SEVENTH FRAMEWORK PROGRAMME

SPLENDID
Personalised Guide for Eating and Activity Behaviour for the Prevention of Obesity and Eating Disorders

Seventh Framework Programme

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D6.2 Annotated database for sensor standardisation and indicator extraction algorithms

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Document History

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[1] Please use a new number for each new version of the deliverable. Use "0.#" for Draft and Peer-Reviewed. "x.#" for Submitted and Approved", where x>=1.Add the date when this version was issued and list the items that have been added or changed.
[2] A deliverable can be in one of these stages: Draft, Peer-Reviewed, Submitted and Approved.

Table of contents

Abbreviations and Acronyms

	Explanation
WPX	SPLENDID work package X
DX.X	SPLENDID deliverable X.X
EMG	Electromyography
PPG	Photoplethysmograph
BMI	Body Mass Index

Executive Summary

The overall aim of WP6 is to evaluate the sensors during the different development stages. In the current stage, the sensors were tested separately. Data has been collected during different experiments at WU, KI and MANDO which are in more detail described in *D1.3 (Final Protocols of Evaluation studies)*. The data has been collected during work tasks *6.2a*, *6.2b* and *6.3*.

At WU a dataset was collected with the chewing/swallowing sensors. Three prototypes of sensors were used, that is a PPG sensor, two types of acoustic sensors: 1) an open air microphone and 2) a bone conduction microphone. Moreover, EMG signals were recorded as a reference measure. In total data, of 23 subjects were collected while eating/drinking different foods/drinks and performing several tasks unrelated to eating/drinking in a random order. The experiment resulted in a large dataset which is organized in a folder structure: one folder containing information on subject characteristics (e.g. age, BMI) and the different tasks per subject. The data files of the different sensors are organized for each subject in a separate folder.

At KI a dataset was collected with the activity sensor. Dataset contains two independent sub-sets; *Sensor Validation* data and the *Free Living* data. Both collected by the same 16 subjects. For the first dataset data was collected with the both SPLENDID activity sensor prototype and a commercially available accelerometer. For the second dataset, subjects wore the activity sensor during their daily life and simultaneously kept a physical activity diary. Per subject datasets were organised MS Excel files with multiple worksheets including the different types of data. A codebook of the variables is provided.

At MANDO a dataset was collected with the Mandometer. The aim was to collect data of different types of food in order to test the validity in a wide range of foods, but also to investigate the possibility to recognize which food is eaten from the Mandometer. For this purpose both "*Novel data*" as well as "*Old data*" was collected. The "Old data" was collected from five different types of experimental foods used in previous studies. For the "Novel data", data was collected from 16 subjects, eating another three types of foods that are often eaten. Per subject, datasets were organised as MS Excel files with multiple worksheets including the different types of data. A codebook of the variables is provided.

To conclude, empirical data was collected successfully. Data was collected for validation purposes, but also to feed the algorithms that will be used in order to develop behavioral indicators. Last, the data will be used for decisions for further development of the system.

1 Introduction

1.1 Aim

The overall aim of WP6 is to evaluate the sensors (separately), the integrated sensors system, the personalized guidance system and finally the entire framework developed within SPLENDID in the target populations, during the different development stages.

In the first year of the project the (newly developed) sensors were evaluated separately at WU, MANDO and KI. Data has been collected during experiments which are in more detail described in *D1.3 (Final Protocols of Evaluation studies)*. The data is shared with WP3 in order to provide WP3 with empirical data for the development and evaluation of algorithms for the extraction of behavioral indicators (D3.1). Furthermore, results of *T3.1*, will provide information for the decisions concerning the further development of the chewing/swallowing sensors for the final system.

1.2 Target audience

The current document can be used by the SPLENDID partners to find guidance in the data that has been collected and shared. For the external reader it gives an overview on the type and amount of data that has been collected during the first evaluations of the sensors.

1.3 Structure of the document

The current deliverable "Annotated database for sensor standardization and indicator extraction algorithms" describes the data that has been collected in Task 6.2a, 6.2b and 6.3. the dataset collected with *i) the chewing/swallowing sensors*, i.e. acoustic signals (both bone conduction and open air microphone, PPG signals, EMG signals, *ii) the physical activity sensors*, and last *iii) the Mandometer*. For all datasets, the document first introduces the data collection and then describes the dataset structure. At the end of the document we end with a conclusion.

2 Chewing/swallowing sensor data

2.1 Introduction

During the Chewing Sensor Study three preliminary prototypes for the chewing/swallowing sensor were tested; two microphone-based acoustic sensors and one PPG-based optical sensor (see *D2.1*). Twenty-three healthy, young adults (i.e. thirteen males and ten females of with a mean age of 23 years) visited the Wageningen University for a test session of ca. 1.5 hour. During this session all three chewing/swallowing sensors were worn by the subjects while they were eating foods of varying structure, alternated by random pauses and other activities such as talking. Additionally, they wore EMG sensors. EMG is a generally recognized method for assessing chewing and swallowing behaviour. These sensors were included in the experiment in order to have a reference to other studies. During the whole session one continuous measurement was made with all sensors simultaneously. For more information on the precise study protocol see *D1.3*.

The anonymized dataset produced by this study will be used in *T3.1* to develop and evaluate new signal processing algorithms for the estimation of chewing/swallowing parameters. The content of this dataset is described below. Furthermore, based on the results of *T3.1*, a decision will be made upon which sensor will be further developed and incorporated in the final system.

2.2 Folder structure of the dataset

The data produced during the Chewing Sensor Study are combined to one dataset. This dataset contains a folder with background information on each session (see 'Session info' in **figure 1**), i.e. exact instructions for the subjects for each session. Furthermore, it contains for each session a folder with the signals produced during that session (i.e. PPG-, acoustic- and EMG-signals) and the corresponding logbook. These folders are named with the corresponding subject number (see 'Participant No." in **Figure 1**).

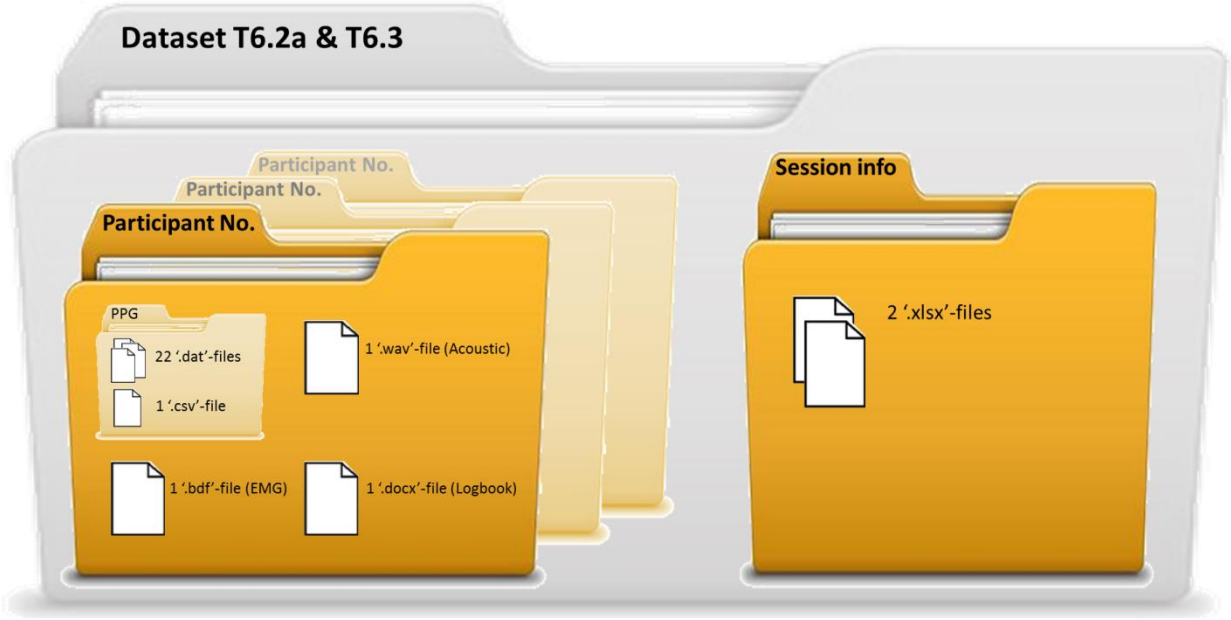


Figure 1 Basic structure dataset chewing sensors

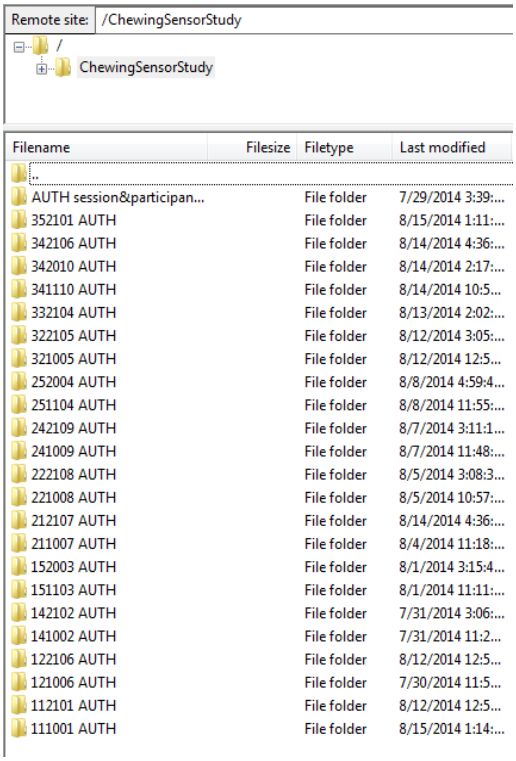


Figure 2 Print screen of folders in dataset

In total, the dataset contains 23 of these folders, for each included participant one folder (see **Figure 2**). Initially, we intended to include 20 participants; however data of three of the male participants was incomplete; in one case the acoustic signal is missing and in two other cases the PPG signal is missing. In order, to get complete datasets for at least 20 subjects we included three additional male participants; this resulted in the numbers mentioned in **table 1**.

Table 1 Number of datasets for each type of signal.

	Acoustic signals	**PPG signals**	**EMG signals**
Males	12	11	13
Females	10	10	10

2.2.1 Session content and participant information

The characteristics and the subsequent tasks during the test sessions is provided as a separate folder. This folder consists of 2 '.xlsx'-files (see **Figure 3**). One '.xlsx'-file contains characteristics of the participants, i.e. age, gender and BMI, and the session they participated in. The other '.xlsx'-file contains information on the tasks included in every session (i.e. foods consumed and actions performed). It shows which tasks have been assigned to which participant/session, as well as the order in which they have been performed. The order of tasks was randomized within participants. In total 25 tasks were assigned to every participant/test session. These included 15 tasks that were included in each test session (the underlined tasks in **Table 2**) and a selection of ten tasks out of the 37 other tasks (the other tasks in **Table 2**). **Table 2** shows the frequency of the different tasks during the experiment.

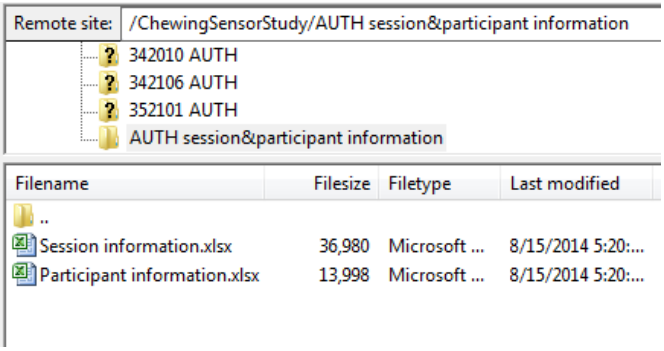


Figure 3 Print screen of folder with information on participants and test sessions

Table 2 Frequency of tasks.

Tasks	Frequency
Other activities	
Describing a picture (out loud)	23
Talking by other	23
Swallowing	23
Coughing	23
Pause (1 min)	23
Eat/Drink	
Water	23
Milk	11
Diet coke	12
Apple juice	11
Yoghurt	23
Vanilla custard	12
Pureed apple	11
Potato chips	12
Cookie	11
Apple	23
Lettuce	12
Bread	23
Cake	11
Banana	12

Tasks	Frequency
Strawberry	11
Candy bar	12
Toffee	11
Chewing gum	23
Eat + Drink water	
Yoghurt	2
Pureed apple	3
Potato chips	2
Apple	3
Bread	2
Banana	2
Toffee	2
Chewing gum	2
Eat/Drink + Talk	
Water	3
Diet coke	2
Milk	3
Yoghurt	3
Pureed apple	2
Potato chips	2
Apple	3
Bread	2
Banana	2
Toffee	2
Chewing gum	2
Mystery tasks[3]	
M1	7
M2	8
M3	4
M4	9
M5	9
Pauses	
Pause (0.5 min)	23
Pause (1.0 min)	23
Pause (1.5 min)	23
Pause (2.0 min)	23
Pause (2.5 min)	23

[3] Mystery tasks are tasks of which the contents are unknown to AUTH. AUTH can use these tasks to test their algorithms. Once they believe they have figured out what these tasks entail WU will reveal their actual contents.

2.3 Data file description

2.3.1 Acoustic data

Every test session, one stereo recording (i.e. '.wav'-file) was produced that contains the signals of both acoustic chewing/swallowing sensors; i.e. the air-conduction microphone and the bone-conduction microphone. These files all have unique names related to the corresponding session. In *D2.1* it is described how these files can be imported in MATLAB for processing. Furthermore, these files are mapped together with the other signals obtained during that specific session and the corresponding logbook (see **Figure 4** for an example).

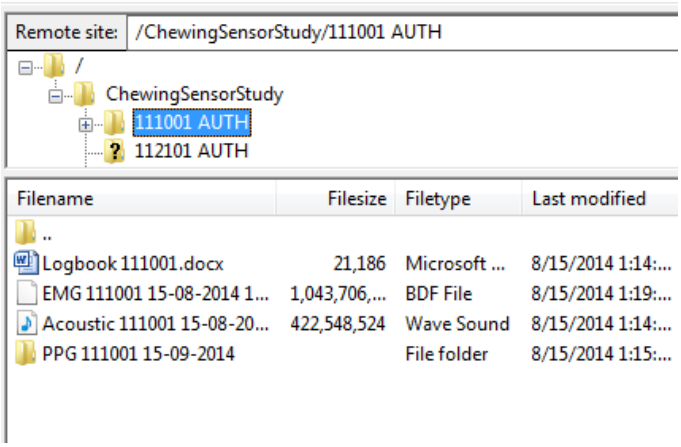


Figure 4 Print screen of folder with signals and logbook from one of the participants/ test sessions

2.3.2 PPG data

Every test session 22 '.dat'-files and 1 '.csv'-file were produced by the PPG-based chewing/swallowing sensor. The '.dat'-files contain the produced signals and the '.csv'-file contains background information on the recording session (e.g. date and start time of signal recording). These files are saved in a separate folder for each session. These folders all have unique names related to the corresponding session and are stored in a folder together with the other signals obtained during that specific session and the corresponding logbook (see **Figure 4** for an example). Furthermore, in *D2.1* it is described how these session-specific folders can be imported in MATLAB for processing.

2.3.3 EMG data

For every session one '.bdf-file' was produced by the EMG-based chewing/swallowing sensors. This file type can store multichannel biological and physicals signals like the produced EMG-signals (i.e. in these case 8 signals. Besides these EMG-signals the produced '.bdf-files' also include timestamps indicating the moments the tasks started and ended (when a task consisted of eating and/or drinking its end was defined as the moment the participant emptied his/her mouth). These annotations can be transferred to the acoustic- and PPG-signals after synchronizing the signals in time (this will be done by AUTH). Furthermore the '.bdf-files' all have unique names related to the corresponding session and are stored in a folder together with the other signals obtained during that specific session and the corresponding logbook (see Figure 4 for an example).

3 Activity Sensor data

3.1 Introduction

The study related to work task 6.2b: *Activity sensor versus commercially available sensor* was divided into two independent sub-protocols; the *Sensor Validation* protocol and the *Free Living* protocol. During the *Sensor Validation* protocol, the participants wore both the SPLENDID activity sensor prototype and a commercially available activity sensor during a scripted set of activities, lasting 40-60 minutes. In the *Free Living* protocol the participants filled in an activity diary while wearing the commercial activity sensor for 24h in an unscripted real-life setting. The same sixteen healthy, young adults (for baseline characteristics see **Table 3**) were recruited for participation in both sub-protocols.

The collected data from the *Sensor Validation* protocol of this study will be used in *T3.1* to compare the sensitivity and the validity of the raw accelerometry signals of the SPLENDID activity sensor prototype to the commercially available activity sensor. The collected data from the *Free Living* protocol will be used to develop algorithms for the extraction of physical activity behavioural indicators from real-life environment measures. The dataset is described below.

Table 3 Baseline characteristics of participants in the Activity Sensor Study

	Male	Female
Sample size (n)	8	8
Age (years)	27.3 ± 1.4	25.5 ± 2.4
BMI	25.1 ± 5.5	23.3 ± 4.9

3.2 Data file description

This dataset consists of one excel workbook (.xlsx) per participant. Each workbook was named after the corresponding participant's study identification code (**Figure 5**). All collected physical activity data from one participant was then imported to the excel workbook, comprised of four worksheets. i) The worksheet named *Participant info*, which contains: A. the participant characteristics and B. participant-specific information for the *Sensor Validation* sub-protocol. ii) The worksheet named *Sensor Validation – BodyMedia*, which contains data collected from the commercially available activity sensor during the *Sensor Validation* protocol. *iii*) The worksheet named *Sensor Validation – CSEM*, which contains data collected from the SPLENDID activity sensor prototype during the *Sensor Validation* protocol. iv) The worksheet named *Free Living*, which contains data collected from the commercially available activity sensor during the *Sensor Validation* protocol.

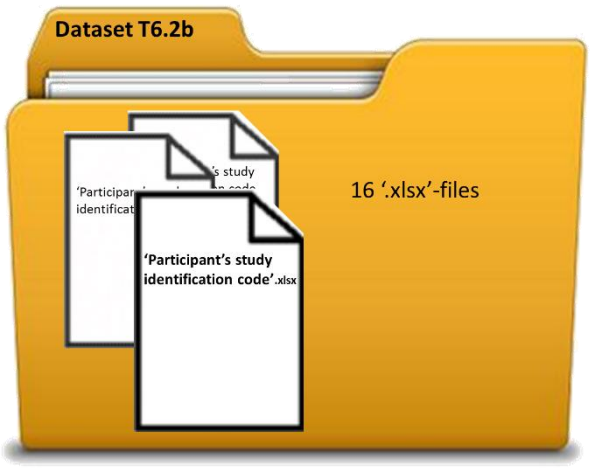
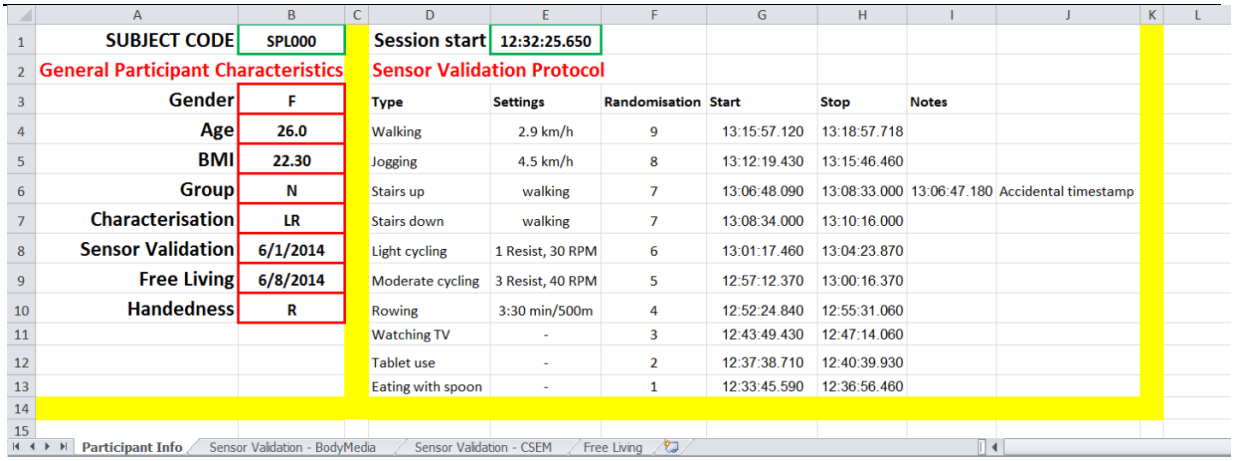


Figure 5 Basic structure dataset T6.2b



	A	B	C	D	E	F	G	H	I	J	K	L
1	SUBJECT CODE	SPL000		Session start	12:32:25.650							
2	General Participant Characteristics			Sensor Validation Protocol								
3	Gender	F		Type	Settings	Randomisation	Start	Stop	Notes			
4	Age	26.0		Walking	2.9 km/h	9	13:15:57.120	13:18:57.718				
5	BMI	22.30		Jogging	4.5 km/h	8	13:12:19.430	13:15:46.460				
6	Group	N		Stairs up	walking	7	13:06:48.090	13:08:33.000	13:06:47.180	Accidental timestamp		
7	Characterisation	LR		Stairs down	walking	7	13:08:34.000	13:10:16.000				
8	Sensor Validation	6/1/2014		Light cycling	1 Resist, 30 RPM	6	13:01:17.460	13:04:23.870				
9	Free Living	6/8/2014		Moderate cycling	3 Resist, 40 RPM	5	12:57:12.370	13:00:16.370				
10	Handedness	R		Rowing	3:30 min/500m	4	12:52:24.840	12:55:31.060				
11				Watching TV	-	3	12:43:49.430	12:47:14.060				
12				Tablet use	-	2	12:37:38.710	12:40:39.930				
13				Eating with spoon	-	1	12:33:45.590	12:36:56.460				
14												
15												

Participant Info | Sensor Validation - BodyMedia | Sensor Validation - CSEM | Free Living

Figure 6 Screenshot of the template .xlsx worksheet *Participant Info*, containing: A) general subject information and B) participant-specific information for the *Sensor Validation* sub-protocol.

General information about each subject is provided in *General Participant Characteristics* section (**Figure 6** columns A-B and **Table 4**) of the *Participant Info* worksheet. Specifically, it contains an anonymized identification code for the subject, general characteristics of the subject including age, sex, BMI, handedness, group, risk characterization and dates of the two physical activities sessions.

Table 4 List of variables in the .xlsx worksheet *Participant Info*; section *General participant characteristics* and their attributes, i.e., type of variable, format and/or measurement units.

Variable name	Variable type	Measurement unit	Comments
SUBJECT CODE	**String**	-	Non-identifiable unique subject code
Gender	**Categorical** M: Male F: Female	-	-
Age	**Real number**	Years	
BMI	**Real number**	kg/m2	
Group	**Categorical** N: Normal	-	In this dataset the category will always be "N". The category exists because of the D6.1 dataset, which also included "O" and "ED" for obese and eating disorder patients respectively, (see D6.1)
Characterisation	**Categorical** LR: Low risk (N) HRO: High risk for obesity (N) HRED: High risk for eating disorders (N)	-	The physical activity and eating behaviour (obtained by participation in the Mandometer study; see paragraph 4) of each participant were analysed by medical experts, in similar fashion as in the D6.1 dataset
Sensor validation	**Date** (MM/DD)	Months/days	Date of sensor validation session

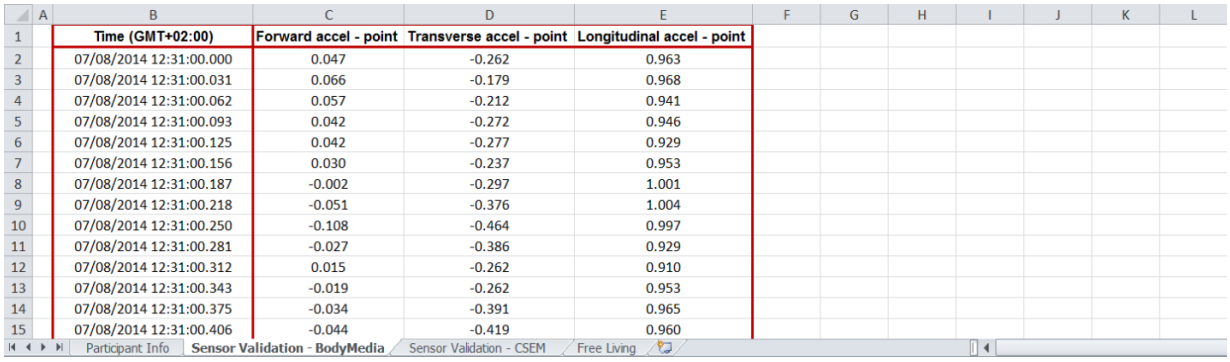
Free living	**Date** (MM/DD)	Months/days	Date of free living session
Handedness	**Categorical** L: Left-handed R: Right-handed	-	-

The *Sensor Validation protocol* section (**Figure 6** columns D-J and **Table 5**) of the *Participant Info* worksheet, contains session-related information about each participant.

Table 5 List of variables in the .xlsx worksheet *Participant Info*; section *Sensor Validation Protocol* and their characteristics, i.e., type of variable, format and/or measurement units.

Variable name	Variable type	Measurement unit	Comments
Session start	**Time** (hh:mm:ss.ms)	Hours, minutes, seconds, milliseconds	Start time of session
Type	**String**	-	Type of activity performed. Check D1.3 for more details on the protocol of this session.
Settings	**Depending on the type of activity**	-	Participants-selected settings for each activity (e.g., km/h when using the treadmill and resistance between 1 and 20 when using the bike).
Randomisation	**Integer**	1 - 9	The order of the activities in the session (1=first, 9=last). Check D1.3 for more details on the randomisation of the activities.
Start	**Time** (hh:mm:ss.ms)	Hours, minutes, seconds, milliseconds	Timestamp on the BodyMedia device marking the start time of the activity
Stop	**Time** (hh:mm:ss.ms)	Hours, minutes, seconds, milliseconds	Timestamp on the BodyMedia device marking the stop time of the activity
Notes	**String**	-	Additional notes from investigator on the activity performed (if any).

The *Sensor Validation - Bodymedia* worksheet includes Bodymedia derived data (32Hz sampling rate), collected during the structured activity sessions (**Figure 7**, **Table 6**). The point measurements per measured axis (forward, transverse and longitudinal acceleration) are provided, as requested by AUTH. The synchronization of data from this worksheet and the worksheet *Sensor Validation – CSEM* will be performed by AUTH (WP3).



	Time (GMT+02:00)	Forward accel - point	Transverse accel - point	Longitudinal accel - point
2	07/08/2014 12:31:00.000	0.047	-0.262	0.963
3	07/08/2014 12:31:00.031	0.066	-0.179	0.968
4	07/08/2014 12:31:00.062	0.057	-0.212	0.941
5	07/08/2014 12:31:00.093	0.042	-0.272	0.946
6	07/08/2014 12:31:00.125	0.042	-0.277	0.929
7	07/08/2014 12:31:00.156	0.030	-0.237	0.953
8	07/08/2014 12:31:00.187	-0.002	-0.297	1.001
9	07/08/2014 12:31:00.218	-0.051	-0.376	1.004
10	07/08/2014 12:31:00.250	-0.108	-0.464	0.997
11	07/08/2014 12:31:00.281	-0.027	-0.386	0.929
12	07/08/2014 12:31:00.312	0.015	-0.262	0.910
13	07/08/2014 12:31:00.343	-0.019	-0.262	0.953
14	07/08/2014 12:31:00.375	-0.034	-0.391	0.965
15	07/08/2014 12:31:00.406	-0.044	-0.419	0.960

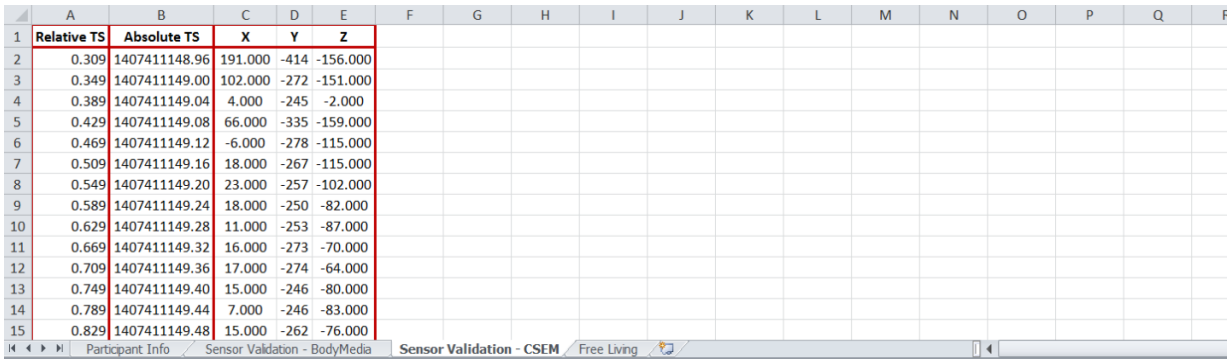
Participant Info | Sensor Validation - BodyMedia | Sensor Validation - CSEM | Free Living

Figure 7 Screenshot of worksheet *Sensor Validation – BodyMedia* with point acceleration measurements for each of the measured axes.

Table 6 List of variables in the *Sensor Validation – BodyMedia* worksheet, their type, format and/or the measurement unit.

Variable name	Variable type	Measurement unit	Comments
Time (GMT + 02:00)	**Time** (MM/DD/YYYY HH:MM:SS.MS)	Month, day, year, hours, minutes, seconds, milliseconds	Sampling frequency: 32Hz
Transverse / Longitudinal / Forwards acceleration – point	**Real number**	g	Point acceleration at the transverse/longitudinal /forward axes respectively

The *Sensor Validation - CSEM* worksheet includes data collected by the SPLENDID activity sensor prototype (CSEM; 25Hz sampling rate), collected during the structured activity sessions (**Figure 8**,**Table 7**). The point measurements per measured axis (X, Y, Z) are provided, as requested by AUTH. The synchronization of data from this worksheet and the worksheet *Sensor Validation – BodyMedia* will be performed by AUTH (WP3).



	Relative TS	Absolute TS	X	Y	Z
2	0.309	1407411148.96	191.000	-414	-156.000
3	0.349	1407411149.00	102.000	-272	-151.000
4	0.389	1407411149.04	4.000	-245	-2.000
5	0.429	1407411149.08	66.000	-335	-159.000
6	0.469	1407411149.12	-6.000	-278	-115.000
7	0.509	1407411149.16	18.000	-267	-115.000
8	0.549	1407411149.20	23.000	-257	-102.000
9	0.589	1407411149.24	18.000	-250	-82.000
10	0.629	1407411149.28	11.000	-253	-87.000
11	0.669	1407411149.32	16.000	-273	-70.000
12	0.709	1407411149.36	17.000	-274	-64.000
13	0.749	1407411149.40	15.000	-246	-80.000
14	0.789	1407411149.44	7.000	-246	-83.000
15	0.829	1407411149.48	15.000	-262	-76.000

Participant Info | Sensor Validation - BodyMedia | Sensor Validation - CSEM | Free Living

Figure 8 Screenshot of worksheet *Sensor Validation - CSEM*. Physical activity data example.

Table 7 List of variables in the *Sensor Validation – CSEM* worksheet, their type, format and/or the measurement unit.

Variable name	Variable type	Measurement unit	Comments
Relative TS	**Time** (SS.MS)	Seconds, milliseconds	Time stamp (TS) from when the activity sensor was turned on
Absolute TS	**Time** (SS.MS)	Seconds, milliseconds	Time stamp in seconds since the year 1970
X/Y/Z	**Real number**	g*300	Acceleration at each time point at the X/Y/Z axes respectively

The *Free Living* worksheet includes the 24h-session BodyMedia data collected with a sampling rate of 1 measurement / minute. Additionally, energy expenditure estimations, based on BodyMedia embedded algorithms are included for each measured minute. Finally, the worksheet includes the transcript of the self-reported (through the use of the physical activity diary) physical activities (**Figure 9** and **Table 8**). The synchronization of data from the BodyMedia armband and the Activity Diary was performed manually by KI and Mando.

	A	B	C	D	E	F	G	H	I	J
1		Time (GMT+02:00)	Forward accel - average	Transverse accel - average	Longitudinal accel - average	Energy expenditure	Diary	Anotation		
2		06/30/2014 12:43:00.000	-0.135	0.956	-0.208	10.493	0			
3		06/30/2014 12:53:00.000	-0.197	0.984	-0.090	20.139	0			
4		06/30/2014 12:54:00.000	-0.182	0.963	-0.139	20.410	0			
5		06/30/2014 12:55:00.000	-0.349	0.485	-0.809	4.900	1	Commuting, metro		
6		06/30/2014 12:56:00.000	-0.396	0.485	-0.779	4.747	1	Commuting, metro		
7		06/30/2014 13:18:00.000	-0.476	0.765	-0.409	4.865	1	Commuting, metro		
8		06/30/2014 13:19:00.000	-0.583	0.492	-0.343	4.648	1	Commuting, metro		
9		06/30/2014 13:20:00.000	-0.092	0.984	0.091	11.686	1	Commuting, metro		
10		06/30/2014 13:21:00.000	-0.072	0.982	0.052	11.551	1	Walking, shopping		
11		06/30/2014 13:22:00.000	-0.097	0.975	0.005	11.685	1	Walking, shopping		
12		06/30/2014 13:23:00.000	-0.125	0.977	0.106	11.519	1	Walking, shopping		
13		06/30/2014 13:24:00.000	-0.145	0.977	0.003	11.255	1	Walking, shopping		
14		06/30/2014 13:25:00.000	-0.080	0.980	0.042	11.468	1	Walking, shopping		
15		06/30/2014 13:26:00.000	-0.155	0.929	-0.110	11.664	1	Walking, shopping		

Participant Info | Sensor Validation - BodyMedia | Sensor Validation - CSEM | Free Living

Figure 9 Screenshot of worksheet *Free Living*. Physical activity data example.

Table 8 List of variables in the *Free Living* worksheet, their type, format and/or the measurement unit.

Variable name	Variable type	Measurement unit	Comments
Time (GMT + 02:00)	**Time** (MM/DD/YYYY HH:MM:SS.MS)	Month, day, year, hours, minutes, seconds, milliseconds	Sampling frequency 1/min
Transverse / Longitudinal / Forwards acceleration – average	**Real number**	g	Average acceleration during the sampling period at the transverse/longitudinal /forward axes respectively
Energy expenditure	**Real number**	kJ	Estimation of energy expenditure based on embedded Bodymedia algorithms
Diary	**Binary**	-	Simple binary code for presence (1) or absence (0) of a reported activity in the physical activity diary

Annotation	**String**	-	Annotation of activity label from the activity diary for the time period

4 Mandometer data

4.1 Introduction

In the study related to task 6.3: *Sensor testing with different foods*, participants ate three meals with the Mandometer in a semi-controlled environment, while being video-recorded. The foods served were vegetables with chicken (in cubes), tomato and meat soup (i.e. tomato soup with finely grinded meat) and hamburgers (**Table 9**). For more information on the study protocol see *D1.3*. These data (i.e., *Novel data*) was combined with comparable past data (i.e., *Old data*) collected from different healthy individuals eating five different types of food (**Table 5**). The study procedure and data collection of both *Old Data* and *Novel Data* are identical. The Mandometer and the Activity sensor studies ran in parallel, using the same subjects (**Table 3**).

The combined dataset will be used in T3.1, to test the sensitivity and the validity of the Mandometer in meals with a wide range of food types. The dataset will also be used to investigate the possibility of using the Mandometer signal to identify different food types being eaten.

Table 9 Baseline characteristics of participants of the *Novel Data* and *Old Data* studies

Novel Data	**Male**	**Female**	**Food type**
Sample size (n)	8	8	• Vegetables with chicken • Tomato and meat soup • Hamburger
Age (years)	27.3 ± 1.4	25.5 ± 2.4	
BMI	25.1 ± 5.5	23.3 ± 4.9	
Old Data			
Sample size (n)	7	8	• Curry rise with chicken
Age (years)	24.1 ± 3.2	22.8 ± 2.5	
BMI	24.1 ± 3.4	21.9 ± 1.6	
Sample size (n)	-	7	• Macaroni with minced meat
Age (years)	-	23.3 ± 2.1	
BMI	-	22.5 ± 2.5	
Sample size (n)	6	6	• Meatballs and potatoes
Age (years)	25.2 ± 4.3	24.4 ± 3.2	
BMI	25.4 ± 0.8	23.4 ± 2.9	
Sample size (n)	6	6	• Minced meat and potato purée
Age (years)	25.2 ± 4.3	24.4 ± 3.2	
BMI	25.4 ± 0.8	23.4 ± 2.9	
Sample size (n)	-	5	• Oat porridge
Age (years)	-	22.1 ± 1.8	
BMI	-	22.3 ± 2.7	

4.2 Data file description

The collected *Novel data* was stored in one excel workbook, comprised of four worksheets (Figure 10 and Figure 11. Information on the participant was added to the worksheet named *Participant Info*. Mandometer recordings from the meal sessions with different foods were stored into three separate worksheets (*Food type A*, *Food type B* and *Food type C* for *Vegetables with chicken*, *Tomato and meat soup* and *Hamburger*, respectively). The same template file was used for *Old Data*, but since there was only one meal session per participant, worksheets *Food type B* and *Food type C* were left empty (Figure 10 and Figure 11).

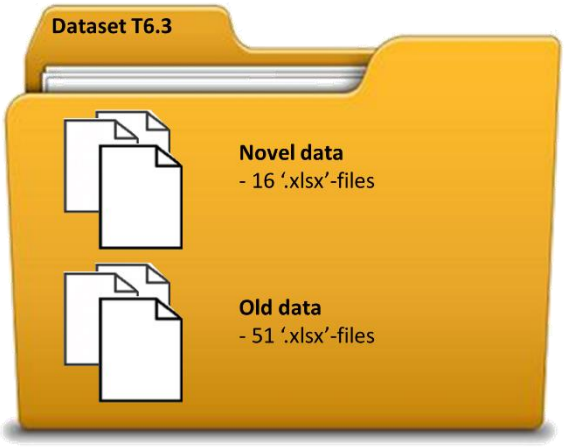
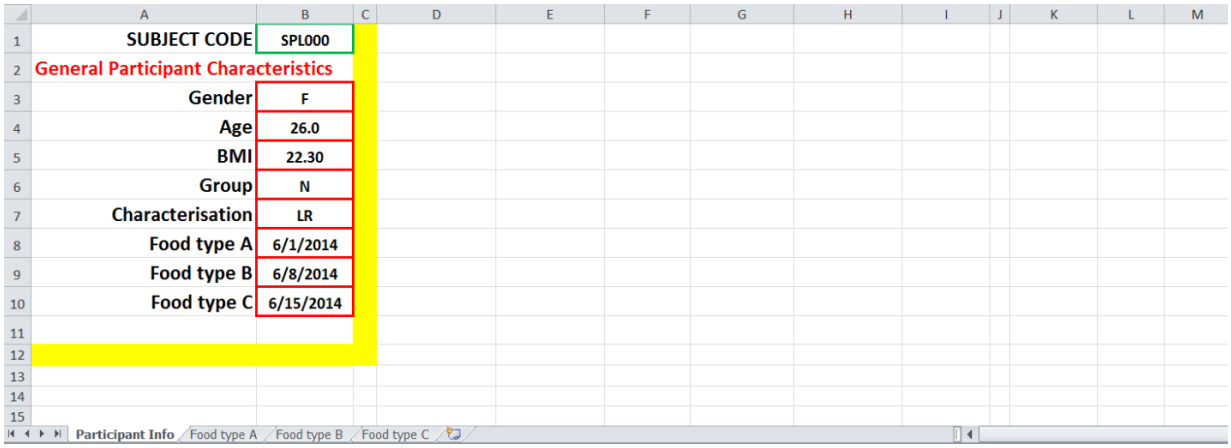


Figure 10 Basic structure dataset T6.3 (data collected with Mandometer)



	A	B
1	SUBJECT CODE	SPL000
2	General Participant Characteristics	
3	Gender	F
4	Age	26.0
5	BMI	22.30
6	Group	N
7	Characterisation	LR
8	Food type A	6/1/2014
9	Food type B	6/8/2014
10	Food type C	6/15/2014

Participant Info | Food type A | Food type B | Food type C

Figure 11 Screenshot of the template .xlsx worksheet *Participant Info*, containing general subject information.

The *Participant Info* worksheet (**Figure 11**, **Table 10**) contains general information on each participant in the study.

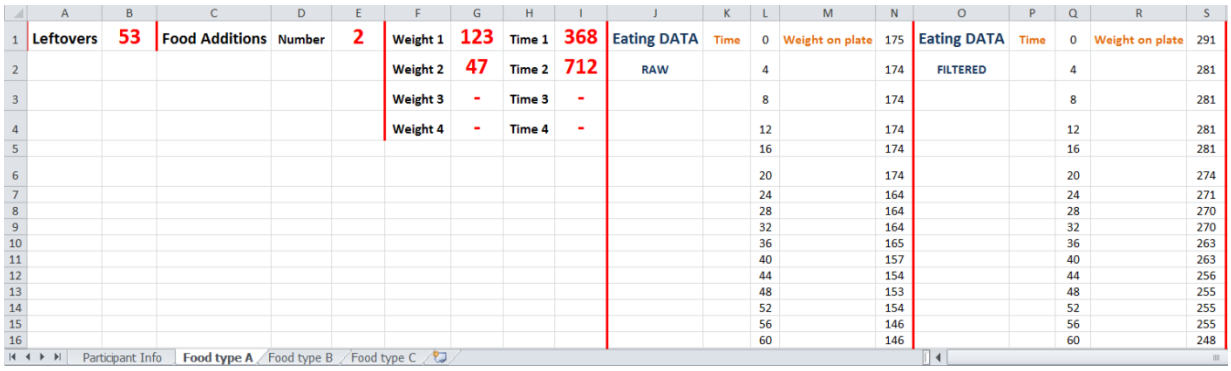
Table 10 List of variables in the .xlsx worksheet *Participant Info* and their characteristics, i.e., type of variable, format and/or measurement units.

Variable name	Variable type	Measurement unit	Comments
SUBJECT CODE	**String**	-	Non-identifiable unique subject code
Gender	**Categorical** M: Male F: Female	-	-
Age	**Real number**	Years	-
BMI	**Real number**	kg/m2	-
Group	**Categorical** N: Normal	-	In this dataset the category will always be "N". The category exists because of the D6.1 dataset, which also

Variable name	Variable type	Measurement unit	Comments
			included "O" and "ED" for obese and eating disorder patients respectively (see D6.1)
Characterisation	**Categorical** LR: Low risk (N) HRO: High risk for obesity (N) HRED: High risk for eating disorders (N)	-	The physical activity (obtained by participation in the Activity Sensor study; see paragraph 3) and eating behaviour of each participant were analysed by medical experts, in similar fashion as in the D6.1 dataset
Food Type A/B/C	**Date** (MM/DD)	Months/days	Date of meal sessions. Novel Data included 3 meals (Food type A: Vegetables with chicken, Food type B: Tomato and meat soup and Food type C: Hamburger). In Old Data workbooks only include data from one meal/individual. Thus Food type B and C are left empty

During the meals in both the *Novel* and *Old Data*, the Mandometer sampling rate was set to 1Hz. The *Food type A/B/C* worksheets created from these sessions include cumulative information about the meals, as well as raw and filtered Mandometer dataseries (**Figure 12**,

Table 11).



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1	Leftovers	53	Food Additions	Number	2	Weight 1	123	Time 1	368	Eating DATA	Time	0	Weight on plate	175	Eating DATA	Time	0	Weight on plate	291
2						Weight 2	47	Time 2	712	RAW		4		174	FILTERED		4		281
3						Weight 3	-	Time 3	-			8		174			8		281
4						Weight 4	-	Time 4	-			12		174			12		281
5												16		174			16		281
6												20		174			20		274
7												24		164			24		271
8												28		164			28		270
9												32		164			32		270
10												36		165			36		263
11												40		157			40		263
12												44		154			44		256
13												48		153			48		255
14												52		154			52		255
15												56		146			56		255
16												60		146			60		248

Participant Info | Food type A | Food type B | Food type C

Figure 12 Screenshot of worksheet *Food type A*. Meal data example.

Table 11 List of variables of the meal session and their type, format and/or measurement units.

Variable name	Variable type	Measurement unit	Comments
Leftovers	**Integer**	g	Weight of leftovers on the plate after meal
Food additions number	**Integer**	-	Number of food additions on the plate during meal
Food additions weight	**Integer**	g	Weight of each food addition
Eating Data - Raw	**-**	-	Raw weight-on-the-scale Mandometer data
Eating Data - Filtered	**-**	-	Weight-on-the-scale Mandometer data, filtered manually by using the video data captured during the meals
Time	**Integer**	sec	Time since the start of meal
Weight on plate	**Integer**	g	Food-weight on the scale, measured at each time during the meal

5 Conclusions

Empirical data was collected successfully for the different sensors, i.e. prototypes of the chewing and swallowing sensor, the physical activity sensor and the Mandometer. Data was collected for validation purposes, but also to feed the algorithms that will be used in order to develop behavioral indicators. Last, the data will be used for decisions for further development of the system.