

FETPROACT-2-2014: Knowing, doing, being: cognition beyond problem solving

ACTION ACRONYM

**TIMESTORM**

ACTION FULL TITLE

**" MIND AND TIME: INVESTIGATION OF THE TEMPORAL  
TRAITS OF HUMAN-MACHINE CONVERGENCE"**

GRANT AGREEMENT NO:

**641100**



DELIVERABLE D1.2

**[FIRST INTERIM PROJECT REPORT]**

DUE DATE

**[MONTH 12]**

RESPONSIBLE PARTNER

**[FOUNDATION FOR RESEARCH AND TECHNOLOGY HELLAS]**

Contents

<b>Executive Summary</b> .....	<b>2</b>
<b>1 Explanation of the work carried out by the beneficiaries and overview of the progress</b> .....	<b>3</b>
<b>1.1 Objectives</b> .....	<b>4</b>
<b>1.2 Summary of the research effort devoted on WPs</b> .....	<b>5</b>
<b>1.3 Explanation of the work carried out per WP</b> .....	<b>5</b>
1.3.1 WP1: Management and dissemination activities.....	5
1.3.2 WP2: Methodological framework and experimental setup specifications.....	6
1.3.3 WP3: Knowledge management over time.....	7
1.3.4 WP4 Timely action planning .....	8
1.3.5 WP5 Short and long term aspects of social self.....	9
1.3.6 Deliverables and milestones tables .....	10
<b>1.4 Ethical Issues</b> .....	<b>11</b>
<b>1.5 Impact</b> .....	<b>11</b>
<b>2 Update of the plan for exploitation and dissemination of results</b> .....	<b>13</b>
<b>3 Update of the data management plan</b> .....	<b>13</b>

# First Interim Project Report

## Executive Summary

The TimeStorm project has been funded by the EU FETPROACT-2-2014 invited innovative and high impact research under the topic "Knowing, doing, being: cognition beyond problem solving". The goal of the TimeStorm project entitled "Mind and Time: Investigation of the Temporal Traits of Human-Machine Convergence" is to examine the role of time in multi-agent collaboration, considering particularly the case of daily human-robot interaction.

More specifically, the increasing need for robots smoothly integrated into our daily lives assumes focused exploration of the temporal aspects which are innately present in human machine interaction. In contrast to humans, ordinary computational systems cannot efficiently handle time, an issue that significantly hampers fluency in short-term human-robot interaction and long-term human-robot symbiosis.

TimeStorm postulates that sense of time acts as a neuro-cognitive 'glue' that integrates processes from different cognitive modalities, resulting in more complete and powerful intelligent systems. In that sense, the equipment of artificial agents with temporal cognition establishes a new framework for the investigation and integration of "knowing", "doing", and "being" in artificial systems.

TimeStorm aims at the multidisciplinary investigation of time perception in order to extract working principles that enable implementing a computational architecture, analogous to natural temporal cognition, in robotic systems. To this end, TimeStorm explores the temporal aspects of multi-modal cognition in the context of real-world scenarios. The project aims at implementing a new generation of autonomous robots perfectly situated both in space and time depending on the goals and the wider collaborative framework. The achievement of TimeStorm goals will be demonstrated in the context of assistive human-robot interaction, in a kitchen environment.

The current document<sup>1</sup> summarizes the progress achieved in the first year of the TimeStorm project.

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<sup>1</sup>The TimeStorm Annual Report follows the structure of the Horizon2020 Periodic Report Template [http://ec.europa.eu/research/participants/data/ref/h2020/gm/reporting/h2020-tmpl-periodic-rep\\_en.pdf](http://ec.europa.eu/research/participants/data/ref/h2020/gm/reporting/h2020-tmpl-periodic-rep_en.pdf)

# 1 Explanation of the work carried out by the beneficiaries and overview of the progress

TimeStorm is set up as a three and a half year project. The work in TimeStorm is separated into six technical work packages and one work package covering project management and project-dissemination activities. The breakdown of the overall work plan in Workpackages (WPs) and their timing are graphically shown in Figure 1.

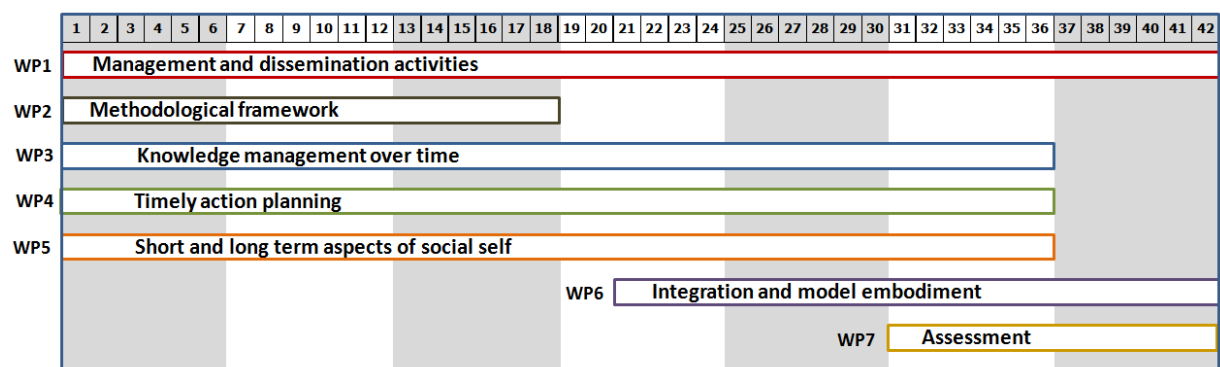


Figure 1. Gantt chart of the TIMESTORM project.

This report covers the first 12 months of TimeStorm, from 1/1/2015 to 31/12/2015. In the first year of the project, all the resources devoted in the project are amassed in WPs 1-5. In short, WP1 considers project management issues, WP2 considers the details of the TimeStorm research plan aiming at a coherent bridging between interdisciplinary research endeavors and WPs 3, 4 and 5 aim respectively at the focused exploration of subtopics roughly described in the EU FETPROACT-2-2014 as "knowing", "doing" and "being".

In that period, TimeStorm has adopted an interdisciplinary research approach that exploits the expertise each partner brings into the project and in doing so has addressed important topics of mind-time interaction. Current efforts involve research streams of developmental, brain-imaging and computational modeling studies, properly directed to mutually address key questions on temporal cognition from complementary perspectives.

## 1.1 Objectives

TimeStorm postulates that the perception of time and temporal cognition is not an optional extra but a necessity towards the development of truly autonomous and intelligent machines that are seamlessly and actively integrated into human societies.

To direct research in TimeStorm, we have identified five core objectives as part of understanding mind-time interactions and developing real world robots that effectively collaborate with humans in the short- and long-term. The relevance of the TimeStorm first year work to the objectives of the project are analyzed below:

**Objective 1 -** *Reveal the temporal aspects of the self and conspecifics, and describe an implementation framework for robots that perceive the flow of time.*

Empirical work is in full progress in the first year of the project. We adopt novel experimental setups to address unexplored aspect of time perception in the three main research directions considered in the project, namely, "knowing", "doing" and "being". It is a major goal of the TimeStorm empirical work to formulate a holistic theory that adequately explains all experimental data, and thus provide a clear target for modeling.

**Objective 2 -** *Adopt a joint developmental, neuroimaging investigation of the human brain to decipher the circuits and neurofunctional processes involved in temporal cognition and perception.*

The overlapping interests of TimeStorm partners on temporal cognition has greatly facilitated collaborations, specifying bridging points between individual research endeavours. From the first year of the project we have already identified research directions where collaboration between TimeStorm partners will provide significant insight in mind-time interactions and will also accomplish high scientific impact.

**Objective 3 -** *Implement a new generation of artificial cognitive systems that realize diverse aspects of time perception and their links to ordinary cognitive skills.*

Significant work has already begun in modeling time perception and time-related cognitive capacities. We have used various technologies to implement particularly novel models addressing, among others, short- and long-term time perception, mental time travel in the form of episode recall, and multi-criteria time-informed planning.

**Objective 4 -** *Embody cognitive systems in humanoid robots and enable the latter to exploit sense of time in order to effectively engage in symbiotic human-robot interaction situations.*

Significant work has already begun in practically testing the implemented models. Current efforts have mainly considered the simulated environment ArmarX and realistic scenarios of robot-robot collaboration in a kitchen environment. This procedure reveals potential shortcomings in the first versions of the implemented models, therefore pointing out directions for immediate improvements in the following months.

**Objective 5 -** *Provide added value on the neuro-behavioral and computational studies by jointly considering the obtained multidisciplinary results.*

The strong coupling of neuroscientific and computational research endeavours is in the centre of TimeStorm workplan. In this direction we have already compiled a research agenda inviting bipartite, tripartite and more complex collaborations among the beneficiaries. We expect that the implemented models will provide novel means for exploring temporal cognition (e.g. artificial damages on timing models, experimental setups that cannot be applied in human subjects) providing significant feedback to neuroscience by revealing unexplored aspects of mind-time coupling.

Clearly, in the first year of the project work was performed on all objectives, with the specific goal of achieving the project’s first two milestones by Month 12:

Milestone 1: Major progress in methodological framework specification, neuroscientific and modeling work commenced.

Milestone 2: Early neuroscientific results, computational modeling in full progress.

The submission of the first year TimeStorm deliverables D1.1, D1.2, D2.1, D3.1, D4.1, D5.1, verify full achievement of the two milestones.

## 1.2 Summary of the research effort devoted on WPs

TimeStorm combines complementary methodologies, theoretical approaches and expertise for studying temporal cognition. All technical work packages amassed work from multiple beneficiaries accomplishing the multi-disciplinary investigation of the relevant topics. Analytic description of how the work conducted by individual partners is located in the context of the TimeStorm network is given below.

The following table summarizes the current (to date) person months contributed by each beneficiary to WPs 1-5 that was active in the first year of the project.

<b>Beneficiary</b>	<b>WP1</b>	<b>WP2</b>	<b>WP3</b>	<b>WP4</b>	<b>WP5</b>	<b>Total</b>
<b>FORTH</b>	2.8	3.2	6	6	1.57	<b>19.57</b>
<b>UBP</b>	0.44	2	2	4	2	<b>10.44</b>
<b>UoS</b>	0.45	1	1	3	6	<b>11.45</b>
<b>UoG</b>	0.6	2	8	4	1	<b>15.6</b>
<b>Imperial</b>	0.34	5	3	1	4	<b>13.34</b>
<b>KIT</b>	0.3	9.3	2	2	1	<b>14.6</b>

## 1.3 Explanation of the work carried out per WP

The following paragraphs summarize the work and the relevant accomplishments in the first year of the project, broken down in WPs.

### 1.3.1 WP1: Management and dissemination activities

In the first year of the project, the coordinator has taken specific measures to establish efficient communication among partners, and monitor the overall performance of the project. In particular, FORTH has been in direct communication with all the institutes participating in the project in order to facilitate their smooth cooperation and direct joint

research endeavors towards the achievement of the project objectives. Moreover, FORTH had a high level monitoring on the resources spend by beneficiaries to ensure they are used in agreement to the research goals and procedures of the project.

From the very beginning of the project, FORTH established two TimeStorm related mailing lists, one for the TimeStorm-PIs and one for all academics, researchers, technicians and students participating in the project. Using mailing lists, TimeStorm participants could easily coordinate their actions towards mutual research goals.

In order to further encourage focused collaboration, FORTH organized a one-day meeting in Frankfurt Airport with the participation of computational partners, namely FORTH, KIT and IMPERIAL, discussing the interface of individual modelling activities. Moreover, FORTH has hosted an internal project meeting with the participation of all TimeStorm beneficiaries on September 2015, where successful progress along the workplan has been verified and alternative options for strengthening collaboration between groups were extensively discussed. Additionally, decisions have been taken about the organization and storage of research data in order to facilitate their future use after the end of the project.

FORTH has implemented the TimeStorm-website ([timestorm.eu](http://timestorm.eu)) to promote the visibility of the project and make research results known to the scientific and general audience. To facilitate dissemination of the project, most PIs participated in European and international meetings to present the work that is currently conducted in TimeStorm.

### 1.3.2 WP2: Methodological framework and experimental setup specifications

The work in WP2 has been mainly devoted to bridging individual research endeavors in order to strengthen interaction and collaboration between the partners of the project. To this end, productive communications between the TimeStorm beneficiaries, under the lead and coordination of partner Imperial, have identified eight experimental and modeling themed research activities that invite high impact multidisciplinary research. The eight themes are summarized below (for an analytic description see D 2.1):

1. **Effect of Temporal Context on Time Perception.** Find the neurophysiological signatures of temporal context on the perception of time (e.g. effects of recent sensory experience on time perception), explore how temporal context priors are implemented and maintained over time
2. **Modal Influences on Time Perception.** Explore time distortions between the sensory modalities as a function of different age groups / different cognitive abilities, explore how temporal estimates are modulated by a variation in sensorimotor coupling and the feeling of immersion and naturalness
3. **Working Memory, Internal Clocks and Time.** Explore the strong coupling of interval timing and working memory, how the mechanisms related to WM are also involved in time processing, understand the procedure of encoding elements into working memory, explore how they are filtered and stored in long-term memory.
4. **Time and Long-Term Memory.** Study the mechanisms supporting long-term time perception, how they are different from short-term time perception, explore which processes make us perceive recent and far past at different time scales, consider how time interferes to other memory processes such as mental time travel.

5. **Interaction of Time and Cognitive Capacities.** Explore the differences in time judgment as a function of temporal task and demand, in terms of cognitive abilities required by each task, investigate how cognitive capacities at different ages affect time perception, understand how attention, working memory and behavior planning are linked to time perception
6. **Time and Embodiment.** Explore in what extent duration judgments are affected by interoception and perceived embodiment, how the brain forms representations of time within and across both the self and in different contexts, study the effect of emotional context on humans' abilities to synchronize with others.
7. **Time and Behaviour.** Investigate how prior knowledge on action duration affects time perception, consider the length and order of action primitives in relation to the broader context, explore how activities are synchronized to events and behaviors of third parties, explore the procedures involved in activity planning under temporal constraints.
8. **Time in Human Robot Interaction.** Integrate time-informed perception and action planning capacities in a single composite system, explore decision making based on past experiences and future goals, consider the management of personal time within a broader social context, short and long-term aspects of action execution.

Besides identifying key research themes that are crucial for understanding mind-time interactions, WP2 has considered a number of alternative technologies to support computational modeling. In support of these efforts, KIT has implemented a new ArmarX simulation environment enabling simultaneous simulation of multiple robots for collaborative manipulation tasks. This simulation environment is expected to significantly facilitate TimeStorm modeling efforts, and smooth embodiment of the implemented models into the series of ARMAR robots.

FORTH, Imperial, UoS and KIT have considered ideas from a range of different modeling methodologies to develop partial models of temporal cognition. Current formulations and model implementations are based on modular neural networks, reservoir computing (both echo-state-networks, ESN, and liquid-state-machines, LSM), evolutionary algorithms and co-evolution, graph theory, fuzzy systems, probabilistic modeling, symbolic modeling and kinematic trajectory generation.

Interfacing the relevant modelling techniques is crucial for implementing the full TimeStorm model. The partners involved in computational modeling have already considered interfacing and they have made early towards integrating existing models. These efforts will be significantly facilitated by the ArmarX simulation framework that enables integration and testing the relevant models. It seems that offline optimization will significantly facilitate integration through the global, multi-criteria tuning of key parameters for each model.

### 1.3.3 WP3: Knowledge management over time

This is one of the three main experimental work packages that are active in the first year of the project. The work conducted in WP3 has highlighted the importance of investigating time perception in naturalistic tasks outside of carefully designed laboratory settings that aim to sterilize time, often excluding the broader context.



Interestingly, adhering to the retrospective versus prospective timing dichotomy renders it practically impossible to study how interval timing affects complex, everyday, real-life behavior. To address this issue, UoG explored a new theoretical framework which aims to explain interval timing in real world settings based on a reinterpretation of existing knowledge about human brain mechanisms. This framework is named the Continuative Timing Theory (CTT), as it focuses on the continuation of time during the estimation of multiple intervals. The proposed CTT is partly based on the Striatal Beat Frequency Model (SBF) that allows for the perception of intervals of arbitrary duration. In support of this theory UoG has reviewed the influence of memory processes on interval timing to identify properties of everyday temporal cognition that are not sufficiently explained by previous theories but can be more completely explained by CTT (e.g. concurrent timing of multiple intervals).

Moreover, to explore subjective experience of time in relation to physical time in children and adults, UBP has conducted developmental studies to provide insight into the time perception maturation mechanisms as a function of the cognitive abilities required for tasks. The self-referential effect of knowing how emotions shape time perception has been explored in another study by UBP showing that the conscious awareness of time distortions may change the effect of emotion on time perception.

In another line of work, UoG explored the role of attention in perceiving time regularities, such as the "beat" while listening music and how much this is affected by the subjects expertise and proficiency in relevant topics. The obtained results indicate that hierarchical beat perception is an automatic process that requires minimal attentional resources.

Early modeling work by FORTH aimed to integrate time perception in the wider context of memorizing events, keeping track of both "how-long" an event has lasted and additionally "when" it occurred in the past. The combined consideration of these two temporal aspects is vital for an artificial agent to perceive and understand the sequence and evolution of real world events in a rich and meaningful way that adequately informs future human-robot interaction sessions.

#### **1.3.4 WP4 Timely action planning**

Research work within WP4 aims to explore how time affects and is affected by the procedures involved in the planning and implementation of actions. Along this line, UBP examined the effects of emotional bodily expressions on the perception of time, showing that fearful bodily expressions and actions result into the overestimation of experienced time.

Based on the implementation of a new experimental setup, KIT and UoG tested the ability of humans to repeat actions demonstrated by an artificial agent. The obtained results show that humans were able to approximately reproduce the temporal characteristics of relevant action sequences even if there were no explicit indicators to highlight the starting and ending points of the actions and tasks.

The mechanisms enabling long-term time perception in the order of minutes, and more, have been explored by UBP. The relevant study explored temporal judgements and their relation to judgements of time passage in young and elderly people showing there is no

clear directional bias for any of the two groups, as well as that the two temporal judgements are largely unrelated.

Early modelling work has explored how temporal information and time constraints may be integrated into behaviour planning for artificial agents. FORTH devised a new planning framework that assumes the representation of time as fuzzy numbers that can be directly used into arithmetic calculations aiming to rank alternative action sequences. Interestingly, the fuzzy representation of time enables mixing temporal information with the emotional and other characteristics of actions to implement more complete models of human decision-making and action planning as suggested by UBP.

FORTH and KIT have integrated the implemented planner in to the simulation environment ArmarX to assess its performance in simple, yet still realistic, scenarios on multi-agent collaboration in a kitchen environment.

### **1.3.5 WP5 Short and long term aspects of social self**

WP5 aims to uncover how the brain forms representations of time within and across both the self and in different contexts. To this end, UoS has used innovative “substitutional reality” methods to explore how temporal and interoceptive perception interact with one another in naturalistic sensory settings.

The substitutional reality framework introduced by UoS provides a platform for cutting-edge empirical work that will provide insight into the interactions between interoceptive and temporal processes, necessary to inform a model of fully embodied temporal cognition.

UoS reports that coherent sensorimotor coupling (the coupling of an observer’s head movements with the contents of their visual scene) has an impact on temporal judgments such that temporal intervals experienced in the presence of natural sensorimotor coupling are judged to be longer than those experienced in the absence of such coupling.

Building on earlier work by TimeStorm partner Gronigen, UoS has additionally found that the rate of presentation of a scene (framerate) modulates reported estimates of duration such that scenes presented at a faster rate are reported as persisting for longer than those presented at normal or slower speeds – all in the highly immersive substitutional reality environment. In general, UoS reports that individuals exhibiting low interoceptive awareness generally overestimate the duration of an interval.

In a different direction, UBP has begun investigation of the effect of emotional context on humans’ abilities to synchronize with others, reporting that the emotional content of a visual stimulus can affect the ability of human observers to maintain a rhythmic motor action.

In an attempt to provide insight into the mechanisms monitoring and predicting the duration of sensory events, UoS used mismatch negativity effect (MMN), to explore the possible neural correlates of prediction in the temporal context. The obtained results are in agreement with the hypothesis of neural processes dedicated to the prediction of durations, and additionally suggest that the relevant processes might be distinguishable from previous demonstrations of simple rhythmic prediction or entrainment.

Collaborative modelling work between UoS and Imperial has begun empirically investigating components of a putative “predictive coding” model of temporal

perception. Consistent with previous Bayesian models, early results nicely demonstrate that recent sensory experience biases perception such that estimates of duration are shifted towards the mean of a range of intervals.

### 1.3.6 Deliverables and milestones tables

#### Deliverables

The following table shows an overall picture of the deliverables that have been submitted since the beginning of the project.

Deliv. No	Deliverable Title	WP No	Lead Beneficiary	Type	Dissemin. Level	Due Date (in months)	Submitted
D1.1	Project web site	WP1	FORTH	Website	Public	4	✓
D1.2	First interim project report	WP1	FORTH	Report	Public	12	✓
D1.6	Data Management Plan in relation to the EU Open Research Data Pilot	WP1	FORTH	Report	Public	6	✓
D2.1	Experimental and modelling specifications	WP2	Imperial	Report	Public	6	✓
D2.2	Robotic simulator	WP2	KIT	Other	Public	12	✓
D3.1	Preliminary version of D3.2: Intermediate results on human brain mechanisms over time	WP3	UoG	Report	Public	12	✓
D4.1	Preliminary version of D4.2: Intermediate results on timely action planning human brain mechanisms	WP4	UBP	Report	Public	12	✓
D5.1	Preliminary version of D5.2: Intermediate results on the temporal aspects of social self	WP5	UOS	Report	Public	12	✓

As it is shown in the table, all deliverables have been submitted on time and in accordance to the project work plan.

#### Milestones (MS)

The following table shows the milestones that have been reached since the beginning of the project.

MS No	Milestone title	Lead Beneficiary	Due Date (in months)	Means of verification	Achieved Yes/No
MS1	Well defined experimental and modelling work	FORTH	6	D2.1, D1.6, D1.1	Yes
MS2	Capacity to obtain insight in temporal cognition brain mechanisms	FORTH	12	D3.1, D4.1, D5.1, D2.2, D1.2	Yes

*Comments on MS1.* By month 6, TimeStorm beneficiaries finalized the specification of the methodological framework that will be followed throughout the project identifying eight research themes that invite high impact multidisciplinary research. Based on the directions provided by the methodological framework specification, experimental and modeling work started in the first months of the project.

*Comments on MS2.* By month 12, TimeStorm beneficiaries have already obtained early neuroscientific results on the time-processing mechanisms of the human brain. The simulation environment ArmarX has been implemented to assist computational modeling efforts. The first computational models on temporal cognition have been already developed and tested.

## 1.4 Ethical Issues

All the experiments with humans, conducted in UBP, UoG and UoS, comply with standard ethics procedures, according to the principles of the Helsinki Declaration. The procedure of each experiment have been previously validated by the relevant local committees for the protection of participants (e.g. Sud-Est VI Statutory Ethics Committee (CPP) for UBP, Ethical Committee Psychology of the Heymans Institute for UoG, Science and Technology Cross-Schools Research Ethics Committee (C-REC) for UoS). All three organizations have readily available the relevant documents and will provide them upon request.

The experiments in the three organizations collected behavioral data and general information about the applicability to participate in the experiments. Due to the nature of the experiments, no incidental findings are expected for the participants. All organizations have readily available the Informed Consent Forms signed by the participants, with Information Sheets in language and terms understandable to the participants and will immediately provide them upon request.

## 1.5 Impact

In the first year of the project, the development of TimeStorm is in agreement to the information provided in the DoA, with respect to the expected impacts by the project.

To maximize the impact of TimeStorm, the consortium has so far implemented the following concrete actions:

**TimeStorm website.** Development of the TimeStorm website <http://timestorm.eu/> to maximize the visibility of the project and assist the project goals and experimental results be appreciated by scientific community and the wider public.

**Scientific publications.** The project beneficiaries have already published 10 articles that acknowledge TimeStorm in the most relevant scientific journals in the field. A list of the relevant articles is given below:

- S. Droit-Volet, J. Wearden, & P. Zélanti (2015). Cognitive abilities required in time judgment depending on the temporal task used: a comparison of children and adults. *Quarterly Journal of Experimental Psychology*, 68(11), pp. 2216-2242.

- S. Droit-Volet, M., Lamotte, & M. Izaute (2015). The conscious awareness of time distortions regulates the effect of emotion on the perception of time. *Consciousness and Cognition*, 38, pp.155-164.
- S. Droit-Volet, & S. Gil (2015). The Emotional body and time perception. *Cognition & Emotion*, 1-13.
- D. Linares, I. Cos, & W. Roseboom (2016). Adaptation for multisensory relative timing, *Current Opinion in Behavioral Sciences*, 8, pp. 35-41.
- H. Van Rijn (2016). How Memory Mechanisms Influence Interval Timing: A Review, *Current Opinions in Behavioral Sciences*.
- Halbersma, & H. Van Rijn (2016). An Evaluation of the Effect of Auditory Emotional Stimuli on Interval Timing. *Timing and Time Perception*.
- S. Droit-Volet, & J. Wearden, J. (2016). Passage of time judgments are not duration judgments: Evidence from a study using Experience Sampling Methodology. *Frontiers in psychology*, 7:176. doi: 10.3389/fpsyg.2016.00176
- M. Maniadakis, & P. Trahanias (2015). Integrated Intrinsic and Dedicated Representations of Time: A Computational Study Involving Robotic Agents, *Timing & Time Perception*, 3 (3-4), pp. 246 – 268.
- Droit-Volet, S. (In press). Temporalités, Emotion, Humeur, et troubles de l'humeur. In E. Laurent & P. Vandel (eds.). *De l'humeur quotidienne à la dépression sévère: Manuel pluridisciplinaire de la thymie*. Éditions De Boeck-Solal.
- Droit-Volet, S. (In press). Développement du temps, psychologie. *Encyclopaedia Universalis*.

Moreover a number of articles have been submitted and are currently considered for publication in scientific journals as outline below:

- *Damsma and Van Rijn, Pupillary Response Indexes the Metrical Hierarchy of Unattended Rhythmic Violations*, submitted for publication.
- N. Schlichting, A. Damsma, E. Aksoy, M. Wächter, T. Asfour, H. van Rijn, *Temporal Context Influences the Perceived Duration of Everyday Actions*, submitted for publication.
- M. Maniadakis and P. Trahanias, *When and How-long: A unified approach for time perception*, submitted in the *Frontiers Research Topic: Understanding the role of the time dimension in the brain information processing*.

The project beneficiaries have submitted 4 papers acknowledging TimeStorm to be presented in leading international scientific conferences. The list of currently submitted papers is given below.

- D. Bhowmik, K. Nikiforou, M. Shanahan, M. Maniadakis and P. Trahanias, *A Reservoir Computing Model Of Episodic Memory*, submitted to the 2016 International Joint Conference on Neural Networks (IJCNN-16)
- M. Maniadakis, E. Hourdakis and P. Trahanias, *Time-Informed Task Planning in Human-Robot Collaboration*, submitted to the 25th International Joint Conference on Artificial Intelligence (IJCAI-16)
- M. Maniadakis and P. Trahanias, *A Fuzzy Perspective on Time-Informed Multi-Robot Synchronization*, submitted to the 25th International Joint Conference on Artificial Intelligence (IJCAI-16)

- M. Maniadakis, E. Aksoy, T. Asfour, and P. Trahanias, Collaboration of Heterogeneous Agents Through Incremental Planning in Time Constrained Tasks, submitted to the 2016 Robotics: Science and Systems conference (RSS-16)

## 2 Update of the plan for exploitation and dissemination of results

There is no important update on the dissemination plan for TimeStorm.

In the first year of the project, TimeStorm was referenced and acknowledged in the following events:

- Trahanias, P., ICT 2015 Conference, Innovate Connect Transform, 20-22 Oct. 2015, Lisbon, Portugal.
- Trahanias, P., EU Robotics Day, 18 Nov 2015, Brussels, Belgium.
- Asfour, T., Keynote, "Taxonomy for Whole-Body Loco-Manipulation Actions", International Symposium on Robotics Research (ISRR), September 14, 2015.
- Asfour, T., Invited Speaker, "Affordance-based Grasping, Balancing and Walking", Workshop on Robot Learning, International Conference on Advanced Robotics, July 31, 2015
- Asfour, T., Aksoy, E., Workshop on "Semantic Action and Policy Representations for Autonomous Robots", 2015 IEEE/RSJ International Conference on Intelligent Robots and Systems, September 28 – October 03, 2015, Hamburg, Germany; (co-organization with Y. Yang, N.T. Dantam).
- Droit-Volet, S. (2015). Le temps psychologique: éléments de connaissance. Journée de formation du groupe de réflexion éthique "Temps et soins", Hôpital de Bagnols, Surcèze, 15 octobre. (Invited)
- Droit-Volet, S. (2015). Le temps de soi. Congrès national de la FEPS, Clermont-Ferrand, 17-18 octobre. (Invited)
- Droit-Volet, S. & Monier-Mompied, F. (2015). Emotion and Sensorimotor synchronization in children. 3rd International congress of educational sciences and development. San Sebastian, 24 - 26 June. (Invited)
- Droit-Volet, S. (2015). Time and fear. ISRE, Université de Genève, Genève, 8-10 july. (Invited)
- Lamotte, M., Droit-Volet, S., & Izaute, M. (2015). Metacognitive approach of decision processes implied in time perception. 56th Annual Meeting of the Psychonomic Society, Chicago, IL, USA, 19-22 november.
- Seth, A.K. (2015). Big data in and on the brain, Reconsidering Humanity symposium, Gothenburg. (invited)

## 3 Update of the data management plan

The Data Management Plan of TimeStorm with respect to (i) peer-reviewed scientific research articles (published in scholarly journals) and (ii) research data (data underlying publications, curated data and/or raw data), has been described in detail in the deliverable D1.6. In short, TimeStorm will provide on-line open access to scientific information that will be free of charge to the end-user and that will be re-usable.

