
13	36.4	36.3	36.6	36.2	37.1	37	37.1	36.7	37.1	36.7
14	36.4	36.3	36.7	36.2	37.1	37.1	37.1	36.7		36.7
15	36.4	36.3	36.7	36.2	37.1	37.1	37.1	36.7	37	36.7
16	36.3	36.3	36.7	36.2	37.1	37.1	37.1	36.7	37	36.7
17	36.3	36.3	36.7	36.2	37.1	37	37.1	36.7	37.1	36.7
18	36.3	36.3	36.7	36.2	37.1	37.1	37.1	36.7	37	36.7
19	36.4	36.3	36.7	36.1	37	37.1	37	36.7	37.1	36.7
20	36.4	36.3	36.6	36.1	37	37.1	37.1	36.7	37.1	36.8
21	36.4	36.3	36.7	36.1	36.9	37.1	37	36.7	37	36.8
22	36.3	36.3	36.7	36.1	37	37	37.1	36.7	37.1	36.8
23	36.4	36.3	36.8	36.1	37	37	37	36.7	37.1	36.8
24	36.4	36.3	36.7	36.1	37	37	37	36.7	37.1	36.8
25	36.4	36.3	36.8	36.1	37.1	37	37.1	36.7	37.1	36.8
26	36.4	36.4	36.8	36.1	37	37	37.1	36.7	37.1	36.8
27	36.5	36.4	36.8	36.1	37.1	37	37.1	36.7	37	36.8
28	36.5	36.4	36.7	36.1	37	37	37.1	36.7	37.1	36.8
29	36.5	36.4	36.7	36.1	37	37	37.1	36.7	37.2	36.8
30	36.5	36.4	36.8	36.1	37	37	37	36.7	37.1	36.8
31	36.4	36.4	36.8	36.1	37	37	37.1	36.7	37.2	36.8
32	36.5	36.4	36.8	36.1	37.1	37	37	36.7	37.1	36.9
33	36.5	36.5	36.8	36.1	37.1	37.1	37.1	36.7	37.2	36.9
34	36.4	36.5	36.8	36.1	37.1	37.1	37	36.7	37.2	36.9
35	36.4	36.5	36.8	36.1	37.1	37.1	37.1	36.7	37.1	36.9
36	36.4	36.5	36.8	36.1	37	37.1	37.1	36.7	37.2	36.9
37	36.5	36.5	36.8	36.1	37	37.1	37.2	36.7	37.1	36.9
38	36.5	36.5	36.8	36.1	37.1	37.1	37.1	36.7	37.2	36.9
39	36.5	36.5	36.8	36.1	37.1	37	37.1	36.7	37.3	36.8
40	36.4	36.5	36.8	36.1	37.1	37	37.1	36.7	37.3	36.8
41	36.5	36.5	36.9	36.1	37.1	37.1	37.2	36.7	37.1	36.8
42	36.5	36.6	36.9	36.1	37.1	37	37.2	36.7	37.2	36.8
43	36.5	36.6	36.8	36.2	37.1	37	37.2	36.7	37.2	36.9
44	36.5	36.6	36.8	36.2	37.1	37	37.1	36.7	37.2	36.9
45	36.5	36.6	36.8	36.2	37.1	37.1	37.2	36.7	37.2	36.9
46	36.6	36.6	36.8	36.2	37.1	37.1	37.2	36.7	37.2	36.9
47	36.5	36.6	36.8	36.2	37.1	37.1	37.2	36.7	37.2	36.9
48	36.5	36.6	36.8	36.2	37.1	37.1	37.1	36.7	37.3	36.9
49	36.5	36.6	36.9	36.2	37.1	37	37.2	36.7	37.3	36.9
50	36.5	36.6	36.9	36.2	37.1	37	37.2	36.8	37.3	36.9
51	36.6	36.6	36.9	36.2	37	37	37.3	36.8	37.1	36.9
52	36.7	36.7	36.9	36.2	36.9	37.1	37.1	36.8	37.1	36.9
53	36.7	36.8	36.8	36.2	36.9	37.1	37.1	36.8	37.1	36.9
54	36.8	36.8	36.8	36.3	37	37.1	37.1	36.9	37.1	36.9
55	36	36.9	36.9	36.5	36.9	37.2	37	37	37.1	37
56	36.4	37	36.9	36.6	37	37.3	37	37.1	37	37.2
57	36	36.1	36.9	36.7	37	37.3	37.1	37.2	36.9	37.3
58	36.2	36.2	36.9	36.7	37	37.3	37.1	37.2	37	36.9
59	36.1	36.2	36.9	36.7	37	36.6	37.1	37.2	37	36.9
60	36.3	36.2	36.9	36.5	37	36.6	37.1	37.3	37	37
61	36.2	36.2	36.8	36.5	37	36.6	37.2	37.2	37	37
62		36.2	36.9	36.5	37	36.6	37.1	37.1	37	36.9
63	36.2	36.2	36.9	36.4	37.1	36.6	37.2	37.1	37	36.9
64	36.1	36.2	36.9	36.5	37.1	36.7	37.2	37.1	37	36.9
65	36.3	36.2	36.9	36.4	37	36.7	37.2	37.1	37	37

NOTE TO USERS

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Test 9, Subjects 1 to 5

TIME (min)	SUBJECT 1		SUBJECT 2		SUBJECT 3		SUBJECT 4		SUBJECT 5	
	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR
1	36.9	36.8	36	36.4	36.6	36.8	36.9	36.8	36.6	36.7
2	36.9	36.8	36	36.5	36.6	36.9	36.9	36.9	36.5	36.7
3	36.9	36.8	36.1	36.5	36.6	36.9	36.9	36.9	36.6	36.7
4	36.9	36.9	36.1	36.5	36.6	36.9	36.9	36.9	36.7	36.8
5	36.9	36.9	36	36.5	36.6	37	36.9	36.9	36.8	36.8
6	36.9	36.9	36	36.5	36.5	37	36.9	36.9	36.7	36.8
7	36.8	36.9	36	36.5	36.5	37	36.9	36.9	36.5	36.8
8	36.8	36.9	36	36.5	36.5	37.1	36.8	36.9	36.5	36.8
9	36.8	36.9	35.9	36.5	36.5	37.1	36.8	36.9	36.6	36.8
10	36.8	36.9	35.9	36.5	36.5	37.1	36.8	36.9	36.6	36.8
11	36.8	36.9	35.9	36.5	36.5	37.1	36.9	36.9	36.5	36.8
12	36.8	36.9	35.9	36.5	36.6	37.1	36.8	36.9	36.6	36.8
13	36.8	36.9	36	36.5	36.6	37.1	36.8	36.9	36.5	36.8
14	36.8	36.9	36	36.5	36.6	37.1	36.9	36.9	36.6	36.8
15	36.8	36.9	36	36.5	36.6	37.1	36.9	36.9	36.6	36.8
16	36.8	36.9	36.1	36.5	36.6	37.1	36.8	36.9	36.7	36.8
17	36.7	36.8	36.1	36.5	36.5	37.1	36.8	36.9	36.5	36.8
18	36.8	36.8	35.9	36.5	36.5	37.1	36.8	36.9	36.5	36.8
19	36.7	36.8	36	36.5	36.5	37.1	36.8	36.9	36.6	36.8
20	36.8	36.8	35.9	36.5	36.5	37.1	36.8	36.9	36.6	36.8
21	36.7	36.8	36.1	36.5	36.6	37.1	36.8	36.8	36.6	36.8
22	36.8	36.8	36	36.5	36.6	37.1	36.9	36.8	36.7	36.8
23	36.7	36.8	36	36.4	36.6	37.1	36.9	36.9		36.8
24	36.8	36.8	36	36.5	36.6	37.1	36.9	36.9	36.6	36.8
25	36.7	36.8		36.4	36.6	37.1	37	36.9	36.6	36.8
26	36.7	36.8	36	36.4	36.6	37.1	36.9	36.9	36.7	36.8
27	36.8	36.8	36.1	36.4	36.5	37.1	36.9	36.9	36.6	36.8
28	36.7	36.8	36	36.4	36.5	37.1	36.8	36.9	36.5	36.8
29	36.8	36.8	36	36.4	36.5	37.1	36.9	36.9	36.6	36.8
30	36.8	36.8	36	36.4	36.5	37.1	36.9	36.9	36.6	36.8
31	36.7	36.8	36	36.5	36.5	37.1	36.9	36.9	36.7	36.8
32	36.8	36.8	36.1	36.5	36.6	37.1	36.9	36.9	36.8	36.8
33	36.8	36.8	36.1	36.5	36.6	37.1	36.8	36.9		36.8
34	36.8	36.8	36.1	36.5	36.7	37.1	36.9	36.9	36.7	36.8
35	36.8	36.8		36.5	36.7	37.1	36.9	36.9	36.7	36.9
36	36.8	36.8		36.4	36.6	37.1	36.9	36.9	36.7	36.9
37	36.8	36.8		36.4	36.6	37.1	36.9	36.9	36.6	36.9
38	36.9	36.8		36.4	36.6	37.1	37	36.9	36.7	36.9
39	36.8	36.8		36.4	36.6	37.1	36.9	36.9	36.8	36.9
40	36.8	36.8		36.4	36.6	37.1	36.9	36.9	36.7	36.9
41	36.9	36.8		36.4	36.7	37.1	37	36.9	36.7	36.9
42	36.8	36.8	36	36.4	36.7	37.1	36.9	36.9	36.8	36.9
43	36.9	36.8	36.1	36.4	36.7	37	36.9	36.9	36.7	36.9
44	36.9	36.9	36.1	36.4	36.7	37	37	36.9	36.7	36.9
45	36.9	36.9	36.1	36.5	36.7	37.1	37	36.9	36.8	36.9
46	36.9	36.9	36.1	36.4	36.7	37.1	37	36.9	36.8	36.9
47	36.8	36.9	36.1	36.4	36.6	37	37	36.9	36.8	36.9
48	36.9	36.9	36	36.4	36.6	37	37	36.9	36.7	36.9
49	36.9	36.9	36	36.5	36.6	37	36.9	36.9	36.7	36.9
50	36.9	36.9	36.1	36.4	36.6	37	37	36.9	36.8	36.9
51	36.9	36.9	36.3	36.4	36.6	37	37	36.9	36.7	36.9
52	36.9	36.9	36.3	36.4	36.6	37	37	36.9	36.7	36.9
53	36.9	36.9	36.3	36.4	36.6	37	37	36.9	36.7	36.8
54	36.9	36.9	36.1	36.4	36.6	37	37	36.9	36.6	36.8
55	36.9	36.9	36.3	36.4	36.6	37	37	36.9	36.7	36.8
56	36.8	36.9	36.6	36.4	36.6	37	37.1	36.9	36.6	36.8
57	36.8	36.9	36.5	36.4	36.6	37	37.1	37	36.9	36.8
58	36.9	36.9	36.4	36.4	36.7	37	37	37	36.7	36.8
59	36.9	36.9	36.4	36.4	36.7	37	37	37	36.7	36.9
60	36.9	36.9	36.4	36.4	36.7	37	37	37	37	36.9
61	36.9	36.9	36.4	36.4	36.7	37	37	37	36.7	36.9
62	36.9	36.9	36.3	36.4	36.7	37	37	37	36.7	36.9
63	36.9	36.9	36.5	36.4	36.7	37	37	37	36.9	36.9
64	36.9	36.9	36.5	36.4	36.8	37.1	37	37	36.9	36.9
65	36.9	36.9	36.5	36.4	36.7	37.1	37.1	37	36.8	36.9

Test 9, Subjects 6 to 10

TIME (min)	SUBJECT 6		SUBJECT 7		SUBJECT 8		SUBJECT 9		SUBJECT 10	
	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR
1	37	37.2	37.1	36.9	37.1	36.9	36.9	36.5	36.9	36.5
2	37.1	37.2	37	36.9	37.1	36.9	37	36.6	36.9	36.5
3	37.1	37.2	37	36.9	37.1	36.9	37	36.6	36.9	36.5
4	37	37.2	37	36.9	37.1	36.9	37	36.6	36.8	36.6
5	37.1	37.2	37	36.9	37.1	36.9	37	36.6	36.8	36.6
6	37.1	37.2	37	36.9	37.1	36.9	37	36.6	36.8	36.6
7	37	37.2	37	36.9	37.1	36.9	37	36.6	36.8	36.7
8	37.1	37.2	37	36.9	37	36.9	37	36.6	36.9	36.7
9	37.1	37.2	37	36.8	37	36.9	37	36.6	36.9	36.7
10	37.1	37.2	36.9	36.9	37	36.9	37	36.6	36.9	36.7
11	37.1	37.2	37	36.9	37	36.9	37.1	36.7	36.9	36.7
12	37.2	37.2	36.9	36.9	37.1	36.9	37	36.7	36.9	36.8
13	37.1	37.2	37	36.9	37.1	36.9	37	36.7	37	36.8
14	37.1	37.2	37	36.9	37	36.9	37	36.7	37	36.8
15	37.2	37.2	37	36.9	37	36.9	37.1	36.7	37	36.8
16	37.2	37.2	37	36.9	37.1	36.9	37.1	36.7	37	36.8
17	37.1	37.2	37.1	36.9	37.1	36.9	37.1	36.7	36.9	36.8
18	37.1	37.2	37	36.9	37.1	36.9	37.1	36.7	36.9	36.8
19	37.2	37.2	37	36.9	37.1	36.9	37.1	36.7	36.8	36.8
20	37.2	37.2	37.1	36.9	37.1	36.9	37.1	36.7	36.9	36.8
21	37.2	37.2	37	36.9	37.1	36.9	37.2	36.7	36.9	36.8
22	37.2	37.3	37.1	36.9	37.1	36.9	37.2	36.7	37	36.8
23	37.1	37.3	37	36.9	37.1	37	37.2	36.7		36.9
24	37.1	37.3	37	36.9	37.2	37	37.2	36.7	37	36.9
25	37.2	37.3	37.1	36.9	37.2	37	37.2	36.8	37	36.9
26	37.2	37.3	37.1	36.9	37.2	37	37.2	36.7	37	36.8
27	37.2	37.3	37.1	36.9	37.2	37	37.2	36.7	36.9	36.8
28	37.3	37.3	37	36.9	37.2	37	37.2	36.7	36.9	36.8
29	37.2	37.3	37.1	36.9	37.2	37	37.2	36.7	36.9	36.8
30	37.2	37.3	37.1	36.9	37.2	37	37.2	36.7	36.9	36.8
31	37.3	37.3	37.1	36.9	37.2	37	37.2	36.7	36.9	36.8
32	37.3	37.3	37.1	36.9	37.2	37	37.2	36.7	36.9	36.8
33	37.2	37.4	37.1	36.9	37.2	37	37.2	36.7	36.9	36.8
34	37.2	37.3	37.1	37	37.2	37	37.2	36.7	37	36.8
35	37.3	37.4	37.1	37	37.2	37	37.2	36.7	37	36.8
36	37.3	37.4	37.2	36.9	37.2	37	37.3	36.7	37	36.8
37	37.2	37.4	37.2	36.9	37.2	37	37.3	36.7	37	36.8
38	37.1	37.4	37.2	36.9	37.2	37	37.3	36.7	37.1	36.8
39	37.3	37.4	37.2	36.9	37.2	37	37.2	36.7	37.1	36.8
40	37.2	37.4	37.2	36.9	37.2	37	37.3	36.7	37.1	36.8
41	37.3	37.4	37.2	36.9	37.3	37	37.3	36.7	37.1	36.8
42	37.2	37.4	37.2	37	37.2	37	37.3	36.7	37.1	36.8
43	37.3	37.4	37.2	37	37.3	37	37.3	36.7	37.1	36.8
44	37.3	37.4	37.1	37	37.2	37	37.3	36.7	37	36.8
45	37.3	37.4	37.2	37	37.3	37	37.3	36.8	37.1	36.8
46	37.3	37.4	37.2	37	37.2	37	37.3	36.8	37.1	36.8
47	37.2	37.6	37.2	36.9	37.3	37	37.3	36.7	37.1	36.8
48	37.2	37.5	37.2	36.9	37.2	37	37.2	36.7	37.1	36.8
49	37.3	37.5	37.2	36.9	37.3	37	37.3	36.7	37.1	36.8
50	37.3		37.2	36.9	37.3	37	37.3	36.7	37.1	36.8
51	37.3		37.2	36.8	37.3	37	37.4	36.7	37.1	36.8
52	37.3		37.2	36.8	37.3	37	37.3	36.7	37.1	36.8
53	37.2	37.6	37.2	36.8	37.3	37	37.3	36.6	37.1	36.8
54	37.2	37.4	37.2	36.8	37.3	37	37.3	36.6	37.1	36.8
55	37.3	37.4	37.2	36.8	37.3	37	37.3	36.6	37.1	36.8
56	37.3	37.3	37.2	36.8	37.3	37	37.3	36.5	37.2	36.8
57	37.3	37.3	37.2	36.9	37.4	37	37.3	36.5	37.2	36.8
58	37.3	37.3	37.2	36.9	37.4	37	37.3	36.5	37.2	36.8
59	37.4	37.3	37.2	36.9	37.4	37	37.3	36.5	37.2	36.8
60	37.4	37.3	37.2	36.9	37.4	37	37.3	36.5	37.2	36.8
61	37.4	37.3	37.2	36.9	37.4	37	37.3	36.6	37.2	36.8
62	37.4	37.3	37.3	36.9	37.4	37	37.3	36.6	37.2	36.8
63	37.4	37.4	37.3	36.9	37.4	37.1	37.4	36.6	37.3	36.8
64	37.4	37.4	37.3	36.9	37.4	37.1	37.3	36.6	37.2	36.8
65	37.4	37.4	37.3	36.9	37.4	37.1	37.3	36.6	37.2	36.8

Test 10, Subject 1, 3 to 5

TIME (min)	SUBJECT 1		SUBJECT 3		SUBJECT 4		SUBJECT 5	
	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR
1	36.8	36.5	36.9	36.7	37.2	36.6	37.1	36.6
2	36.7	36.5	36.8	36.7	37.2	36.6	37.1	36.6
3	36.8	36.5	36.9	36.7	37.1	36.6	37.1	36.7
4	36.8	36.5	36.9	36.7	37.2	36.5	37	36.7
5	37	36.6	37	36.8	37.3	36.5	37.1	36.7
6	37	36.6	37	36.8	37.3	36.6	37.2	36.8
7	37.1	36.7	37	36.8	37.4	36.6	37.3	36.9
8	37.2	36.7	37.1	36.8	37.4	36.6	37.4	36.9
9	37.2	36.8	37.1	36.9	37.4	36.7	37.4	37
10	37.1	36.8	37.1	36.9	37.3	36.7	37.3	37.1
11	37.2	36.8	37.1	36.9	37.3	36.7	37.3	37.1
12	37.2	36.8	37.1	37	37.2	36.7	37.5	37.1
13	37.3	36.8	37.1	37	37.3	36.7	37.4	37.2
14	37.2	36.9	37.2	37	37.2	36.7	37.2	37.2
15	37.2	36.9	37.1	37	37.4	36.7	37.4	37.2
16	37.3	36.9	37.1	37	37.4	36.7	37.4	37.2
17	37.3	36.9	37	37	37.4	36.8	37.6	37.3
18	37.4	36.9	37.1	37	37.3	36.8	37.4	37.3
19	37.4	37	37.1	37	37.4	36.8	37.6	37.3
20	37.4	37	37.1	37	37.4	36.8	37.6	37.3
21	37.4	37	37.1	37	37.4	36.8	37.7	37.4
22	37.3	37	37.1	37	37.3	36.7	37.6	37.4
23	37.4	37	37.1	37	37.4	36.7	37.6	37.5
24	37.4	37	37.1	37	37.4	36.7	37.7	37.5
25	37.4	37	37.1	37	37.6	36.7	37.7	37.5
26	37.4	37.1	37	36.9	37.6	36.7	37.8	37.5
27	37.4	37.1	37	36.9	37.6	36.7	37.8	37.5
28	37.5	37.1	37.1	37	37.5	36.7	37.7	37.6
29	37.6	37.2	37.1	37	37.5	36.8	37.7	37.6
30	37.6	37.2	37.1	37	37.6	36.8	37.9	37.6
31	37.6	37.2	37.1	37	37.5	36.8	37.8	37.7
32	37.5	37.2	37.1	37	37.5	36.8	37.9	37.7
33	37.5	37.2	37.1	37	37.6	36.8	37.9	37.8
34	37.6	37.2	37.1	37	37.7	36.9	38	37.8
35	37.6	37.2	37	37	37.7	36.9	38	37.9
36	37.7	37.3	37	37	37.8	36.9	38	37.9
37	37.7	37.3	37.1	37	37.8	36.9	38.1	37.9
38	37.8	37.4	37.2	37	37.8	36.9	38.1	37.9
39	37.8	37.4	37.2	37	37.6	36.9	38.1	37.9
40	37.8	37.4	37.2	37	37.7	36.9	38.1	37.9
41	37.8	37.4	37.2	37	37.7	36.9	38.1	37.9
42	37.8	37.4	37.2	37	37.7	36.9	38.1	37.9
43	37.8	37.5	37.2	37	37.7	36.9	38.2	38
44	37.8	37.5	37.2	37	37.8	37	38.1	38
45	37.8	37.5	37.2	37.1	37.8	37	38.1	38
46	37.9	37.5	37.2	37.1	37.8	37	38	38.1
47	37.9	37.5	37.2	37.1	37.9	37	38	38.1
48	37.9	37.6	37.2	37.1	37.8	37	37.9	38.1
49	37.9	37.5	37.2	37.1	37.7	37	38.2	38.1
50	37.8	37.5	37.1	37.2	37.7	37	38.2	38.1
51	37.7	37.5	37.2	37.2	37.7	36.9	37.7	38
52	37.7	37.4	37.1	37.2	37.7	36.9	38	38
53	37.7	37.4	37.1	37.2	37.7	36.9	37.9	38
54	37.7	37.4	37	37.2	37.7	36.9	37.9	38
55	37.6	37.4	37	37.2	37.6	36.9	37.9	38
56	37.6	37.3	37	37.2	37.6	36.9	37.9	38
57	37.6	37.3	37	37.1	37.6	36.9	37.9	38
58	37.6	37.3	37.1	37.1	37.6	36.9	37.8	38.1
59	37.6	37.3	37.1	37	37.6	36.9	37.9	38.1
60	37.6	37.3	37.1	37	37.5	36.8	37.8	38
61	37.6	37.3	37.2	37	37.5	36.8	38	38
62	37.6	37.3	37.2	37	37.6	36.8		38
63	37.6	37.3	37.1	37	37.6	36.8		38
64	37.6	37.3	37.1	37.1	37.6	36.8		
65	37.5	37.3	37.2	37.1	37.5	36.8		

Test 10, Subjects 7 to 10

TIME (min)	SUBJECT 6		SUBJECT 7		SUBJECT 8		SUBJECT 9		SUBJECT 10	
	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR
1	37.1	37	37.1	36.8	36.9	36.6	37.1	36.8	37.3	36.9
2	37.1	37	37.1	36.8	36.8	36.6	37.1	36.8	37.3	36.9
3	37	37	37.1	36.8	36.9	36.6	37.2	36.8	37.3	36.9
4	37	37	37.1	36.8	36.8	36.6	37.2	36.8	37.3	36.9
5	37.1	36.9	37.1	36.8	36.9	36.6	37.2	36.9	37.4	36.9
6	37.1	36.9	37.2	36.8	36.9	36.6	37.3	36.9	37.4	36.9
7	37.2	36.9	37.2	36.9	36.9	36.6	37.4	36.9	37.4	36.9
8	37.1	37	37.2	36.9	37	36.7	37.4	37	37.5	36.9
9	37.2	37	37.3	37	37	36.7	37.4	37	37.5	36.9
10	37.1	37	37.3	37	37.1	36.7	37.5	37.1	37.6	36.9
11	37.2	37	37.3	37	37.1	36.8	37.5	37.1	37.4	36.9
12	37.3	37	37.3	37	37.1	36.8	37.6	37	37.5	36.9
13	37.3	37	37.2	37	37	36.8	37.6	37	37.5	36.9
14	37.2	37	37.2	37	37.1	36.8	37.5	37.1	37.5	36.9
15	37.3	37	37.3	37	37.1	36.8	37.6	37.1	37.6	36.9
16	37.3	37	37.3	36.9	37.3	36.8	37.6	37.1	37.6	36.9
17	37.3	37	37.3	36.9	37.3	36.9	37.6	37.1		37
18	37.3	37.1	37.3	36.9	37.2	36.8	37.6	37.1		37
19	37.3	37.1	37.3	36.9	37.3	36.9	37.7	37.1		37
20	37.3	37.1	37.3	36.9	37.4	36.9	37.6	37.1	37.3	37
21	37.3	37.2	37.3	36.9	37.3	36.9	37.7	37.2	37.5	37.1
22	37.4	37.2	37.3	36.9	37.4	36.9	37.6	37.2	37.5	37.1
23	37.4	37.2	37.3	36.9	37.4	36.9	37.7	37.2	37.6	37.1
24	37.4	37.2	37.4	36.9	37.3	36.9	37.7	37.2	37.6	37.1
25	37.5	37.2	37.4	36.9	37.3	36.9	37.7	37.2	37.7	37.1
26	37.5	37.2	37.4	36.9	37.4	36.9	37.7	37.1	37.7	37
27	37.5	37.2	37.4	36.9	37.3	37	37.7	37.2	37.7	37
28	37.5	37.3	37.4	36.9	37.3	37	37.6	37.2	37.8	37.1
29	37.6	37.3	37.4	37	37.4	37	37.7	37.2	37.8	37.1
30	37.4	37.3	37.3	36.9	37.4	37	37.7	37.3	37.8	37.1
31	37.6	37.3	37.4	36.9	37.3	37	37.8	37.3	37.8	37.1
32	37.7	37.3	37.4	36.9	37.4	37.1	37.8	37.3	37.8	37.1
33	37.7	37.4	37.4	36.9	37.4	37	37.8	37.3	37.9	37.2
34	37.6	37.4	37.4	36.9	37.4	37	37.7	37.3	37.8	37.2
35	37.6	37.4	37.4	36.9	37.5	37	37.8	37.3	37.8	37.2
36	37.7	37.4	37.4	36.9	37.5	37	37.8	37.3	37.9	37.2
37	37.8	37.5	37.4	36.9	37.5	37	37.8	37.3	37.9	37.2
38	37.8	37.5	37.4	37	37.4	37	37.8	37.3	37.7	37.2
39	37.7	37.5	37.4	37	37.5	37	37.8	37.3	37.9	37.3
40	37.8	37.5	37.4	37	37.5	37	37.8	37.4	37.9	37.3
41	37.9	37.6	37.4	37	37.5	37	37.8	37.4	37.9	37.3
42	37.8	37.6	37.4	37	37.5	37	37.9	37.4	37.9	37.3
43	37.8	37.6	37.4	37	37.5	37	37.9	37.4	37.9	37.3
44	37.9	37.6	37.4	37	37.5	37	37.9	37.4	38	37.3
45	37.9	37.7	37.5	37	37.5	37	37.9	37.4	38	37.3
46	38	37.7	37.4	36.9	37.5	37	37.9	37.4	38	37.3
47	37.9	37.7	37.4	36.9	37.5	37	37.9	37.4	37.9	37.4
48	37.9	37.7	37.4	36.9	37.5	37	37.9	37.4	37.9	37.4
49	37.9	37.7	37.4	36.9	37.4	37	37.9	37.4	37.9	37.4
50	37.9	37.7	37.4	36.9	37.4	37	37.8	37.4	37.8	37.4
51	37.9	37.7	37.4	36.9	37.5	37	37.8	37.4	37.9	37.4
52	37.7	37.7	37.3	36.9	37.5	37	37.7	37.4	37.9	37.4
53	37.8	37.7	37.3	36.9	37.5	37	37.7	37.3	37.9	37.3
54	37.8	37.7	37.3	36.8	37.4	37	37.6	37.3	37.9	37.3
55	37.7	37.6	37.3	36.8	37.4	37	37.6	37.3	37.8	37.3
56	37.7	37.6	37.3	36.8	37.3	37	37.7	37.3	37.8	37.3
57	37.7	37.6	37.3	36.8	37.3	37	37.7	37.3	37.8	37.3
58	37.7	37.6		36.8	37.2	37	37.7	37.3	37.7	37.3
59	37.7	37.6		36.8	37.2	37	37.7	37.3	37.7	37.3
60	37.7	37.5	37.3	36.8	37.2	37	37.7	37.3	37.7	37.3
61	37.7	37.5	37.3	36.8	37.3	37	37.7	37.3	37.7	37.3
62	37.7	37.5	37.3	36.8	37.3	37	37.7	37.3	37.7	37.3
63	37.7	37.5	37.3	36.8	37.3	37	37.7	37.3	37.7	37.3
64	37.7	37.5	37.3	36.8	37.4	37	37.7	37.3	37.7	37.3
65	37.7	37.5	37.4	36.8	37.3	36.9	37.7	37.3	37.7	37.3

Test 11, Subjects 1 to 5

TIME (min)	SUBJECT 1		SUBJECT 2		SUBJECT 3		SUBJECT 4		SUBJECT 5	
	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR
1	36.9	36.5	36.4	36.5	37.2	36.9	37.1	36.8	36.9	36.6
2	36.9	36.5	36.4	36.5	37.2	36.9	37.1	36.7	36.9	36.7
3	36.9	36.5	36.3	36.5	37.2	36.9	37.1	36.6	36.9	36.6
4	37	36.5	36.5	36.5	37.2	36.9	37	36.6	37	36.7
5	37.1	36.5	36.5	36.5	37.2	37	37	36.6	37.1	36.7
6	37.2	36.6	36.7	36.6	37.2	37	37.1	36.7	37.2	36.8
7	37.2	36.6			37.3	37.1	37.1	36.7	37	36.8
8	37.2	36.6	36.7		37.3	37.1	37.2	36.7	37.2	36.9
9	37.3	36.6	36.6	36.8	37.4	37.2	37.2	36.8	37.2	36.9
10	37.2	36.6	36.6	36.8	37.4	37.2	37.2	36.8	37.3	36.9
11	37.2	36.6	36.7	36.8	37.4	37.2	37.2	36.8	37.1	36.9
12	37.3	36.6	36.7	36.8	37.4	37.2	37.1	36.8	37.2	36.9
13	37.2	36.6	36.6	36.8	37.4	37.2	37.1	36.8	37.3	37
14	37.2	36.6	36.6	36.8	37.4	37.2	37.2	36.8	37.3	37
15	37.2	36.6	36.6	36.8	37.3	37.2	37.3	36.9	37.2	37
16	37.2	36.7	36.6	36.8	37.2	37.2	37.3	36.9	37.3	37
17	37.2	36.7	36.7	36.8	37.2	37.1	37.2	36.9	37.4	37
18	37.3	36.7	36.7	36.9	37.2	37.1	37.2	36.9	37.2	37
19	37.4	36.7	36.8	36.9	37.3	37.1	37.3	36.9	37.3	37
20	37.3	36.7		36.9	37.4	37	37.3	36.9	37.2	37
21	37.3	36.7		37	37.4	37	37.1	36.9	37.4	37
22	37.4	36.7		37	37.4	37	37.3	36.9	37.5	37
23	37.4	36.7	36.3		37.4	37	37.3	36.9	37.3	37.1
24	37.3	36.7	36.5	37.1	37.3	37	37.3	36.9	37.4	37.1
25	37.4	36.7	36.5	37.1	37.3	37	37.4	37	37.3	37.1
26	37.4	36.7	36.7	37.1	37.3	37	37.4	37	37.4	37.1
27	37.5	36.8	36.8	37.1	37.3	37	37.5	36.9	37.5	37.1
28	37.5	36.8	37		37.3	37	37.4	36.9	37.5	37.1
29	37.6	36.8	36.8	37.1	37.3	37	37.4	36.9	37.4	37.2
30	37.6	36.8	36.9	37.2	37.4	37	37.4	36.9	37.6	37.2
31	37.6	36.8	36.9	37.2	37.3	37	37.4	36.9	37.5	37.2
32	37.6	36.9	37	37.2	37.3	37	37.4	36.9	37.7	37.2
33	37.6	36.9	36.9	37.2	37.3	37	37.4	36.9	37.7	37.3
34	37.6	36.9	37	37.2	37.3	37	37.4	37	37.6	37.3
35	37.7	36.9	37	37.3	37.3	37	37.5	36.9	37.7	37.3
36	37.7	36.9	37.1	37.3	37.3	37	37.5	37	37.7	37.4
37	37.8	36.9	37.2	37.3	37.3	37	37.6	37	37.7	37.4
38	37.8	37		37.4	37.4	37	37.5	37	37.8	37.4
39	37.8	37		37.4	37.3	37	37.5	37	37.6	37.4
40	37.8	37	36.8	37.5	37.4	37	37.5	37	37.7	37.4
41	37.8	37.1	36.9	37.5	37.3	37	37.5	37	37.8	37.5
42	37.6	37.1	37	37.6	37.4	37	37.5	37	37.8	37.5
43	37.7	37.1	37.2	37.6	37.4	37	37.6	37	37.7	37.5
44	37.9	37.1	36.9		37.3	37	37.6	37	37.8	37.5
45	37.8	37.1	36.6	37.7	37.3	37	37.6	37	37.8	37.6
46	37.8	37.1	36.9	37.7	37.3	37	37.6	37	37.8	37.6
47	37.9	37.1	37.3	37.7	37.4	37	37.6	37	37.9	37.6
48	37.9	37.1			37.3	37	37.6	37	38	37.6
49	37.7	37.1			37.3	37	37.6	37	38	37.6
50	37.8	37.1			37.3	37	37.5	37	37.8	37.6
51	37.8	37.1			37.3	37.1	37.5	37	37.8	37.6
52	37.8	37.1			37.2	37.1	37.4	37	37.7	37.6
53	37.7	37.1			37.1	37.1	37.3	37	37.5	37.5
54	37.6	37.1			37.1	37.2	37.3	37.1	37.4	36
55	37.4	37.1			37.1	37.2	37.2	37.2	37.4	36.1
56	37.3	37.1			37.1	37.3	37.2	37.3	37.3	36.1
57	37.2	37.2			37.1	37.3	37.2	37.4	37.3	36.1
58	37.1	36.5			37.2	36.5	37.2	37.4	37.1	37
59	37.1	36.5			37.1	36.5	37.3	37.4	37	36.9
60	37.1	36.5			37.2	36.4	37.3	37.4	37.1	36.9
61	37.1	36.5			37.2	36.4	37.3	37.4	37	36.9
62	37.1	36.5			37.2	36.4	37.3	36.9	37	36.9
63	37.2	36.5			37.2	36.4	37.3	36.9	37.1	36.8
64	37.2	36.5			37.2	36.4	37.3	36.9	37.1	36.8
65	37.2	36.5			37.2	36.4	37.3	36.9	37.1	36.8

Test 11, Subjects 6 to 10

TIME (min)	SUBJECT 6		SUBJECT 7		SUBJECT 8		SUBJECT 9		SUBJECT 10	
	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR
1	36.9	37	36.9	36.7	37	36.6	36.9	36.7	36.9	36.5
2	36.8	37	36.9	36.7	37	36.6	37.1	36.7	36.9	36.5
3	36.8	36.9	36.9	36.6	36.9	36.6	37	36.7	36.9	36.5
4	36.8	36.9	36.9	36.7	36.9	36.7	37.1	36.7	36.9	36.5
5	36.9	36.9	37	36.6	37	36.6	37.2	36.7	36.9	36.5
6	36.7	36.9	37	36.6	37	36.6	37.2	36.8	37	36.5
7	36.9	36.9	37	36.6	37	36.7	37.1	36.8	36.9	36.5
8	36.9	36.9	37	36.6	37	36.7	37.2	36.9	37.1	36.5
9	36.9	36.9	37	36.7	37.1	36.7	37.3	36.9	37.2	36.6
10	36.8	36.9	37.1	36.7	37.1	36.7	37.3	36.9	37.3	36.7
11	36.8	36.9	37.1	36.7	37.2	36.8	37.2	36.9	37.3	36.7
12	36.9	36.9	37.1	36.7	37.1	36.8	37.4	36.9	37.3	36.7
13	37	37	37.1	36.7	37.1	36.8	37.1	36.9	37.2	36.7
14	37	37	37.1	36.7	37.1	36.8	37.4	36.9	37.3	36.6
15	37	37	37.1	36.7	37.2	36.8	37.4	36.9	37.3	36.7
16	37.1	37	37.2	36.7	37.2	36.8	37.5	36.9	37.3	36.6
17	37.1	37.1	37.3	36.6	37.2	36.8	37.5	36.9	37.3	36.7
18	37.1	37.1	37.2	36.7	37.3	36.8	37.5	36.9	37.4	36.7
19	37.1	37.1	37.2	36.7	37.2	36.9	37.5	36.9	37.4	36.7
20	37.1	37.1	37.2	36.7	37.1	36.9	37.5	36.9	37.5	36.7
21	37.3	37.1	37.2	36.7	37.3	36.9	37.6	36.9	37.5	36.7
22	37.2	37.1	37.2	36.7	37.2	36.9	37.6	36.9	37.5	36.8
23	37.2	37.2	37.2	36.7	37.2	36.9	37.6	36.9	37.5	36.8
24	37.3	37.2	37.2	36.7	37.2	36.9	37.6	37	37.4	36.8
25	37.3	37.2	37.2	36.7	37.2	36.9	37.6	37	37.5	36.8
26	37.4	37.2	37.2	36.7	37.3	36.9	37.6	37	37.5	36.8
27	37.4	37.3	37.2	36.7	37.3	36.9	37.5	37	37.6	36.9
28	37.4	37.3	37.2	36.7	37.2	36.9	37.7	37	37.6	36.9
29	37.4	37.3	37.2	36.7	37.2	36.9	37.7	37.1	37.6	36.9
30	37.4	37.3	37.3	36.7	37.3	36.9	37.6	37.1	37.6	36.9
31	37.4	37.3	37.3	36.7	37.2	36.9	37.7	37.1	37.6	36.9
32	37.4	37.4	37.3	36.7	37.2	36.9	37.7	37.1	37.6	36.9
33	37.3	37.4	37.3	36.7	37.3	37	37.7	37.1	37.6	36.9
34	37.5	37.4	37.3	36.7	37.3	37	37.7	37.1	37.6	37
35	37.5	37.4	37.3	36.8	37.3	37	37.8	37.1	37.6	37
36	37.6	37.5	37.3	36.8	37.3	37	37.8	37.1	37.6	37
37	37.6	37.5	37.2	36.8	37.4	37	37.8	37.2	37.7	37
38	37.6	37.5	37.3	36.8	37.4	37	37.8	37.2	37.7	37
39	37.5	37.5	37.3	36.8	37.4	37	37.8	37.2	37.8	37
40	37.6	37.5	37.3	36.8	37.4	37	37.8	37.2	37.6	37
41	37.6	37.5	37.3	36.8	37.4	37	37.8	37.2	37.8	37
42	37.6	37.6	37.3	36.8	37.4	37	37.9	37.2	37.6	37.1
43	37.7	37.6	37.4	36.8	37.4	37	37.7	37.2	37.7	37.1
44	37.7	37.6	37.4	36.8	37.4	37	37.8	37.2	37.8	37.1
45	37.7	37.6	37.4	36.8	37.4	37	37.9	37.2	37.8	37.1
46	37.8	37.6	37.3	36.8	37.4	37	37.8	37.2	37.9	37.1
47	37.8	37.7	37.4	36.8	37.4	37	37.8	37.2	37.9	37.1
48	37.7	37.7	37.3	36.8	37.4	37	37.7	37.3	37.8	37.1
49	37.8	37.7	37.3	36.8	37.5	37	37.8	37.3	37.8	37.1
50	37.8	37.7	37.4	36.8	37.5	37	37.8	37.3	37.8	37.1
51	37.8	37.7	37.4	36.8	37.5	37	37.8	37.2	37.8	37.1
52	37.6	37.7	37.3	36.8	37.5	37	37.8	37.2	37.8	37.1
53	37.5	37.7	37.3	36.8	37.4	37.1	37.6	37.2	37.6	37.1
54	37.3	37.7	37.2	36.9	37.4	37.1	37.5	37.3	37.5	37.1
55	37.3	37.6	37.2	37	37.3	37.2	37.5	37.3	37.4	37.2
56	37.2	37.6	37.2	37	37.3	37.3	37.5	37.4	37.3	37.2
57	37.2	37.6	37.2	37	37.3	37.4	37.4	37.5	37.3	37.3
58	37.2	37.1	37.1	37	37.2	36.8	37.4	37.5	37.2	37.3
59	37.1	37	37.2	37	37.3	36.9	37.4	36.9	37.2	36.3
60	37.1	37	37.2	36.9	37.3	36.9	37.4	36.9	37.2	36.3
61	37.1	37	37.2	36.9	37.3	36.9	37.4	36.8	37.2	36.3
62	37.1	37	37.2	36.9	37.3	36.9	37.5	36.8	37.2	36.8
63	37.1	37	37.2	36.9	37.3	36.9	37.5	36.8	37.3	36.7
64	37.1	37	37.3	36.9	37.3	36.9	37.5	36.7	37.3	36.7
65	37.1	37	37.2	36.9	37.4	36.9	37.5	36.7	37.3	36.7

Test 12, Subjects 1 to 5

TEST (min)	SUBJECT 1		SUBJECT 2		SUBJECT 3		SUBJECT 4		SUBJECT 5	
	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR
1	36.5	36.3	36.3	36.2	36.9	36.4	37	36.7	36.3	36.8
2	36.4	36.3	36.3	36.2	36.9	36.4	36.9	36.8	36.4	36.9
3	36.4	36.3	36.2	36.2	36.9	36.5	36.9	36.8	36.2	36.9
4	36.5	36.4	36.2	36.2	37	36.5	36.9	36.8	36.2	37
5	36.4	36.4	36.3	36.2	37.1	36.5	37.1	36.8	36.2	37
6	36.6	36.5	36.4	36.2	37.1	36.6	37.1	36.8	36.2	37
7	36.5	36.5	36.5	36.2	37.2	36.6	37.2	36.9	36.2	37.1
8	36.6	36.6	36.6	36.3	37.2	36.6	37.2	36.9	36.2	37.1
9	36.8	36.6	36.6	36.3	37.3	36.7	37.2	36.9	36	37.2
10	36.7		36.7	36.3	37.2	36.7	37.3	37	36.3	37.2
11	36.9		36.6	36.3	37.3	36.7	37.3	37	36.3	37.2
12	36.9		36.7	36.3	37.3	36.8	37.2	37	36.4	37.2
13	36.9		36.6	36.3	37.3	36.8	37.2	37	36.4	37.3
14	36.8		36.7	36.3	37.3	36.8	37.2	37	36.4	37.2
15	36.8	36.8	36.7	36.3	37.4	36.8	37.3	37		37.3
16	36.8	36.8	36.8	36.3	37.3	36.8	37.4	37		37.3
17	36.8	36.8	36.8	36.4	37.3	36.8	37.3	37		37.3
18	36.9	36.8	36.7	36.4	37.4	36.8	37.3	37	36.3	37.3
19	37	36.9	36.7	36.4	37.4	36.8	37.3	37	36.4	37.3
20	37.1	36.9	36.8	36.4	37.3	36.8	37.4	37	36.4	37.3
21	37.1	36.9	36.8	36.4	37.4	36.8	37.4	37.1	36.2	37.3
22	37	36.9	36.8	36.4	37.3	36.8	37.4	37.1	36.3	37.3
23	37	36.9	36.9	36.4	37.3	36.8	37.4	37.1	36.4	37.3
24	37.2	37	36.7	36.4	37.3	36.8	37.5	37.1	36.5	37.3
25	37		36.7	36.4	37.3	36.8	37.5	37.1	36.5	37.3
26	37		36.8	36.4	37.3	36.7	37.5	37.1	36.4	37.3
27	37.1		36.8	36.4	37.3	36.7	37.5	37.1	36.4	37.3
28	37.3		36.8	36.4	37.4	36.7	37.5	37.1	36.5	37.3
29	37.3		36.7	36.4	37.4	36.7	37.4	37.1	36.6	37.4
30	37.4		36.7	36.4	37.4	36.7	37.5	37.1	36.8	37.4
31	37.3	37.1	36.7	36.4	37.4	36.7	37.5	37.1	36.6	37.4
32	37.4	37.2	36.6	36.4	37.4	36.7	37.5	37.1	36.6	37.4
33	37.4	37.2	36.7	36.4	37.4	36.8	37.5	37.1	36.6	37.6
34	37.3	37.2	36.7	36.4	37.4	36.8	37.5	37.1	36.7	37.5
35	37.4	37.2	36.7	36.4	37.4	36.7	37.6	37.2	36.6	37.5
36	37.3	37.2	36.8	36.4	37.4	36.7	37.6	37.1	36.4	37.5
37	37.4	37.2	36.8	36.4	37.4	36.7	37.6	37.1	36.5	37.5
38	37.5	37.2	36.8	36.4	37.4	36.7	37.6	37.1	36.6	37.5
39	37.4	37.3	36.8	36.4	37.4	36.7	37.5	37.1	36.7	37.5
40		37.3	36.9	36.4	37.4	36.7	37.6	37.1	36.6	37.6
41			36.8	36.4	37.4	36.7	37.6	37.1	36.7	37.6
42			36.8	36.4	37.4	36.7	37.6	37.2	36.7	37.6
43	37.6		36.8	36.4	37.4	36.7	37.6	37.2	36.7	37.6
44	37.5		36.8	36.4	37.5	36.7	37.7	37.2	36.6	37.6
45	37.4		36.8	36.5	37.4	36.7	37.7	37.2	36.6	37.6
46		37.4	36.9	36.5	37.4	36.7	37.7	37.2	36.7	37.6
47		37.4	36.9	36.5	37.5	36.7	37.7	37.2	36.8	37.6
48		37.4	36.9	36.5	37.5	36.7	37.5	37.2	37	37.6
49		37.4	36.9	36.5	37.4	36.7	37.6	37.2	36.9	37.6
50	37.5	37.4	36.9	36.5	37.4	36.7	37.6	37.2	36.9	37.6
51		37.4	36.8	36.5	37.4	36.7	37.5	37.2	36.9	37.6
52	37.7	37.4	36.7	36.4	37.3	36.7	37.5	37.2	36.7	37.5
53	37.5	37.4	36.7	36.4	37.2	36.7	37.5	37.1	36.7	37.5
54		37.3	36.7	36.4	37.2	36.7	37.4	37.1	36.6	37.4
55	37.5	37.2	36.7	36.4	37.1	36.6	37.4	37.1	36.6	37.4
56	37.5	37.2	36.7	36.4	37.1	36.6	37.4	37.1	36.6	37.4
57	37.4	37.1	36.7	36.4	37.2	36.6	37.4	37.1	36.7	37.3
58	37.4	37.1	36.8	36.4	37.2	36.6	37.4	37.1	36.9	37.3
59	37.4	37	36.8	36.4	37.2	36.6	37.4	37.1	36.9	37.4
60	37.3	37	36.8	36.4	37.2	36.6	37.4	37.1	36.8	37.4
61	37.3	37	36.8	36.4	37.2	36.6	37.4	37.1	36.7	37.4
62	37.2	37	36.8	36.4	37.3	36.7	37.5	37.1	36.6	37.4
63	37.2	36.9	36.8	36.4	37.2	36.6	37.4	37.1	36.9	37.5
64	37.2	36.9	36.8	36.4	37.2	36.6	37.4	37.1	36.9	37.5
65	37.2	36.9	36.8	36.4	37.2	36.7	37.4	37.1	36.9	37.5

Test 12, Subjects 6 to 10

TIME (min)	SUBJECT 6		SUBJECT 7		SUBJECT 8		SUBJECT 9		SUBJECT 10	
	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR
1	36.8	36.8	37	36.8	36.9	36.6	37.4	37.1	36.9	36.7
2	36.8	36.9	37	36.8	36.9	36.7	37.3	37.1	36.9	36.8
3	36.7	36.8	37	36.8	36.9	36.7	37.3	37.1	36.9	36.8
4	36.6	36.9	37	36.8	36.9	36.7	37.4	37.1	36.9	36.9
5	36.7	36.8	37	36.8	37	36.7	37.4	37.2	36.9	36.9
6	36.9	36.8	37	36.8	37	36.7	37.5	37.2	37	37
7	36.9	36.8	37	36.8	37	36.8	37.6	37.2		37
8	36.9	36.9	36.9	36.8	37	36.8	37.6	37.2		37
9	37	36.9	37.1	36.7	37	36.8	37.6	37.2		37.1
10	36.9	36.9	37.1	36.7	37.1	36.9	37.6	37.2		37.1
11	36.8	36.9	37	36.8	37.1	36.9	37.6	37.3		37.2
12	37.1	36.9	37.1	36.8	37.1	36.9	37.6	37.3	37	37.2
13	37.1	36.9	37.1	36.8	37.2	36.9	37.7	37.3	37.1	37.2
14	37.1	37	37.1	36.8	37.1	36.9	37.7	37.3	37.1	37.2
15	37.2	37	37.1	36.8	37.1	36.9	37.7	37.2	37.2	37.2
16	37.2	37.1	37.1	36.8	37.2	36.9	37.7	37.2	37.3	37.2
17	37.1	37.1	37.1	36.7	37.1	36.9	37.7	37.1	37.3	37.2
18	37.2	37.1	37	36.7	37.2	36.9	37.7	37.1	37.4	37.2
19	37.2	37.1	37.1	36.7	37.3	36.9	37.6	37.1	37.3	37.2
20	37.3	37.1	37.2	36.7	37.2	36.9	37.7	37.1	37.4	37.2
21	37.2	37.1	37.2	36.7	37.3	37	37.6	37	37.4	37.2
22	37.1	37.1	37.2	36.7	37.2	37	37.7	37.1	37.4	37.2
23	37.3	37.1	37.2	36.8	37.3	37	37.6	37.1	37.4	37.2
24	37.4	37.1	37.2	36.8	37.3	37	37.7	37.1	37.4	37.2
25	37.3	37.1	37.2	36.8	37.3	37	37.8	37		37.2
26	37.4	37.2	37.2	36.7	37.3	37	37.8	37	37.1	37.2
27	37.4	37.2	37.2	36.6	37.4	37	37.8	37	37.2	37.2
28	37.3	37.2	37.2	36.6	37.5	37	37.7	37	37.3	37.2
29	37.4	37.3	37.2	36.6	37.3	37	37.9	37	37.4	37.2
30	37.4	37.3	37.3	36.6	37.4	37	37.8	37	37.4	37.2
31	37.4	37.3	37.2	36.6	37.4	37	37.8	37	37.4	37.2
32	37.5	37.3	37.3	36.7	37.4	37	37.9	37	37.4	37.2
33	37.3	37.3	37.2	36.7	37.5	37	37.8	37	37.5	37.2
34	37.5	37.3	37.3	36.7	37.4	37	37.8	37	37.5	37.2
35	37.4	37.3	37.3	36.7	37.4	37	37.9	37	37.5	37.2
36	37.5	37.3	37.3	36.6	37.5	37	37.9	37	37.5	37.2
37	37.6	37.3	37.3	36.6	37.5	37	37.9	37	37.6	37.2
38	37.5	37.3	37.3	36.6	37.4	37	38	37.1	37.7	37.2
39	37.6	37.3	37.2	36.6	37.5	37	38	37.1	37.7	37.2
40	37.6	37.3	37.3	36.6	37.5	37	37.9	37	37.6	37.2
41	37.5	37.3	37.3	36.6	37.4	37	37.9	37	37.6	37.2
42	37.4	37.4	37.3	36.7	37.5	37	37.9	36.9	37.6	37.2
43	37.6	37.4	37.3	36.7	37.3	37	37.9	36.9	37.5	37.2
44	37.7	37.4	37.4	36.8	37.4	37	38	36.9	37.6	37.2
45	37.5	37.4	37.3	36.7	37.5	37	37.9	36.9	37.6	37.2
46	37.6	37.4	37.3	36.7	37.5	37	38	36.9	37.6	37.2
47	37.7	37.4	37.4	36.7	37.4	37	38.1	36.9	37.6	37.2
48	37.6	37.5	37.3	36.7	37.4	37	37.9	36.9	37.7	37.2
49	37.5	37.5	37.3	36.7	37.4	37	37.9	36.9	37.6	37.2
50	37.6	37.4	37.3	36.6	37.4	37	37.9	36.8	37.5	37.2
51	37.6	37.4	37.3	36.6	37.4	37	37.8	36.8	37.5	37.2
52	37.6	37.4	37.3	36.5	37.4	37	37.8	36.7	37.6	37.2
53	37.6	37.4	37.2	36.5	37.4	37	37.8	36.7	37.5	37.1
54	37.5	37.4	37.2	36.5	37.3	37	37.8	36.7	37.5	37.1
55	37.4	37.3	37.2	36.5	37.3	37	37.8	36.7	37.5	37.1
56	37.4	37.3	37.2	36.5	37.3	37	37.8	36.7	37.5	37.1
57	37.4	37.2	37.2	36.5	37.3	36.9	37.8	36.6	37.5	37.1
58	37.4	37.2	37.2	36.5	37.2	37	37.8	36.6	37.5	37.1
59	37.4	37.2	37.2	36.5	37.2	37	38	36.6	37.5	37.1
60	37.3	37.2	37.2	36.6	37.2	37	37.9	36.7	37.5	37.1
61	37.4	37.3	37.2	36.6	37.2	37	37.9	36.7	37.5	37.1
62	37.4	37.3	37.2	36.6	37.2	37	37.8	36.7	37.5	37.1
63	37.4	37.3	37.2	36.6	37.3	37	37.8	36.8	37.5	37.1
64	37.4	37.3	37.2	36.6	37.3	37	37.8	36.8	37.5	37.1
65	37.4	37.3	37.2	36.6	37.2	37	37.8	36.8	37.5	37.1

Test 13, Subjects 1 to 5

TIME (min)	SUBJECT 1		SUBJECT 2		SUBJECT 3		SUBJECT 4		SUBJECT 5	
	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR
1	36.8	36.5	36.5	36.2	37.1	37	37.4	37.1	36.7	36.8
2	36.9	36.5	36.4	36.1	37	37	37.3	37.1	36.6	36.8
3	36.9	36.5	36.4	36.1	37	37	37.3	37.1	36.8	36.9
4	36.9	36.6	36.3	36.1	37.1	37.1	37.3	37.2	36.8	37
5	37	36.6	36.4	36.1	37.1	37.1	37.4	37.2	36.9	37.1
6	37	36.6	36.6	36.2	37.1	37.1	37.5	37.2	37	37.2
7	37.1	36.7	36.6	36.2	37.1	37.1	37.5	37.3	37	37.3
8	37.1	36.7	36.7	36.2	37.2	37.1	37.5	37.3	37	37.4
9	37.2	36.7	36.7	36.2	37.2	37.2	37.6	37.3	37	37.4
10	37.2	36.7	36.6	36.3	37.2	37.2	37.5	37.3	37	37.5
11	37.2	36.7	36.6	36.3	37.2	37.2	37.5	37.3	36.8	37.5
12	37.1	36.7	36.7	36.3	37.2	37.2	37.5	37.3	37	37.5
13	37.2	36.7	36.7	36.3	37.2	37.2	37.5	37.3	36.9	37.6
14	37.2	36.7	36.6	36.3	37.2	37.2	37.6	37.3	37	37.6
15	37.2	36.7	36.7	36.3	37.2	37.2	37.7	37.3	37.1	37.7
16	37.2	36.7	36.8	36.3	37.2	37.2	37.7	37.3	37.1	37.7
17	37.2	36.7	36.8	36.3	37.2	37.2	37.7	37.3	37.2	37.7
18	37.2	36.7	36.8	36.3	37.2	37.2	37.7	37.3		37.7
19	37.2	36.7	36.9	36.3	37.3	37.2	37.7	37.4	37.2	37.7
20	37.3	36.8	36.7	36.4	37.3	37.2	37.7	37.4	37.1	37.8
21	37.3	36.8	36.8	36.4	37.3	37.2	37.7	37.4	37.2	37.8
22	37.2	36.8	36.8	36.4	37.3	37.2	37.7	37.4	37.1	37.8
23	37.2	36.8	36.9	36.4	37.3	37.2	37.7	37.5	37.3	37.8
24	37.2	36.8	36.9	36.4	37.3	37.2	37.7	37.5	37.3	37.9
25	37.3	36.9	36.9	36.4	37.3	37.2	37.8	37.5	37.4	37.9
26	37.3	36.9	36.9	36.5	37.3	37.2	37.9	37.5	37.4	37.9
27	37.4	36.9	36.9	36.5	37.3	37.2	37.9	37.5	37.4	37.9
28	37.4	36.9	36.9	36.5	37.3	37.3	37.9	37.5	37.3	37.9
29	37.5	36.9	36.9	36.6	37.4	37.3	37.8	37.5	37.4	37.9
30	37.4	36.9	37	36.6	37.4	37.3	37.9	37.5	37.5	38
31	37.5	36.9	37	36.6	37.4	37.3	37.9	37.5	37.4	38
32	37.5	37	37	36.6	37.4	37.3	38	37.5	37.4	38
33	37.5	37	36.9	36.7	37.4	37.3	37.9	37.6	37.4	38
34	37.4	37	37	36.7	37.4	37.3	37.9	37.6	37.5	38.1
35	37.5	37	37	36.7	37.4	37.3	38	37.6	37.6	38.1
36	37.5	37	37	36.7	37.4	37.3	38	37.6	37.7	38.1
37	37.6	37	37	36.7	37.4	37.3	38	37.6	37.7	38.1
38	37.6	37	37.1	36.7	37.3	37.3	38	37.6	37.6	38.1
39	37.5	37.1	37.1	36.7	37.4	37.3	38.1	37.6	37.6	38.1
40	37.6	37.1	37.1	36.7	37.5	37.3	38.1	37.7	37.6	38.1
41	37.6	37.1	37.1	36.7	37.5	37.3	38.1	37.7	37.7	38.2
42	37.6	37.1	37.2	36.7	37.5	37.3	38.1	37.7	37.7	38.1
43	37.6	37.1	37.2	36.7	37.5	37.3	38.1	37.7	37.6	38.1
44	37.5	37.2	37.2	36.8	37.5	37.3	38.2	37.7	37.7	38.2
45	37.6	37.2	37.2	36.8	37.5	37.3	38.2	37.7	37.8	38.2
46	37.6	37.2	37.3	36.8	37.5	37.3	38.2	37.7	38.1	38.2
47	37.6	37.2	37.2	36.8	37.5	37.4	38.3	37.7	37.9	38.2
48	37.6	37.2	37.2	36.9	37.5	37.4	38.1	37.8	37.9	38.3
49	37.7	37.2			37.5	37.4	38.1	37.7	37.9	38.3
50	37.7	37.2			37.5	37.4	38.2	37.7		38.3
51	37.6	37.1			37.5	37.5	38.1	37.7	38	38.3
52	37.6	37.1			37.5	37.5	38	37.7	38	38.3
53	37.6	37.1			37.4	37.5	37.9	37.7	37.7	38.3
54	37.5	37.1			37.4	37.5	38	37.7	38	38.3
55	37.4	37.1			37.4	37.5	37.9	37.7	37.9	38.3
56	37.4	37.1			37.4	37.5	37.9	37.7		38.3
57	37.4	37.1			37.4	37.5	37.9	37.6	37.9	38.3
58	37.3	37.1			37.4	37.5	37.8	37.6	37.8	38.3
59	37.4	37.1			37.4	37.5	37.8	37.6	37.8	38.3
60	37.3	37.1			37.4	37.5	37.8	37.6		38.3
61	37.3	37			37.4	37.5	37.8	37.5	38	38.3
62	37.3	37			37.4	37.5	37.8	37.5	38	38.3
63	37.3	37			37.5	37.5	37.8	37.5	37.8	38.3
64	37.2	37			37.4	37.6	37.8	37.5	37.8	38.3
65	37.2	37			37.4	37.5	37.8	37.5	37.9	38.3

Test 13, Subjects 6 to 10

TEST (min)	SUBJECT 6		SUBJECT 7		SUBJECT 8		SUBJECT 9		SUBJECT 10	
	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR
1	36.8	36.9	37.3	36.9	37.4	37.4	37.1	36.7	36.8	36.6
2	36.8	36.9	37.2	36.9	37.5	37.4	37.1	36.7	36.8	36.6
3	36.7	36.8	37.2	36.9	37.5	37.4	37.1	36.7	36.8	36.6
4	36.6	36.8	37.3	36.9	37.4	37.4	37.2	36.7	36.8	36.6
5	36.7	36.8	37.4	36.9	37.5	37.4	37.1	36.8	36.9	36.6
6	36.8	36.8	37.5	36.9	37.5	37.4	37.2	36.8	37	36.6
7	36.9	36.8	37.6	36.9	37.5	37.4	37.2	36.8	37	36.6
8	36.8	36.9	37.6	36.9	37.5	37.4	37.3	36.8	37.1	36.7
9	36.9	36.9	37.6	37	37.6	37.5	37.2	36.8	37	36.7
10	36.9	36.9	37.6	37	37.6	37.5	37.3	36.9	37.1	36.7
11	37	36.9	37.6	37	37.7	37.5	37.4	36.9	37.1	36.7
12	36.9	36.9	37.6	37	37.6	37.5	37.5	36.9	37.2	36.8
13	36.8	36.9	37.6	37	37.6	37.5	37.4	36.9	37.2	36.8
14	37	36.9	37.5	37	37.6	37.5	37.5	36.9	37.2	36.8
15	37.1	36.9	37.4	37	37.7	37.5	37.5	36.9	37.3	36.8
16	37.1	36.9	37.4	37	37.7	37.6	37.5	36.9	37.4	36.8
17	37.1	37	37.4	37	37.6	37.6	37.5	36.9	37.3	36.8
18	37.1	37	37.4	37	37.6	37.6	37.5	36.9	37.4	36.8
19	37.1	37.1	37.4	36.9	37.7	37.6	37.3	36.9	37.4	36.8
20	37.1	37.1	37.4	36.9	37.7	37.6	37.5	36.9	37.4	36.9
21	37.2	37.1	37.5	36.9	37.8	37.6	37.5	36.9	37.4	36.9
22	37.2	37.1	37.4	36.9	37.7	37.6	37.6	36.8	37.4	36.9
23	37.2	37.1	37.4	37	37.8	37.5	37.5	36.8	37.4	36.9
24	37.2	37.2	37.4	37	37.8	37.6	37.6	36.8	37.4	36.9
25	37.3	37.1	37.5	37	37.8	37.6	37.6	36.9	37.5	37
26	37.3	37.2	37.5	36.9	37.8	37.6	37.6	36.9	37.6	37
27	37.3	37.2	37.4	36.9	37.8	37.6	37.6	36.9	37.5	37
28	37.2	37.2	37.4	36.9	37.9	37.6	37.6	36.9	37.6	37
29	37.4	37.2	37.5	36.9	37.8	37.6	37.6	37	37.6	37
30	37.4	37.3	37.5	36.9	37.9	37.6	37.6	37	37.6	37
31	37.3	37.3	37.5	36.9	37.9	37.6	37.6	37	37.6	37.1
32	37.3	37.3	37.5	36.9	37.8	37.7	37.7	37	37.6	37.1
33	37.5	37.3	37.4	36.9	37.9	37.7	37.7	37	37.6	37.1
34	37.4	37.3	37.5	36.9	37.9	37.7	37.6	37	37.6	37.1
35	37.5	37.3	37.5	36.9	37.9	37.7	37.7	37	37.7	37.2
36	37.5	37.4	37.5	36.9	37.9	37.7	37.7	37	37.8	37.2
37	37.6	37.4	37.5	36.9	37.7	37.7	37.7	37	37.8	37.2
38	37.3	37.4	37.5	36.8	37.9	37.7	37.7	37	37.8	37.2
39	37.5	37.5	37.5	36.8	38	37.7	37.6	37.1	37.8	37.2
40	37.6	37.5	37.5	36.8	38	37.7	37.6	37.1	37.8	37.2
41	37.6	37.5	37.5	36.9	37.9	37.7	37.7	37.1	37.8	37.3
42	37.6	37.5	37.5	36.9	38	37.7	37.7	37.1	37.7	37.3
43	37.5	37.5	37.5	36.9	38	37.7	37.7	37.1	37.8	37.3
44	37.6	37.5	37.5	36.9	38	37.7	37.8	37.1	37.9	37.3
45	37.7	37.6	37.5	36.9	38	37.7	37.8	37.1	37.9	37.3
46	37.7	37.6	37.5	36.9	38	37.7	37.7	37.1	37.9	37.4
47	37.6	37.6	37.5	36.9	38	37.7	37.7	37.1	38	37.4
48	37.6	37.6	37.5	36.9	37.9	37.7	37.6	37.1	38	37.4
49	37.7	37.6	37.5	36.8	38	37.7	37.7	37.2	37.9	37.4
50	37.7	37.6	37.4	36.8	37.9	37.7	37.6	37.2	37.9	37.4
51	37.6	37.6	37.4	36.8	38	37.7	37.6	37.2	37.8	37.4
52	37.5	37.6	37.4	36.8	37.9	37.7	37.6	37.1	37.8	37.4
53	37.5	37.5	37.4	36.8	37.9	37.7	37.6	37.1	37.8	37.4
54	37.5	37.5	37.4	36.8	37.9	37.6	37.6	37.1	37.8	37.4
55	37.5	37.5	37.3	36.7	37.8	37.6	37.6	37.1	37.8	37.4
56	37.5	37.5	37.3	36.7	37.9	37.6	37.5	37.1	37.7	37.4
57	37.5	37.5	37.3	36.7	37.9	37.6	37.5	37.1	37.7	37.4
58	37.5	37.5	37.3	36.7	37.9	37.7	37.6	37.1	37.7	37.4
59	37.5	37.5	37.3	36.7	37.9	37.6	37.5	37.1	37.7	37.4
60	37.5	37.5	37.3	36.7	37.8	37.6	37.6	37.1	37.7	37.4
61	37.5	37.5	37.3	36.7	37.9	37.6	37.6	37.1	37.7	37.4
62	37.5	37.5	37.3	36.8	37.8	37.6	37.6	37.1	37.6	37.4
63	37.5	37.5	37.4	36.8	37.8	37.6	37.6	37.1	37.6	37.4
64	37.5	37.5	37.3	36.8	37.8	37.6	37.6	37.1	37.6	37.4
65	37.5	37.5	37.4	36.8	37.8	37.6	37.6	37.1	37.6	37.4

Test 14, Subjects 1 to 5

TIME (min)	SUBJECT 1		SUBJECT 2		SUBJECT 3		SUBJECT 4		SUBJECT 5	
	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR
1	36.7	35.9	36.5	36.3	36.9	36.3	37.2	36.8	36.8	36.5
2	36.7	35.9	36.6	36.3	36.8	36.3	37.2	36.8	36.7	36.5
3	36.7	35.9	36.6	36.3	36.9	36.4	37.2	36.8	36.8	36.5
4	36.7	35.9	36.6	36.3	36.9	36.5	37.2	36.8	36.9	36.6
5	36.7	35.9	36.7	36.3	37	36.5	37.3	36.8	36.8	36.7
6	36.8	35.9	36.8	36.3	37	36.5	37.4	36.9	37	36.7
7	36.8	36	36.9	36.4	37.1	36.6	37.4	36.9	37.1	36.8
8	36.9	36.1	36.9	36.4	37.2	36.6	37.4	36.9	37	36.8
9	37	36.1	36.9	36.4	37.2	36.6	37.4	36.9	37.2	36.9
10	37.1	36.2	37	36.5	37.2	36.6	37.4	36.9	37.1	36.9
11	37.1	36.2	36.9	36.5	37.2	36.6	37.3	36.9	36.9	36.9
12	37.2	36.2	37	36.6	37.2	36.7	37.5	36.9	37.1	36.9
13	37.1	36.2	36.9	36.6	37.2	36.6	37.5	36.9	37.2	36.9
14	37.2	36.2	36.9	36.6	37.2	36.6	37.5	36.9	37	37
15	37.2	36.2	36.9	36.6	37.2	36.6	37.6	36.9	36.9	37
16	37.1	36.3	37	36.6	37.1	36.6	37.6	36.9	37.2	37
17	37.1	36.3	36.9	36.6	37.1	36.6	37.6	36.9	37.2	37
18	37.2	36.3	36.9	36.6	37.2	36.6	37.5	37	37	37
19	37.3	36.3	36.9	36.7	37.2	36.6	37.5	37	37.2	37
20	37.3	36.3	36.9	36.7	37.2	36.6	37.6	37	37.2	37.1
21	37.3	36.3	36.9	36.7	37.3	36.6	37.5	37	37.1	37.1
22	37.3	36.4	36.9	36.8	37.3	36.6	37.6	37	37.4	37.1
23	37.4	36.4	36.9	36.8	37.2	36.6	37.7	37	37.3	37.1
24	37.4	36.4	37	36.8	37.3	36.6	37.6	37	37.3	37.2
25	37.4	36.5	36.9	36.8	37.2	36.7	37.7	37	37.4	37.2
26	37.4	36.5	37	36.8	37.2	36.7	37.8	37	37.5	37.2
27	37.4	36.6	37.1	36.8	37.2	36.7	37.8	37	37.5	37.2
28	37.3	36.6	37	36.8	37.3	36.7	37.7	37.1	37.5	37.3
29	37.5	36.6	37.1	36.9	37.3	36.7	37.7	37.1	37.4	37.3
30	37.5	36.6	37.1	36.9	37.3	36.7	37.7	37.1	37.5	37.3
31	37.6	36.7	37.1	36.9	37.3	36.7	37.7	37.1	37.5	37.3
32	37.5	36.7	37	36.9	37.3	36.6	37.8	37.1	37.5	37.3
33	37.5	36.7	37.1	36.9	37.3	36.6	37.8	37.1	37.6	37.4
34	37.6	36.7	37.1	37	37.3	36.6	37.8	37.2	37.4	37.4
35	37.6	36.7	37.1	37	37.3	36.6	37.9	37.2	37.6	37.4
36	37.6	36.7	37.2	37	37.3	36.6	37.9	37.2	37.7	37.4
37	37.6	36.8	37.2	37	37.3	36.6	37.9	37.2	37.7	37.5
38	37.7	36.8	37.2	37	37.3	36.6	37.9	37.1	37.6	37.5
39	37.7	36.8	37.2	37	37.3	36.7	37.8	37.2	37.7	37.5
40	37.7	36.8	37.2	37	37.3	36.7	37.9	37.2	37.8	37.5
41	37.7	36.8	37.2	37	37.3	36.7	37.9	37.2	37.7	37.5
42	37.7	36.9	37.3	37	37.3	36.7	38	37.2	37.8	37.5
43	37.7	36.9	37.3	37	37.3	36.7	38	37.2	37.8	37.6
44	37.7	37	37.3	37	37.3	36.7	38	37.2	37.9	37.6
45	37.7	37	37.3	37.1	37.4	36.7	38	37.2	37.9	37.6
46	37.8	37	37.3	37.1	37.3	36.7	38	37.2	38	37.7
47	37.8	37.1	37.4	37.1	37.4	36.7	38	37.2	38	37.7
48	37.8	37.1	37.3	37.1	37.3	36.7	37.9	37.2	37.9	37.7
49	37.8	37.1	37.3	37.1	37.3	36.7	38	37.2	37.8	37.8
50	37.8	37	37.3	37.1	37.3	36.7	38	37.2	37.9	37.8
51	37.7	37	37.2	37.1	37.3	36.8	37.8	37.2	37.8	37.8
52	37.6	37	37	37.2	37.2	36.8	37.6	37.2	37.7	37.8
53	37.4	37	36.9	37.2	37.1	36.8		37.2	37.7	37.8
54	37.4	37.1	36.8	37.3	37	36.9		37.3	37.7	37.8
55	37.2	37.1	36.7	37.4	37	36.9	37.6	37.4	37.6	37.9
56	37.2	37.1	36.8	37.5	37	37	37.6	37.4	37.5	36.7
57	37.1	35.8	36.8	37.5	37	36.5	37.5	37.5	37.2	36.6
58	36.9	35.7	36.8	37.6	37	36.5	37.5	37.5	37.3	36.6
59	37.1	35.7	36.8	37.6	37	36.4	37.5	37.5	37.3	36.5
60	36.8	35.6	36.8	36.6	37	36.4	37.5	37.5	37.3	36.5
61	36.9	35.6	36.8	36.5	37.1	36.4	37.5	37.2	37.3	36.4
62	36.9	35.6	36.8	36.5	37.1	36.4	37.5	37.1	37.3	36.3
63	37	35.5	36.8	36.5	37.1	36.4	37.5	37.1	37.3	36.3
64	37	35.5	36.8	36.5	37.1	36.3	37.6	37.1	37.3	36.2
65	37	35.5	36.8	36.4	37.1	36.3	37.6	37.1	37.3	36.2

Test 14, Subjects 6 to 10

TIME (min)	SUBJECT 6		SUBJECT 7		SUBJECT 8		SUBJECT 9		SUBJECT 10	
	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR
1	37.4	37.2	36.7	36.4	37.4	37.1	37	36.7	37	36.8
2	37.2	37.2	36.7	36.4	37.4	37.1	37	36.7	37	36.9
3	37.2	37.2	36.7	36.3	37.4	37.2	37	36.7	37	36.9
4	37	37.2	36.8	36.3	37.4	37.2	37	36.8	37.1	37
5	37.2	37.2	36.8	36.3	37.4	37.2	37.1	36.8	37.1	37
6	37.2	37.2	36.8	36.3	37.5	37.3	37.1	36.8	37.1	37.1
7	37.3	37.2	36.8	36.3	37.6	37.3	37	36.8	37.2	37.1
8	37.4	37.2	36.8	36.3	37.6	37.3	37.1	36.8	37.4	37.1
9	37.3	37.3	36.8	36.3	37.6	37.4	37.1	36.9	37.4	37.1
10	37.4	37.3	36.8	36.3	37.6	37.4	37.2	36.9	37.3	37.2
11	37.2	37.3	36.8	36.3	37.7	37.4	37.3	36.9	37.5	37.2
12	37.4	37.3	36.8	36.3	37.7	37.4	37.3	37	37.5	37.3
13	37.5	37.3	36.9	36.3	37.7	37.4	37.3	37	37.5	37.3
14	37.4	37.3	36.8	36.3	37.7	37.4	37.2	37	37.6	37.3
15	37.5	37.3	36.9	36.3	37.7	37.4	37.3	37	37.5	37.3
16	37.5	37.3	36.9	36.3	37.8	37.4	37.3	36.9	37.6	37.3
17	37.5	37.3	36.9	36.3	37.7	37.4	37.4	36.9	37.6	37.3
18	37.5	37.3	36.9	36.3	37.7	37.4	37.2	36.9	37.7	37.3
19	37.4	37.3	36.9	36.3	37.7	37.4	37.4	37	37.7	37.3
20	37.6	37.3	36.9	36.3	37.8	37.4	37.3	37	37.7	37.3
21	37.7	37.3	36.9	36.3	37.7	37.4	37.3	37	37.7	37.4
22	37.6	37.4	36.9	36.3	37.8	37.4	37.5	37	37.7	37.4
23	37.6	37.4	37	36.3	37.7	37.5	37.5	37	37.8	37.4
24	37.5	37.4	37	36.4	37.7	37.5	37.4	37	37.8	37.4
25	37.6	37.4	37	36.4	37.9	37.5	37.5	37	37.7	37.4
26	37.6	37.4	37	36.4	37.8	37.5	37.5	37	37.9	37.5
27	37.7	37.4	37	36.4	37.9	37.5	37.5	37	37.7	37.5
28	37.6	37.4	37	36.4	37.9	37.5	37.4	37	37.6	37.5
29	37.6	37.5	37	36.4	37.9	37.5	37.5	37	37.9	37.5
30	37.7	37.5	37	36.4	38	37.5	37.4	37	37.9	37.6
31	37.7	37.6	37	36.4	37.9	37.5	37.4	37	37.9	37.6
32	37.8	37.5	37	36.4	38	37.5	37.3	37	37.9	37.6
33	37.7	37.5	37.1	36.4	38.1	37.5	37.4	37	37.9	37.6
34	37.7	37.4	37.1	36.4	37.9	37.5	37.4	37	38	37.7
35	37.7	37.4	37.1	36.4	38	37.5	37.5	37	37.9	37.7
36	37.7	37.4	37.1	36.4	38	37.5	37.5	37	37.9	37.7
37	37.7	37.5	37.1	36.4	38	37.5	37.5	37	37.8	37.7
38	37.7	37.5	37.1	36.4	38	37.5	37.5	37.1	37.9	37.7
39	37.8	37.5	37.1	36.4	38.1	37.5	37.5	37.1	38	37.8
40	37.8	37.5	37.1	36.4	38	37.5	37.5	37.1	38.1	37.8
41	37.8	37.5	37.1	36.4	38.1	37.5	37.5	37.1	38.1	37.8
42	37.8	37.5	37.1	36.4	38.1	37.5	37.4	37.1	38.1	37.8
43	37.7	37.5	37.1	36.4	38	37.5	37.4	37.1	38	37.9
44	37.8	37.5	37.2	36.4	38	37.5	37.5	37.1	38.1	37.9
45	37.8	37.6	37.2	36.4	38	37.5	37.5	37.1	38.1	37.9
46	37.8	37.6	37.1	36.4	38.1	37.5	37.5	37.1	38.2	37.9
47	37.9	37.6	37.2	36.4	38.1	37.6	37.6	37.1	38.1	37.9
48	37.7	37.6	37.1	36.4	38.1	37.6	37.4	37.1	38.3	38
49	37.8	37.6	37.1	36.4	38.1	37.6	37.5	37.1	38.1	38
50	37.7	37.6	37.1	36.4	38	37.5	37.5	37.1	38.2	38
51	37.7	37.5	37.1	36.4	38	37.5	37.4	37.1	38.1	38
52	37.6	37.5	37	36.4	38.1	37.5	37.4	37.1	38	38
53	37.6	37.6	37	36.4	38	37.5	37.3	37.1	37.9	38
54	37.4	37.5	37	36.4	37.9	37.6	37.3	37.1	37.8	38
55	37.4	37.5	36.9	36.5	37.9	37.6	37.3	37.1	37.6	38
56	37.3	37.5	36.9	36.5	37.9	37.7	37.3	37.2	37.6	38
57	37.4	37.6	36.9	36.5	37.8	37.8	37.3	37.2	37.5	38
58	37.4	37.6	36.9	36.5	37.8	37.8	37.3	36.6	37.5	38
59	37.4	37.3	37	36.6	37.8	37.8	37.3	36.6	37.5	36.7
60	37.4	37.3	37	36.5	37.6	37.2	37.3	36.6	37.5	36.7
61	37.3	37.3	37	36.5	37.7	37.3	37.3	36.6	37.5	36.7
62	37.4	37.2	37	36.4	37.7	37.3	37.3	36.6	37.5	36.6
63	37.5	37.2	37	36.3	37.6	37.3	37.3	36.6	37.5	36.6
64	37.5	37.2	37	36.3	37.7	37.3	37.3	36.5	37.6	36.5
65	37.5	37.2	37	36.2	37.6	37.3	37.3	36.5	37.6	36.5

Test 15, Subjects 1 to 5

TIME (min)	SUBJECT 1		SUBJECT 2		SUBJECT 3		SUBJECT 4		SUBJECT 5	
	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR
1	36.8	36.7	36	36.2	36.6	36.8	37	36.9	36.9	36.6
2	36.8	36.7	35.9	36.2	36.5	36.9	37.1	36.9	36.9	36.6
3	36.8	36.7	35.8	36.2	36.4	36.9	37	36.9	36.8	36.6
4	36.8	36.7	35.9	36.2	36.4	37	37	37	36.9	36.7
5	36.8	36.7	36		36.5	37	37.1	37	37	36.7
6	36.9	36.8	36.1	36.3	36.5	37	37.1	37	37.1	36.8
7	36.8	36.8	36.1	36.3	36.3	37	37.1	37	37	36.8
8	37	36.9	36.1	36.3	36.3	37.1	37.1	37	37.3	36.9
9	37	36.9	36.1	36.3	36.4	37.1	37.1	37.1	37.3	36.9
10	37	36.9	36		36.5	37.1	37.1	37.1	37.4	36.9
11	37	36.9	36.1		36.4	37.1	37.1	37.1	37.1	37
12	37.1	36.9	35.9	36.3	36.4	37.1	37.1	37.2	37.2	37
13	37	36.9	36	36.3	36.5	37.1	37.2	37.2	37.4	37
14	37	36.8	36	36.3	36.5	37.1	37.1	37.2	37.4	37
15	37	36.8	36.1	36.3	36.6	37.1	37.3	37.2	37.2	37
16	37.1	36.8	36.1		36.7	37.1	37.3	37.2	37.3	37
17	37	36.9	36.2	36.3	36.5	37.1	37.4	37.2	37.3	37
18	37	36.9	36	36.3	36.5	37.1	37.2	37.2	37.3	37
19	37	36.9	36	36.3	36.5	37.1	37.3	37.2	37.4	37
20	37.1	36.8	36.2	36.3	36.5	37.1	37.2	37.2	37.3	37
21	37.1	36.8	36.1		36.5	37.1	37.2	37.2	37.4	37
22	37.1	36.8	36.1		36.5	37.1	37.3	37.3	37.5	37
23	37.1	36.8	36.2	36.3	36.5	37.1	37.1	37.3	37.5	37
24	37.2	36.9	36.1	36.3	36.5	37.1	37.4	37.3	37.3	37
25	37.2	36.9	36.1	36.3	36.6	37.1	37.5	37.3	37.4	37
26	37.2	36.9	36.1	36.3	36.6	37.1	37.5	37.3	37.4	37
27	37.2	37	36.1		36.5	37	37.4	37.3	37.5	37
28	37.2	37	36.1	36.4	36.5	37	37.4	37.3	37.5	37.1
29	37.2	37	36.1	36.4	36.5	37	37.3	37.3	37.6	37.1
30	37.2	37	36.2	36.4	36.5	37	37.4	37.3	37.6	37.1
31	37.2	37	36.2	36.5	36.6	37	37.5	37.3	37.4	37.1
32	37.3	37	36.3		36.6	37	37.5	37.3	37.6	37.1
33	37.3	37	36.3	36.5	36.5	37	37.5	37.4	37.6	37.1
34	37.4	37	36.2	36.5	36.5	37	37.5	37.4	37.6	37.2
35	37.3	37.1	36.2	36.5	36.7	37	37.6	37.4	37.6	37.2
36	37.3	37.1	36.3	36.5	36.6	37	37.6	37.4	37.6	37.2
37	37.3	37.1	36.2		36.5	37	37.6	37.4	37.6	37.2
38	37.4	37.1	36.2	36.5	36.5	37	37.6	37.4	37.7	37.2
39	37.4	37.1	36.3	36.5	36.5	37	37.5	37.4	37.7	37.2
40	37.4	37.1	36.3	36.5	36.5	37	37.6	37.4	37.7	37.2
41	37.4	37.2	36.2	36.5	36.5	37	37.4	37.4	37.8	37.3
42	37.4	37.2	36.3	36.5	36.5	37	37.6	37.4	37.8	37.3
43	37.4	37.2	36.4	36.5	36.5	37	37.6	37.4	37.7	37.3
44	37.5	37.2	36.3	36.5	36.5	37	37.7	37.5	37.7	37.3
45	37.5	37.2	36.4	36.5	36.6	37	37.7	37.5	37.6	37.3
46	37.5	37.2	36.6		36.6	36.9	37.8	37.5	37.7	37.3
47	37.5	37.2	36.4	36.5	36.5	37	37.7	37.5	37.7	37.3
48	37.5	37.2	36.5	36.6	36.5	36.9	37.5	37.5	37.8	37.3
49	37.5	37.2	36.4	36.6	36.6	36.9	37.5	37.5	37.7	37.3
50	37.4	37.2	36.4	36.5	36.6	36.9	37.5	37.5	37.5	37.3
51	37.4	37.1	36.4		36.5	36.9	37.6	37.4	37.5	37.3
52	37.4	37.1	36.4		36.5	36.9	37.4	37.4	37.7	37.2
53	37.2	37	36.3	36.5	36.5	36.9	37.4	37.4	37.4	37.2
54	37.2	37	36.2	36.5	36.5	36.9	37.3	37.4		37.2
55	37	37	36.2	36.5	36.5	36.9	37.3	37.3	37.6	37.1
56	37	37	36.3	36.5	36.6	36.9	37.3	37.3	37.7	37.1
57	37	37	36.3		36.6	36.9	37.3	37.3	37.5	37.1
58	37	36.9		36.4	36.6	36.9	37.3	37.3	37.3	37.1
59	37	36.9	36.4	36.4	36.7	36.9	37.3	37.3	37.7	37.1
60	37	36.9	36.4	36.4	36.7	37	37.3	37.3	37.7	37.1
61	37	36.9	36.4	36.4	36.7	37	37.4	37.3	37.5	37.1
62	37	36.9	36.5	36.5	36.6	37	37.3	37.3	37.8	37.1
63	37	36.9	36.4	36.5	36.7	37	37.3	37.3	37.6	37.1
64	37	36.9	36.5	36.5	36.7	37	37.3	37.3	37.4	37.1
65	37	36.9	36.5		36.7	37	37.3	37.3	37.5	37.1

Test 15, Subjects 6 to 10

TIME (min)	SUBJECT 6		SUBJECT 7		SUBJECT 8		SUBJECT 9		SUBJECT 10	
	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR
1	37.2	37.2	36.9	36.7	37	36.7	37.2	36.9	36.8	36.4
2	37	37.3	36.8	36.8	37.1	36.7	37.3	36.9	36.8	36.4
3	37	37.3	36.8	36.8	37	36.7	37.3	37	36.8	36.5
4	37	37.3	36.8	36.7	37	36.8	37.3	37	36.8	36.6
5	37.1	37.3	36.9	36.7	37	36.8	37.4	37	36.9	36.6
6	37.2	37.3	36.9	36.7	37.1	36.9	37.4	36.9	37	36.7
7	37.2	37.3	36.9	36.7	37.2	36.9	37.5	36.9	36.9	36.7
8	37.3	37.3	36.9	36.7	37.3	37	37.5	36.9	37.1	36.7
9	37.3	37.3	36.9	36.7	37.3	37.1	37.3	36.9	37.2	36.8
10	37.4	37.4	37	36.7	37.4	37.1	37.5	36.9	37.2	36.8
11	37.4	37.4	37	36.7	37.4	37.2	37.5	36.9	37.3	36.8
12	37.4	37.4	37	36.7	37.5	37.2	37.5	36.9	37.2	36.8
13	37.3	37.4	37	36.7	37.5	37.2	37.6	36.9	37.2	36.8
14	37.3	37.4	37.1	36.7	37.5	37.2	37.7	36.9	37.3	36.8
15	37.5	37.4	37.1	36.7	37.5	37.2	37.7	36.9	37.3	36.9
16	37.5	37.4	37.1	36.6	37.5	37.2	37.7	36.9	37.4	36.9
17	37.5	37.4	37.1	36.6	37.6	37.2	37.7	36.9	37.4	36.9
18	37.3	37.4	37.1	36.6	37.6	37.2	37.6	36.9	37.3	36.9
19	37.4	37.5	37.2	36.6	37.6	37.2	37.7	36.9	37.3	36.9
20	37.5	37.5	37.2	36.7	37.6	37.2	37.8	36.9		36.8
21	37.5	37.5	37.2	36.7	37.6	37.2	37.8	36.9		36.8
22	37.4	37.5	37.2	36.7	37.7	37.2	37.8	36.9		36.8
23	37.6	37.5	37.2	36.7	37.6	37.2	37.8	36.9	37.3	36.8
24	37.6	37.5	37.2	36.7	37.7	37.2	37.8	36.9		36.8
25	37.6	37.5	37.2	36.7	37.6	37.2	37.8	36.9		36.8
26	37.6	37.5	37.2	36.7	37.6	37.2	37.9	36.9	37.3	36.8
27	37.6	37.5	37.2	36.7	37.7	37.2	37.9	36.9	37.4	36.8
28	37.6	37.5	37.2	36.7	37.7	37.3	37.9	36.9	37.3	36.8
29	37.6	37.5	37.2	36.7	37.8	37.3	37.9	36.9	37.4	36.8
30	37.5	37.5	37.2	36.7	37.8	37.3	37.9	36.9	37.4	36.8
31	37.7	37.5	37.2	36.6	37.8	37.3	37.8	36.9	37.4	36.8
32	37.8	37.5	37.2	36.6	37.8	37.3	37.9	36.9	37.4	36.8
33	37.5	37.5	37.3	36.7	37.8	37.3	37.9	36.9	37.4	36.8
34	37.7	37.5	37.2	36.7	37.8	37.3	37.7	36.9	37.5	36.7
35	37.7	37.5	37.3	36.7	37.8	37.3	37.9	36.9	37.6	36.7
36	37.7	37.6	37.3	36.7	37.8	37.2	37.9	36.9	37.4	36.7
37	37.8	37.6	37.3	36.6	37.7	37.3	37.9	37	37.4	36.7
38	37.7	37.6	37.3	36.6	37.8	37.3	37.9	37	37.5	36.7
39	37.7	37.6	37.3	36.6	37.8	37.3	37.9	37	37.5	36.7
40	37.8	37.6	37.3	36.6	37.8	37.3	37.9	37	37.5	36.7
41	37.8	37.6	37.3	36.7	37.7	37.3	37.9	37	37.5	36.7
42	37.8	37.6	37.3	36.7	37.8	37.3	38	36.9	37.6	36.7
43	37.7	37.6	37.3	36.7	37.9	37.3	38	36.9	37.5	36.7
44	37.9	37.7	37.3	36.7	37.8	37.3	38	36.9	37.6	36.7
45	37.9	37.7	37.3	36.7	37.8	37.3	38	36.9	37.6	36.7
46	37.9	37.7	37.3	36.7	37.9	37.3	38	36.9	37.7	36.7
47	37.8	37.7	37.3	36.7	37.9	37.3	38	36.9	37.6	36.7
48	37.8	37.7	37.2	36.6	37.8	37.3	37.9	37	37.6	36.7
49	37.9	37.7	37.2	36.6	37.8	37.2	37.9	37	37.6	36.7
50	37.8	37.7	37.2	36.6	37.8	37.2	37.9	36.9	37.6	36.7
51	37.8	37.6	37.2	36.6	37.8	37.2	37.8	37	37.5	36.7
52	37.8	37.6	37.2	36.6	37.8	37.2	37.8	36.9	37.5	36.7
53	37.7	37.6	37.2	36.6	37.7	37.2	37.8	36.9	37.4	36.7
54	37.5	37.5	37.2	36.6	37.7	37.2	37.7	36.9	37.4	36.6
55	37.6	37.5	37.2	36.6	37.7	37.1	37.7	36.9	37.4	36.6
56	37.5	37.5	37.2	36.6	37.6	37.1	37.7	36.9	37.4	36.6
57	37.7	37.5	37.2	36.7	37.6	37.1	37.7	36.9	37.3	36.6
58	37.7	37.5	37.2	36.7	37.6	37.1	37.7	36.9	37.3	36.6
59	37.7	37.5	37.2	36.7	37.6	37.2	37.7	36.9	37.3	36.6
60	37.7	37.5	37.2	36.7	37.6	37.2	37.7	36.9	37.3	36.6
61	37.7	37.5	37.2	36.7	37.6	37.2	37.8	36.9	37.3	36.6
62	37.7	37.5	37.2	36.7	37.6	37.2	37.8	36.9	37.3	36.6
63	37.7	37.5	37.2	36.7	37.6	37.2	37.7	36.9	37.3	36.6
64	37.6	37.5	37.2	36.7	37.6	37.2	37.7	36.9	37.3	36.5
65	37.6	37.5	37.3	36.7	37.6	37.2	37.7	36.9	37.4	36.6

Test 16, Subjects 1 to 5

TIME (min)	SUBJECT 1		SUBJECT 2		SUBJECT 3		SUBJECT 4		SUBJECT 5	
	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR
1	36.4	36.3	36.7	36.4	37	36.6	37.2	36.8	36.9	36.5
2	36.5	36.3	36.6	36.4	36.9	36.6	37.1	36.8	36.9	36.5
3	36.5	36.3	36.6	36.4	37	36.7	37.1	36.8	37	36.5
4	36.6	36.4	36.7	36.3	37	36.7	37.1	36.8	37.1	36.5
5	36.4	36.4	36.8	36.3	37	36.7	37.2	36.8	37.2	36.5
6	36.5	36.4	36.8	36.4	37	36.7	37.3	36.8	37.2	36.6
7	36.6	36.5	36.7	36.4	37.1	36.7	37.3	36.8	37.3	36.7
8	36.7	36.5	36.7	36.4	37.1	36.8	37.3	36.9	37.4	36.7
9	37	36.5	36.8	36.4	37.1	36.8	37.3	36.9	37.4	36.8
10	36.9		36.9	36.5	37.1	36.9	37.3	36.9	37.3	36.8
11	36.8	36.5	36.9	36.5	37.1	36.8	37.2	36.9	37.4	36.8
12	36.9	36.5	36.9	36.5	37.1	36.8	37.3	36.9	37.5	36.9
13	36.9	36.6	36.9	36.5	37.2	36.8	37.2	36.9	37.5	36.9
14	36.9	36.6	36.9	36.5	37.2	36.7	37.2	36.9	37.5	36.9
15	36.9	36.6	36.9	36.6	37.1	36.8	37.4	36.9	37.6	37
16	36.9	36.7	37	36.6	37.1	36.8	37.4	36.9	37.6	37
17	37	36.7	36.9	36.6	37.2	36.8	37.5	37	37.6	37
18	37.3	36.7	37	36.6	37.2	36.8	37.5	37	37.6	37.1
19	37.1	36.8	37	36.7	37.2	36.9	37.4	37	37.7	37.1
20	37.2	36.8	37.1	36.7	37.3	36.9	37.4	37	37.8	37.1
21	37.3	36.9	37.2	36.7	37.3	36.9	37.5	37	37.8	37.2
22	37.2	36.9	37.2	36.8	37.3	36.9	37.5	37	37.8	37.2
23	37.2	36.9	37.3	36.8	37.3	36.9	37.5	37	37.8	37.3
24	37.2	36.9	37.3	36.8	37.3	36.9	37.5	37	37.8	37.3
25	37.5	37	37.4	36.8	37.3	36.9	37.7	37	37.8	37.3
26	37.5	37	37.4	36.9	37.3	36.9	37.6	37	37.8	37.4
27	37.4	37.1	37.3	36.9	37.4	36.9	37.7	37.1	37.9	37.4
28	37.6	37.1	37.5	37	37.4	36.9	37.6	37.1	38	37.4
29	37.7	37.1	37.5	37	37.5	36.9	37.6	37.1	38	37.4
30	37.6	37.2	37.5	37.1	37.5	36.9	37.6	37.1	38.1	37.5
31	37.7	37.3	37.6	37.1	37.5	37	37.6	37.2	38.1	37.5
32	37.7	37.3	37.6	37.1	37.5	37	37.7	37.2	38.1	37.5
33	37.7	37.3	37.7	37.2	37.5	37	37.7	37.2	38.1	37.5
34	37.7	37.4	37.7	37.3	37.6	37.1	37.7	37.2	38.2	37.5
35	37.8	37.4	37.8	37.3	37.6	37.1	37.8	37.2	38.1	37.6
36	37.8	37.4	37.8	37.4	37.6	37.1	37.9	37.3	38.1	37.6
37	37.8	37.5	37.8	37.4	37.6	37.1	37.9	37.3	38.3	37.6
38	37.9	37.5	37.9	37.4	37.7	37.2	37.9	37.3	38.3	37.7
39	37.8	37.5	37.9	37.5	37.7	37.2	37.8	37.3	38.3	37.7
40	37.9	37.5	38	37.5	37.7	37.2	37.9	37.3	38.4	37.8
41	37.9	37.6	38	37.6	37.7	37.3	37.9	37.3	38.3	37.8
42	38.1		38.1	37.6	37.8	37.3	37.9	37.4		
43	38	37.7	38.1	37.6	37.8	37.4	37.9	37.4		
44	38.1	37.8	38.1	37.7	37.8	37.4	38	37.4		
45	38	37.8	38.2	37.7	37.8	37.4	38	37.4		
46	38.1	37.9	38.2	37.7	37.9	37.4	38	37.5		
47	38.2	37.9	38.2	37.8	37.9	37.5	38	37.5		
48	38.1	38	38.1	37.8	37.9	37.5	38	37.5		
49	38.2	38	38.1	37.8	37.9	37.5	38.1	37.5		
50	38.2	38.1	38	37.8	37.9	37.5	38	37.5		
51	38.5	38.1	38	37.8	37.9	37.5	38	37.5	38.2	37.8
52	38.5	38	38	37.8	37.9	37.5	38.1	37.5	38.2	37.8
53	38.5	38	38	37.8	37.8	37.5	38	37.5	38.2	37.8
54	38.5	38	38	37.8	37.8	37.6	38	37.4	38.1	37.8
55	38.4	37.9	38	37.8	37.8	37.6	37.9	37.4	38.1	37.7
56	38.4	37.9	38	37.8	37.8	37.6	37.9	37.4	38.1	37.7
57	38.4	37.9	38	37.8	37.8	37.6	37.8	37.4	38.1	37.7
58	38.4	38	38	37.8	37.8	37.6	37.9	37.3	38.1	37.7
59	38.3	38	38	37.8	37.7	37.6	37.8	37.3	38.1	37.7
60	38.3	38	37.9	37.8	37.7	37.6	37.8	37.3	38.1	37.7
61	38.3	38	37.9	37.9	37.8	37.6	37.8	37.3	38.1	37.7
62		38	38	37.9	37.8	37.5	37.7	37.3	38.1	37.6
63		38	38	37.9	37.8	37.5	37.7	37.3	38.1	37.7
64		38	38	37.9	37.8	37.5	37.7	37.3	38.1	37.7
65		38	38	37.9	37.8	37.5	37.7	37.3	38.1	37.7

Test 16, Subjects 6 to 10

TIME (min)	SUBJECT 6		SUBJECT 7		SUBJECT 8		SUBJECT 9		SUBJECT 10	
	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR
1	36.9	36.9	37.1	36.9	36.9	36.7	37.1	36.8	37	36.6
2	37	36.9	37	36.9	36.9	36.7	37.2	36.8	37.1	36.6
3	37	36.9	37	36.9	36.9	36.7	37.2	36.8	37.2	36.6
4	36.9	36.9	37.1	36.9	36.9	36.7	37.2	36.8	37.2	36.7
5	37	36.9	37.1	36.9	36.9	36.7	37.2	36.9	37.3	36.7
6	37	36.9	37.2	36.9	36.9	36.7	37.2	36.9	37.3	36.7
7	36.9	36.9	37.3	36.9	36.9	36.8	37.2	36.9	37.3	36.8
8	37.1	36.9	37.3	36.9	37	36.8	37.3	36.9	37.4	36.8
9	37.2	36.9	37.3	36.9	37	36.8	37.3	36.9	37.5	36.8
10	37.2	36.9	37.3	36.9	37	36.9	37.3	37	37.4	36.8
11	37	37	37.2	36.9	37.1	36.9	37.4	37	37.5	36.8
12	37.2	37	37.3	36.9	37	36.9	37.4	37	37.5	36.8
13	37.2	37	37.2	36.9	37.1	36.9	37.4	37	37.6	36.8
14	37.2	37	37.3	36.9	37.1	36.9	37.5	37	37.6	36.8
15	37.3	37	37.3	36.9	37.2	36.9	37.5	37	37.6	36.8
16	37.3	37	37.3	36.9	37.2	37	37.5	37	37.7	36.8
17	37.4	37.1	37.4	36.9	37.2	37	37.4	37	37.6	36.9
18	37.2	37.1	37.4	36.9	37.2	37	37.5	37	37.6	36.9
19	37.4	37.1	37.4	36.9	37.3	37	37.5	37	37.7	36.9
20	37.4	37.1	37.4	36.9	37.3	37.1	37.6	37	37.7	36.9
21	37.5	37.1	37.4	36.9	37.4	37.1	37.6	37	37.7	36.9
22	37.3	37.1	37.4	36.9	37.4	37.1	37.6	37	37.8	36.9
23	37.5	37.1	37.4	36.9	37.4	37.1	37.7	37	37.8	36.9
24	37.4	37.2	37.4	37	37.4	37.1	37.7	37	37.8	36.9
25	37.6	37.2	37.4	37	37.4	37.1	37.8	37	37.8	36.9
26	37.6	37.3	37.5	36.9	37.5	37.2	37.7	37.1	37.9	36.9
27	37.7	37.3	37.5	36.9	37.5	37.2	37.6	37.1	37.9	37
28	37.5	37.3	37.5	37	37.5	37.2	37.8	37.2	37.9	37.1
29	37.7	37.3	37.5	37	37.6	37.2	37.8	37.2	38	37.1
30	37.8	37.3	37.5	37	37.6	37.3	37.8	37.2	38	37.2
31	37.7	37.4	37.5	37	37.6	37.3	37.9	37.2	38.1	37.2
32	37.7	37.4	37.5	37	37.6	37.3	37.9	37.2	38.1	37.2
33	37.8	37.4	37.6	37	37.6	37.3	37.9	37.2	38	37.2
34	37.8	37.4	37.6	37	37.6	37.3	38	37.3	38	37.2
35	37.9	37.4	37.7	37	37.6	37.3	38	37.3	38.1	37.2
36	37.9	37.4	37.7	37	37.7	37.3	38	37.3	38.1	37.2
37	37.9	37.5	37.6	37	37.7	37.3	38.1	37.4	38.1	37.2
38	37.8	37.5	37.7	37	37.8	37.3	37.8	37.4	38.2	37.3
39	37.9	37.5	37.6	37	37.8	37.3	38.1	37.5	38.2	37.3
40	38	37.5	37.7	37.1	37.8	37.3	38.1	37.5	38.2	37.4
41	38	37.5	37.7	37.1	37.8	37.3	38.2	37.5	38.3	37.4
42	38	37.6	37.7	37.1	37.8	37.4	38	37.5	38.3	37.4
43	37.9	37.6	37.7	37.1	37.8	37.4	38.2	37.5	38.3	37.4
44	38	37.6	37.7	37.1	37.9	37.4	38.3	37.5	38.3	37.5
45	38.1	37.6	37.7	37.1	37.9	37.5	38.3	37.5	38.4	37.5
46	38.1	37.6	37.7	37.1	37.9	37.5	38.4	37.6	38.4	37.5
47	38.1	37.7	37.8	37.1	37.8	37.5	38.3	37.6	38.4	37.6
48	38	37.7	37.7	37.1	37.7	37.5	38.3	37.6	38.4	37.6
49	38	37.7	37.7	37.1	37.9	37.6	38.3	37.7	38.3	37.6
50	38	37.7	37.7	37.1	37.9	37.5	38.3	37.7	38.3	37.6
51	37.9	37.6	37.7	37.1	37.9	37.5	38.2	37.7	38.3	37.6
52	37.9	37.6	37.7	37.1	37.9	37.5	38.2	37.7	38.4	37.6
53	37.9	37.6	37.6	37.1	37.9	37.4	38.1	37.7	38.3	37.6
54	37.9	37.6	37.6	37.1	37.9	37.4	38.1	37.6	38.3	37.7
55	37.8	37.6	37.6	37	37.9	37.4	38	37.6	38.2	37.6
56	37.8	37.6	37.6	37	37.8	37.4	38	37.6	38.2	37.6
57	37.8	37.6	37.5	36.9	37.8	37.4	38	37.5	38.2	37.6
58	37.9	37.6	37.5	36.9	37.8	37.4	37.9	37.5	38.2	37.5
59	37.8	37.7	37.5	36.9	37.8	37.4	38	37.5	38.1	37.5
60	37.8	37.6	37.5	36.9	37.8	37.4	37.9	37.5	38.1	37.5
61	37.7	37.5	37.5	36.9	37.8	37.4	38	37.5	38.1	37.5
62	37.8	37.5	37.4	36.9	37.8	37.4	38	37.5	38.1	37.5
63	37.8	37.5	37.5	36.9	37.8	37.4	38	37.5	38.1	37.5
64	37.8	37.5	37.5	36.9	37.8	37.4	38	37.5	38.1	37.5
65	37.8	37.5	37.5	36.8	37.8	37.4	38	37.5	38.1	37.5

Test 17, Subjects 1 to 5

TIME (min)	SUBJECT 1		SUBJECT 2		SUBJECT 3		SUBJECT 4		SUBJECT 5	
	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR
1	36.8	36.6	36.5	36.1	36.9	37	37.1	36.6	37.2	36.8
2	36.8	36.6	36.5	36.1	36.7	37	37	36.6	37.3	36.8
3	36.8	36.7	36.5	36.1	36.7	37	37.1	36.6	37.1	36.8
4	36.8	36.7	36.5	36.1	36.7	37	37.1	36.6	37.2	36.9
5	37	36.8	36.5	36.1	36.7	37.1	37.2	36.6	37.3	36.9
6	37	36.8	36.5	36.2	36.7	37.1	37.3	36.6	37.3	36.9
7	37.1	36.8	36.5	36.2	36.7	37.1	37.4	36.7	37.4	36.9
8	37.1	36.8	36.6	36.2	36.8	37.2	37.3	36.7	37.4	36.9
9	37.1	36.9	36.7	36.2	36.8	37.2	37.3	36.7	37.4	37
10	37.1	36.9	36.7	36.2	36.8	37.2	37.3	36.7	37.4	37
11	37.1	36.9	36.6	36.2	36.8	37.2	37.3	36.7	37.4	37
12	37.1	36.9	36.7	36.2	36.9	37.1	37.3	36.7	37.5	37
13	37.2	36.9	36.8	36.3	36.8	37.1	37.4	36.8	37.6	37.1
14	37.2	36.9	36.8	36.3	36.9	37.1	37.3	36.8	37.5	37.1
15	37.2	36.9	36.8	36.4	36.8	37.1	37.4	36.8	37.6	37.1
16	37.2	36.9	36.8	36.4	36.8	37.1	37.5	36.8	37.6	37.2
17	37.3	36.9	36.9	36.4	36.6	37.1	37.5	36.8	37.7	37.2
18	37.3	36.9	36.8	36.4	36.5	37.2	37.5	36.8	37.7	37.2
19	37.3	36.9	36.9	36.4	36.7	37.2	37.5	36.8	37.8	37.3
20	37.3	36.9	36.9	36.4	36.5	37.2	37.5	36.8	37.6	37.3
21	37.4	37	36.9	36.4	36.9	37.2	37.5	36.9	37.8	37.3
22	37.3	37	37	36.4	36.7	37.2	37.5	36.9	37.7	37.4
23	37.4	37	37.1	36.4	36.9	37.2	37.5	36.9	37.8	37.4
24	37.4	37	37.1	36.4	36.9	37.2	37.5	36.9	37.8	37.5
25	37.4	37	37.1	36.5	36.8	37.3	37.6	36.9	37.8	37.5
26	37.4	37.1	37.1	36.5	36.7	37.3	37.7	36.9	37.9	37.6
27	37.5	37.1	37.1	36.5	37	37.3	37.7	37	37.9	37.6
28	37.5	37.2	37.2	36.6	37.1	37.4	37.6	37	38	37.6
29	37.6	37.2	37.3	36.7	37.2	37.4	37.7	37	38.1	37.7
30	37.6	37.3	37.3	36.7	37.1	37.5	37.7	37	38.1	37.7
31	37.6	37.3	37.3	36.8	37.2	37.5	37.7	37	38.1	37.7
32	37.7	37.3	37.3	36.9	37.3	37.5	37.8	37	38.1	37.8
33	37.7	37.3	37.4	36.9	37.3	37.5	37.8	37	38.1	37.8
34	37.6	37.3	37.4	37	37.3	37.5	37.8	37	38.2	37.8
35	37.7	37.3	37.5	37	37.1	37.6	37.8	37.1	38.2	37.8
36	37.7	37.3	37.5	37	37.1	37.6	37.9	37.1	38.2	37.9
37	37.7	37.4	37.5	37	37.2	37.7	37.9	37.1	38.3	37.9
38	37.8	37.4	37.6	37	37.4	37.7	37.9	37.1	38.2	38
39	37.7	37.4	37.6	37.1	37.4	37.8	37.9	37.2	38.3	38
40	37.8	37.4	37.7	37.1	37.6	37.8	37.9	37.2	38.2	38
41	37.8	37.4	37.7	37.1	37.4	37.8	37.9	37.2	38.2	38.1
42	37.9	37.5	37.7	37.2	37.7	37.8	38	37.2	38.2	38.1
43	37.9	37.5	37.8	37.2	37.6	37.8	38	37.2		
44	37.9	37.5	37.8	37.3	37.6	37.8	38	37.2		
45	37.9	37.5	37.9	37.4	37.7	37.9	38.1	37.3		
46	37.9	37.5	37.9	37.4	37.7	38	38.1	37.3		
47	38	37.5	37.9	37.5	37.7	38	38.1	37.3		
48	37.9	37.6	38	37.5	37.7	38.1	38	37.3		
49	37.8	37.5	37.9	37.5	37.8	38.1	38	37.3		
50	37.8	37.5	37.9	37.5	37.8	38.1	38.1	37.3		
51	37.8	37.5	37.8	37.5	37.8	38.1	38	37.2	38.2	38.1
52	37.5	37.5	37.7	37.5	37.8	38.2	37.9	37.3	37.9	38
53	37.5	37.5	37.5	37.5	37.8	38.2	37.8	37.3	38	38.1
54	37.4	37.6	37.4	37.5	37.6	38.2	37.8	37.4	37.8	38.1
55	37.3	37.7	37.3	37.6	37.4	38.2	37.6	37.5	37.9	38.1
56	37.2	38.2	37.1	37.6	37.4	38.2	37.6	37.5	37.9	38.2
57	37	36.3	37.1	36.7	37.3	38.2	37.5	37	37.5	37.2
58	37	36.2	36.9	36.7	37.3	37.5	37.5	37	37.5	37.2
59	37	36.2	37	36.7	37.2	37.4	37.5	36.9	37.5	37.1
60	37	36.2	36.9	36.6	37.1	37.4	37.5	36.9	37.5	37.1
61	37	36.2	36.9	36.6	37	37.3	37.5	36.9	37.5	37.1
62	37	36.1	36.8	36.5	37	37.3	37.5	36.9	37.4	37
63	37	36.1	36.8	36.5	36.9	37.2	37.5	36.9	37.4	36.9
64	37	36.1	36.8	36.4	36.8	37.2	37.4	36.8	37.4	36.9
65	37	36.1	36.9	36.4	37	37.1	37.5	36.8	37.4	36.9

Test 17, Subjects 6 to 10

TIME (min)	SUBJECT 6		SUBJECT 7		SUBJECT 8		SUBJECT 9		SUBJECT 10	
	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR
1	37.2	37	37	36.8	37.1	36.7	37.2	37	37	36.3
2	37.1	37	37	36.8	37	36.7	37.2	37	37	36.3
3	37.1	37	37	36.8	37.1	36.7	37.2	37	36.9	36.3
4	37	37	37	36.8	37	36.8	37.2	37	37	36.3
5	37.1	37	37.1	36.8	37.1	36.8	37.2	37	37	36.3
6	37.1	37	37.1	36.8	37.1	36.8	37.2	37.1	37.1	36.3
7	37.2	37	37.1	36.8	37.1	36.9	37.1	37.1	37	36.4
8	36.9	37.1	37.1	36.8	37.1	36.9	37.3	37.1	37.2	36.4
9	37.1	37.1	37.1	36.8	37.1	37	37.4	37.2	37.2	36.4
10	36.9	37.1	37.1	36.8	37.1	37	37.4	37.2	37.2	36.4
11	37	37.1	37.2	36.8	37.2	37	37.4	37.2	37.3	36.4
12	37.2	37.1	37.2	36.8	37.2	37	37.5	37.1	37.3	36.4
13	37.2	37.1	37.2	36.8	37.2	37	37.5	37.1	37.2	36.4
14	37.2	37.1	37.2	36.8	37.2	37	37.5	37.1	37.3	36.5
15	37.2	37.1	37.2	36.8	37.3	37	37.5	37.1	37.4	36.5
16	37.3	37.2	37.3	36.8	37.3	37	37.5	37.1	37.5	36.5
17	37.4	37.2	37.3	36.8	37.3	37	37.5	37.1	37.4	36.5
18	37.3	37.2	37.3	36.8	37.3	37	37.6	37.2	37.5	36.5
19	37.2	37.2	37.4	36.9	37.4	37	37.6	37.2	37.5	36.5
20	37.3	37.2	37.4	36.9	37.4	37	37.6	37.2	37.6	36.5
21	37.4	37.2	37.4	36.9	37.5	37.1	37.6	37.2	37.6	36.6
22	37.2	37.2	37.4	36.9	37.5	37.1	37.6	37.2	37.6	36.6
23	37.5	37.2	37.4	36.9	37.5	37.1	37.6	37.2	37.6	36.6
24	37.5	37.3	37.4	37	37.5	37.1	37.7	37.2	37.6	36.6
25	37.5	37.3	37.4	36.9	37.5	37.1	37.7	37.2	37.7	36.6
26	37.5	37.3	37.5	37	37.6	37.1	37.7	37.3	37.7	36.7
27	37.6	37.3	37.5	37	37.6	37.2	37.6	37.3	37.7	36.7
28	37.5	37.3	37.5	37	37.6	37.2	37.7	37.3	37.8	36.7
29	37.5	37.4	37.5	37	37.7	37.2	37.7	37.3	37.7	36.8
30	37.6	37.4	37.5	37	37.6	37.3	37.7	37.3	37.8	36.8
31	37.7	37.4	37.5	37.1	37.6	37.3	37.7	37.3	37.8	36.8
32	37.6	37.4	37.5	37.1	37.6	37.3	37.7	37.3	37.9	36.8
33	37.5	37.5	37.6	37.1	37.7	37.3	37.8	37.3	37.9	36.8
34	37.6	37.5	37.6	37.1	37.7	37.4	37.8	37.3	37.9	36.8
35	37.7	37.5	37.6	37.1	37.7	37.4	37.9	37.4	38	36.8
36	37.7	37.5	37.6	37.1	37.8	37.4	37.9	37.4	38	36.8
37	37.8	37.6	37.6	37.1	37.8	37.4	38	37.4	38	36.9
38	37.8	37.6	37.7	37.2	37.8	37.4	37.9	37.4	38.1	36.9
39	37.8	37.6	37.7	37.2	37.8	37.4	38	37.4	38.1	36.9
40	37.9	37.7	37.7	37.2	37.8	37.4	37.8	37.4	38.1	36.9
41	37.8	37.7	37.7	37.3	37.9	37.4	38	37.4	38.1	36.9
42	37.7	37.7	37.7	37.3	37.9	37.4	38	37.4	38.2	37
43	37.8	37.7	37.7	37.3	37.9	37.4	38	37.4	38.2	37
44	38	37.7	37.8	37.3	37.9	37.4	38.1	37.5	38.3	37
45	38	37.8	37.8	37.3	38	37.4	38.1	37.5	38.3	37.1
46	38.1	37.8	37.8	37.3	38	37.4	38.2	37.5	38.4	37.1
47	37.7	37.8	37.8	37.3	37.9	37.5	38.1	37.5	38.3	37.2
48	37.9	37.9	37.8	37.3	37.9	37.5	38.1	37.5	38.4	37.2
49	38	37.9	37.8	37.3	38	37.5	38.1	37.6	38.4	37.2
50	38	37.9	37.7	37.3	38	37.5	38.1	37.6	38.4	37.2
51	37.9	37.9	37.7	37.3	37.9	37.5	38.1	37.6	38.4	37.2
52	37.8	37.9	37.7	37.3	37.8	37.5	38	37.5	38.2	37.2
53	37.8	37.9	37.7	37.3	37.8	37.5	37.8	37.5	38	37.3
54	37.8	37.9	37.6	37.4	37.7	37.5	37.8	37.5	37.9	37.3
55	37.7	37.8	37.5	37.4	37.6	37.6	37.7	37.6	37.8	37.4
56	37.6	37.9	37.4	37.4	37.5	37.6	37.6	37.6	37.8	37.4
57	37.6	37.9	37.3	37.4	37.4	37.7	37.5	37.7	37.7	37.4
58	37.6	37.8	37.2	36.9	37.4	37.6	37.5	37	37.7	37.4
59	37.5	37.4	37.2	36.9	37.3	36.8	37.5	37.1	37.6	37.3
60	37.3	37.4	37.2	36.9	37.3	36.8	37.5	37.1	37.6	37.3
61	37.3	37.4	37.2	36.9	37.2	36.8	37.5	37.1	37.6	37.2
62	37.3	37.3	37.1	36.8	37.2	36.7	37.5	37	37.6	37.2
63	37.3	37.3	37.1	36.8	37.2	36.7	37.5	37	37.6	36.6
64	37.3	37.3	37.1	36.8	37.2	36.7	37.5	37	37.6	36.9
65	37.4	37.3	37.1	36.7	37.2	36.7	37.5	36.9	37.5	36.9

Test 18, Subjects 1 to 5

TIME (min)	SUBJECT 1		SUBJECT 2		SUBJECT 3		SUBJECT 4		SUBJECT 5	
	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR
1			36.4	36	36.8	36.7	37.2	36.7	37.1	36.8
2			36.3	36	36.7	36.8	37.2	36.7	37.1	36.8
3			36.2	36	36.7	36.8	37.2	36.7	37	36.8
4			36.4	36	36.8	36.9	37.3	36.7	37	36.8
5			36.4	36	36.9	36.9	37.3	36.8	37	36.9
6	36.8	36.2	36.5	36	36.9	37	37.4	36.8	37.2	36.9
7	36.8	36.3	36.6	36	37	37	37.3	36.8	37.2	36.9
8	36.9	36.3	36.6	36	37	37	37.4	36.8	37.3	36.9
9	36.9	36.3	36.6	36.1	37.1	37.1	37.2	36.9	37.2	37
10	36.9	36.3	36.5	36.1	37.1	37.1	37.3	36.9	37.3	37
11	36.9	36.3	36.5	36.1	37	37.1	37.4	36.9	37.2	37
12	36.9	36.3	36.6	36.1	37	37.1	37.5	36.9	37.3	37.1
13	37		36.5	36.1	37.1	37.1	37.5	37	37.3	37.1
14	37	36.4	36.6	36.1	37	37.1	37.5	37	37.4	37.1
15	37	36.4	36.7	36.1	37.1	37.1	37.6	37	37.4	37.1
16	37	36.5	36.7	36.2	37.1	37.1	37.6	37	37.4	37.1
17	37.1	36.6	36.7	36.2	37.2	37	37.6	37	37.3	37.1
18	37	36.6	36.7	36.2	37.2	37	37.6	37	37.4	37.1
19	37.1		36.8	36.2	37.2	37	37.7	37	37.5	37.1
20	37		36.8	36.2	37.3	37	37.7	37.1	37.6	37.1
21	37.2		36.8	36.3	37.3	36.9	37.6	37.1	37.4	37.1
22	37.1		36.8	36.3	37.3	37	37.7	37.1	37.5	37.1
23	37.1		36.8	36.3	37.3	37	37.7	37.1	37.5	37.1
24	37.1		36.9	36.3	37.3	37	37.8	37.1	37.5	37.1
25	37.1		36.9	36.3	37.3	37	37.9	37.2	37.6	37.1
26	37.1	36.8	36.9	36.4	37.3	37	37.9	37.2	37.7	37.1
27	37.2	36.8	36.9	36.4	37.3	36.9	37.9	37.2	37.7	37.1
28	37.2	36.8	36.9	36.4	37.4	36.9	37.9	37.2	37.6	37.1
29	37.3	36.8	37	36.4	37.4	36.9	37.9	37.2	37.7	37.2
30	37.2	36.9	37.1	36.4	37.3	36.9	37.9	37.3	37.7	37.2
31	37.3	36.9	37.1	36.5	37.4	36.9	37.9	37.3	37.8	37.2
32	37.3	37	37.2	36.5	37.4	36.9	37.9	37.3	37.7	37.2
33	37.4	37	37.2	36.5	37.4	36.9	38	37.3	37.8	37.2
34	37.5	37	37.2	36.5	37.4	36.9	38	37.3	37.8	37.2
35	37.4	37	37.2	36.5	37.4	36.9	38.1	37.3	37.8	37.2
36	37.7	37.2	37.3	36.6	37.4	36.9	38.1	37.4	37.9	37.2
37	37.8		37.3	36.6	37.4	36.9	38.2	37.4	37.9	37.2
38	37.8		37.4	36.6	37.5	36.9	38.2	37.4	38	37.2
39	37.8		37.4	36.6	37.5	36.9	38.2	37.4	38	37.3
40	37.9		37.4	36.7	37.5	36.9	38.2	37.4	37.9	37.3
41	37.8		37.4	36.7	37.5	36.9	38.2	37.5	37.9	37.3
42	37.9		37.4	36.8	37.5	37	38.2	37.5	38	37.4
43	37.9	37.3	37.4	36.8	37.5	37	38.3	37.5	37.9	37.4
44	37.9	37.3	37.4	36.9	37.5	37	38.3	37.5	38	37.4
45	38	37.3	37.4	36.9	37.5	37	38.4	37.6	38	37.4
46	37.8	37.4	37.5	36.9	37.6	36.9	38.4	37.6	38	37.4
47	38.1	37.4	37.5	37	37.5	37	38.3	37.6	38	37.4
48	38.1	37.4	37.4	37	37.5	37	38.4	37.6	37.9	37.4
49	38.2	37.4	37.5	37	37.5	37	38.3	37.6	38	37.4
50	38.3	37.5	37.4	37	37.5	37	38.3	37.6	37.9	37.4
51	38.4	37.5	37.3	37	37.5	37	38.2	37.6	37.9	37.4
52	38.4	37.5	37.3	37	37.4	37	38.3	37.6	37.8	37.3
53	38.2		37.2	36.9	37.3	36.9	38.1	37.5	37.7	37.3
54	37.9		37.2	36.9	37.3	36.9	38.1	37.5	37.7	37.2
55	37.9		37.3	37.3	37.2	36.9	38	37.5	37.7	37.2
56	37.8		37.3	37.2	37.2	36.9	38	37.4	37.6	37.1
57	37.8		37.2	37	37.2	36.9	38	37.4	37.6	37.1
58	37.7		37.2	36.9	37.2	36.9	38	37.4	37.7	37.1
59	37.5	37.2	37.2	36.9	37.3	37	37.9	37.3	37.6	37.1
60	37.7	37.2	37.2	36.8	37.3	37	37.9	37.3	37.6	37.1
61	37.6	37.1	37.2	36.8	37.3	37	37.9	37.3	37.5	37
62	37.7	37.1	37.1	36.7	37.3	37.1	37.8	37.2	37.6	37
63	37.1	37.1	37.1	36.7	37.3	37.1	37.9	37.2	37.5	37
64	37.6	37.1	37.1	36.7	37.3	37.1	37.9	37.2	37.6	37
65	37.5	37	37.2	36.7	37.3	37.1	37.8	37.2	37.5	37

Test 18, Subjects 6 to 10

TIME (min)	SUBJECT 6		SUBJECT 7		SUBJECT 8		SUBJECT 9		SUBJECT 10	
	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR	ESOPH	ADJ-EAR
1	37.2	37.2	36.7	36.5	37.3	37.2	37	36.7	37	36.3
2	37.2	37.3	36.7	36.6	37.3	37.2	37	36.7	36.9	36.4
3	37	37.3	36.7	36.6	37.3	37.2	37	36.8	36.9	36.4
4	36.9	37.3	36.8	36.6	37.3	37.2	37	36.8	36.9	36.4
5	37.1	37.3	36.9	36.7	37.4	37.2	37	36.9	37	36.5
6	37.2	37.3	36.9	36.7	37.4	37.3	37.1	36.9	37	36.5
7	37.3	37.3	36.9	36.7	37.5	37.3	37.1	36.9	36.9	36.6
8	37.1	37.3	36.9	36.6	37.5	37.4	37.1	36.9	37.1	36.6
9	37.1	37.4	36.9	36.7	37.5	37.4	37.1	36.9	37	36.6
10	37.2	37.4	36.9	36.7	37.5	37.4	37.3	37	37.1	36.6
11	37.2	37.4	36.8	36.7	37.6	37.4	37.2	37	37.1	36.7
12	37.3	37.4	36.9	36.7	37.6	37.4	37.2	37	37.1	36.7
13	37.3	37.4	36.8	36.7	37.6	37.4	37.3	37	37.1	36.6
14	37.4	37.4	36.9	36.7	37.6	37.4	37.3	36.9	37.1	36.6
15	37.5	37.5	37	36.6	37.6	37.4	37.4	36.9	37.2	36.6
16	37.5	37.5	37	36.6	37.7	37.5	37.4	36.9	37.2	36.6
17	37.4	37.5	37	36.5	37.7	37.5	37.2	36.8	37	36.6
18	37.5	37.5	37	36.5	37.7	37.5	37.4	36.8	37.2	36.6
19	37.5	37.5	37	36.5	37.8	37.5	37.4	36.8	37.2	36.7
20	37.6	37.6	37	36.5	37.8	37.5	37.4	36.8	37.3	36.7
21	37.6	37.6	37	36.6	37.8	37.5	37.5	36.8	37.2	36.7
22	37.7	37.6	37	36.6	37.8	37.5	37.5	36.9	37.3	36.7
23	37.8	37.6	37	36.6	37.9	37.5	37.5	36.9	37.3	36.7
24	37.6	37.6	37	36.6	37.9	37.6	37.5	36.9	37.3	36.7
25	37.7	37.6	37.1	36.6	37.9	37.6	37.5	36.9	37.4	36.7
26	37.8	37.6	37.1	36.6	37.9	37.6	37.5	37	37.4	36.7
27	37.8	37.6	37.1	36.5	37.9	37.6	37.6	36.9	37.4	36.7
28	37.7	37.7	37.1	36.5	38	37.6	37.6	36.9	37.5	36.7
29	37.8	37.7	37.1	36.5	38	37.6	37.6	36.9	37.5	36.7
30	37.9	37.7	37.1	36.6	38	37.6	37.6	37	37.5	36.7
31	37.9	37.7	37.1	36.6	38	37.6	37.7	37	37.6	36.8
32	38	37.7	37.1	36.6	38	37.6	37.7	37	37.6	36.8
33	37.9	37.8	37.2	36.7	38.1	37.6	37.6	37	37.6	36.8
34	37.9	37.8	37.1	36.7	38.1	37.7	37.6	37	37.6	36.8
35	38	37.8	37.2	36.6	38.1	37.7	37.7	37	37.6	36.8
36	38	37.8	37.2	36.6	38.1	37.7	37.8	37	37.7	36.8
37	38.1	37.8	37.2	36.6	38.1	37.7	37.7	37	37.6	36.9
38	38	37.9	37.2	36.6	38.2	37.7	37.8	37	37.8	36.9
39	38.1	37.9	37.2	36.6	38.1	37.7	37.8	37	37.8	36.9
40	38	37.9	37.3	36.6	38.2	37.7	37.8	37.1	37.7	36.9
41	38.1	38	37.1	36.6	38.2	37.7	37.8	37.1	37.8	37
42	38.1	38	37.2	36.7	38.2	37.7	37.8	37.1	37.8	37
43	38	38	37.2	36.7	38.2	37.7	37.7	37.2	37.8	37
44	38.1	38	37.2	36.7	38.3	37.7	37.8	37.2	37.8	37
45	38.1	38	37.2	36.6	38.3	37.8	37.8	37.2	37.8	37
46	38.1	38	37.2	36.5	38.3	37.8	37.9	37.1	37.9	37
47	38.1	38	37.2	36.6	38.3	37.8	37.8	37.1	37.8	37
48	38	38	37.2	36.6	38.3	37.8	37.8	37.2	37.9	37
49	38	38	37.2	36.6	38.3	37.7	37.9	37.1	37.8	37
50	38	37.9	37.2	36.5	38.3	37.7	37.9	37.1	37.8	37
51	38	37.9	37.2	36.5	38.3	37.7	37.8	37.1	37.8	37
52	37.9	37.8	37.2	36.5	38.3	37.7	37.8	37.1	37.8	37
53	37.9	37.8	37.1	36.4	38.2	37.6	37.7	37.1	37.8	37
54	37.8	37.8	37.1	36.4	38.3	37.6	37.7	37	37.8	37
55	37.8	37.7	37	36.4	38.2	37.6	37.6	37	37.8	37
56	37.8	37.7	37	36.3	38.2	37.5	37.6	37	37.8	36.9
57	37.7	37.7	37	36.3	38.2	37.5	37.6	36.9	37.7	36.9
58	37.8	37.7	37	36.4	38.2	37.5	37.6	36.9	37.7	36.9
59	37.7	37.7	37	36.4	38.1	37.4	37.6	37	37.7	36.9
60	37.7	37.6	37	36.4	38.2	37.4	37.6	36.9	37.7	36.9
61	37.8	37.6	37	36.4	38.1	37.4	37.6	36.9	37.7	36.8
62	37.7	37.6	37	36.4	38	37.4	37.6	36.9	37.6	36.8
63	37.7	37.6	37	36.4	38.1	37.4	37.5	36.9	37.6	36.8
64	37.6	37.6	37	36.4	38.1	37.4	37.6	36.9	37.6	36.8
65	37.6	37.6	37	36.4	38	37.4	37.6	36.9	37.6	36.8