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Health Behaviour Change – Theories and Models

Current application and future directions for reliable health behavior change

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2 Working Hypothesis and Guiding Questions

Non-communicable and chronic diseases such as diabetes and cardiovascular diseases are on the rise worldwide. Lifestyle behaviors such as physical activity, nutrition and sleep are a critical modifiable factor to prevent and treat such diseases. To this end effective health behavior change interventions are needed, which often suffer from high dropout rates and low rates of long term change. Few interventions to change health behavior are sustainable, especially in the long term.

Health behavior change theories (HBCTs) that allow to explain and predict health behavior could improve these rates. Improving these theories could help increase health behavior change rates. They could offer more efficient and reliable methods of changing health behavior. In this thesis we analyze and compare selected HBCTs against each other.

The leading questions of this doctoral thesis are: Which are the most often used and researched theories of HBC? Which limitations do they have? Which newer theories could complement the traditional theories? Are newer theories and models developed more successful in changing and explaining health behavior than more established theories and models? Do more established theories and models miss important aspects of Health Behavior Change?

Current applications and limitations of theories are presented and discussed. Uniqueness and commonalities are contrasted and the evidence base described. We also propose and explain future directions for further research.

3 Introduction

The leading causes of death and diseases today are lifestyle related. Lifestyle however is mostly changeable through behavior change. This makes effective health behavior change (HBC) interventions of critical importance.

To create effective HBC interventions evidence based behavior change theories are important, because they allow for better intervention design. Good theories give us the ability to predict and understand, at least in part, how and why behavior changes.

However there exist a multitude of HBC theories. This poses difficulties for interventions designers and researchers when these want to design interventions based on evidence based theories. They would require an overview over existing theories.

Plenty of reviews and summaries regarding Health Behavior Change theories have already been conducted. (Davis et al., 2015; Kwasnicka et al., 2016) However, these reviews often select the theories with unclear or highly subjective selections.

Therefore, there is no comprehensive comparison of available HBC theories available yet, which selects theories on a quantitative basis and compares existing theories systematically.

This thesis aims to provide this missing piece by offering a comparison of the top HBC theories selected by quantitative means or by their potential. It assesses the evidence for their effectiveness in predicting behavior change and examines the implications of these findings for developing interventions to change long term health behavior. It also aims to find out commonalities and differences between the selected theories, as well as comparing the empirical support base.

4 Background

The danger of chronic non-communicable diseases (NCDs)

Non-Communicable Diseases (NCDs) are defined by the WHO as non-infectious diseases that “tend to be of long duration and are the result of a combination of genetic, physiological, environmental and behaviors factors.” The most common and severe types of NCDs are cancers, cardiovascular diseases, chronic respiratory and diabetes. (World Health Organization, 2014)

Chronic and NCDs are on the rise in industrialized countries: prevalence of Diabetes Type 2, cardiovascular diseases and some cancers are increasing. (Torre et al., 2016; World Health Organization, 2014, 2016) In 2008, chronic diseases (many of these are also non-communicable diseases (NCDs)) caused 36 millions (63%) of global deaths. In 2015 70% of all deaths were caused by NCDs according to the WHO. (WHO, 2017)

Especially in western societies a major shift from acute diseases especially infectious diseases to chronic diseases evolved over the recent decades. Infections became less prevalent due to basic hygiene and antibiotics, whilst diseases such as Diabetes, cardiovascular diseases, chronic respiratory diseases and certain cancers became more widespread.

Alongside smoking and harmful use of alcohol, unhealthy diets and low levels of physical activity are common behavioral factors in the etiology of the most prevalent and preventable NCDs. Thus, modifiable risk factors are involved in the etiology of most of these NCDs: About 3.2 million deaths annually can be attributed to insufficient physical activity and approximately 1.7 million deaths alone are attributable to low fruit and vegetable consumption. (Lim et al., 2012)

The financial burden of NCDs is also a very significant part of overall healthcare expenditure. Single NCDs such as Cardiovascular disease are responsible for 12-16.5% of healthcare expenditure across several nations. (Muka et al., 2015)

4.1 Lifestyle: cause and cure

Studies such as the EPIC Study (Ford et al., 2009), NHANES (Jung et al., 2015; D. E. King et al., 2009; Sutherland & Gee, 2015), the Whitehall Studies (Kuper & Marmot, 2003; Marmot et al., 1991) and the INTERHEART Study (Yusuf et al., 2004) show clearly how much lifestyle affects health. The EPIC Study demonstrated that over 7,8 years, participants fulfilling 4 health-factors (not smoking, BMI<30, >=3,5h/week of physical activity and adhering to healthy dietary principles) had a 93% lower risk for diabetes, 81% lower risk of myocardial infarction, 50% lower risk of stroke and 36% lower risk of cancer than participants without any of those health-factors. (Ford et al., 2009)

NHANES research showed substantial overall decreases in adherence to the healthy habits of avoiding obesity, not smoking, being physically active, consuming at least 5 portions of fruits and vegetables and limiting alcohol consumption. From NHANES III in 1988-1994 to NHANES IV in 2001-2006 the amount of the population adhering to all five healthy habits shrunk from 15% to 8%. (D. King et al., 2009)

The Whitehall studies provides evidence for the influence of stress levels on CHD development and progression. (Kuper & Marmot, 2003) Whitehall II supports a positive relationship between higher job status and lower prevalence of ischemic heart disease and chronic bronchitis in the studied population of 10 314 British civil servants. (Marmot et al., 1991)

The 52-nation INTERHEART study identified tobacco use, obesity, lipids, and psychosocial factors as accounting for about 90% of the population-attributable risks for myocardial infarction. (Lanas et al., 2007; Yusuf et al., 2004) Fruit and vegetable consumption and exercise were identified by Lanas et al. and Yusuf et al. as protective factors. Psychosocial stress was also strongly associated with risk of myocardial infarction.

Other research by Ornish et al. also documents the possible effects of comprehensive lifestyle changes such as reversing heart disease (Ornish et al.,

1990, 1998), slowing prostate cancer progression (Ornish et al., 2005) and increasing telomerase activity (Ornish et al., 2008).

4.2 Why Health Behavior Change (HBC)

Many of these risk factors are modifiable and part of a person's lifestyle. "Lifestyle" can be defined as the aggregate of daily behaviors (nutrition, physical activity, psychosocial factors), which significantly influence physiology and health. (Rippe, 2013)

The solutions to these lifestyle related diseases could be found in lifestyle change. HBC therefore, is of critical importance, however behavior change interventions have only a very low success rate as shown in the following.

4.3 "Why is it so difficult?": The Challenge of changing health behavior

The most prominent problem in changing health behavior, besides the initial change in behavior, is in long term adherence. Dropout rates are high and most programs fail to change health behavior of participants long term as shown by the low rates of effectiveness in meta-analyses. For example in one 7-month lifestyle change intervention, only 35% of participants finished the program. (Bazzano et al., 2009) An analysis of a multidisciplinary adult weight management program with 1205 patients also showed an average attrition rate of 42.8% at the 6 month follow up. Even if participants actually would complete the program, the rather low effectiveness of most interventions is also a pressing issue. In a meta-synthesis of 62 meta-analyses across several health domains the researchers found low to medium effect sizes of 0.08-0.45. (Johnson, Scott-Sheldon, & Carey, 2010) Basing interventions on evidence based theories could improve these numbers as explained in the following section.

4.4 Theories and models of health behavior change

Theories of behavior change are comprehensive answers to the question: “Why does behavior change?” They incorporate a variety of constructs, interventions and methods to explain relationships or causal pathways that influence behavior. (Michie et al., 2008) Smaller formalized concepts of reality are called **Models**. They are often more descriptive than theories. An example would be the “Fogg behavior model” that will be explained in more detail later on.

Understanding the "why" of change and which factors matter in which context, allows researchers and clinicians to more effectively tailor interventions to individuals or target populations.

Theories that explain and predict behavior change better could help in designing more effective interventions, which would reduce the high dropout rates and increase effects of existing intervention.

What makes a theory useful?

Useful theories show clear relationships between the constructs and are operationalized in a way that makes them simple to integrate into interventions. As the psychologist Kurt Lewin said: ”There is nothing more practical as a good Theory” (Lewin et al., 1951)

It’s also important to consider, that interventions can have negative effects, just like bad advertisements can “unsell” goods by harming overall sales. (Bushman & Stack, 1996; Hornik et al., 2008) Therefore it is of critical importance that the invisible mechanisms in behavior change processes do become visible through theories and models. Only in this way the targeted removal, addition or modification of elements in behavior change interventions can be tested, in order to achieve a greater impact of the intervention.

5 Methods

5.1 A data driven process to select theories

In researching the selection criteria of relevant meta-analyses and reviews, it becomes apparent that such criteria often lack entirely for large scale comparisons of Health Behavior Change Theories (HBCTs). Researchers simply pick certain theories, but do not offer any explanation why these were selected.

For example in the following review the authors simply state which theories have “received the most attention” (Brawley & Culos-Reed, 2000) on page 158S: “The most commonly investigated theories of health behavior are the health belief model, the protection motivation theory, the theory of reasoned action, the theory of planned behavior, and the social-cognitive theory and self-efficacy (one's perceived ability to make or maintain specific changes). “ and on page 159S: "In addition to the theories used to predict adherence to health behaviors, there are also models that address the processes of behavior change and thus allow for the examination of adherence. Briefly, those that have received the most attention are self-efficacy/social-cognitive theory, the relapse prevention model and the transtheoretical model, often referred to as the stages-of-change model (also see the precaution, adoption, process model)."

The same goes for institutions in other fields, such as the world bank in economics, which presented a selection of health behavior change theories in their 2010 report on behavior change without providing any reasoning for selecting them. (World Bank, 2010) Often these are just called the "most prevalent theories".

A targeted search

The usual process for conducting reviews or meta-analyses consists of a targeted search for single or few health behaviors such as condom use or fruit and vegetable intake. The search results are then filtered down by predetermined criteria, often just based on the contents of the abstract and then analyzed.

As this thesis aims to analyze and describe older and newer theories of health behavior change this process is not advisable, due to the extensiveness of the

available literature. Even if one would conduct such a wide ranging, systematic analysis, little would be gained as quality of studies based on single theories varies considerable from trial to trial. Different laboratories and researchers have different standards for methodological quality such as regarding data collection, analyses and controlling for variables. Also the methods sections are often incomplete as they only list a selection of the actual methods.

Surveying other researchers

Another method for selecting theories to review, consists of researchers surveying other scientists to identify the theories (Davis et al., 2015, pp. 327–328):

“To inform the literature search strategy, theories of behavior and behavior change were identified through expert consultation with the advisory group and an initial scoping of the literature using generic and discipline-specific terms related to behavior and behavior change theories. For example, the term ‘cultural change’ tended to be used by anthropologists, ‘action’ by sociologists and ‘behavior’ by psychologists.”

However, this method also carries a lot of inherent biases. An invisible selection bias could lead to a sample of researchers that focused their research on certain theories or are only familiar with a few of them. This would bias the entire following analysis and comparison and make the overall work less valuable form a scientific standpoint as well as making it less useful from a clinical perspective, as one would be missing useful parts of the available evidence.

The solution

The solution to this conundrum presents itself in a research strategy to select the most prevalent theories, whilst explaining the reasoning for the selection and also providing quantitative data for the relevance of the selected theories.

Due to the large amount of available HBCT in general, only select few of them can be presented. One scoping review of Health Behavior Change Theories (HBCTs) found 82 health behavior change theories in their initial research of theories. (Davis et al., 2015) This review will be presented in more detail in a separate chapter (in “5.4 Evidence from a scoping review”). In the following we describe our process to select these theories.

We started with an initial research using Google Scholar, PubMed, Web of Science and Google searches for “health behavior change theories” as well as literature research using “The Oxford handbook of health communication, behavior change, and treatment adherence” (Martin & DiMatteo, 2013) and “the Handbook of health behavior change” (4th edition) (Riekert et al., 2014). In this process we also followed the citations in the literature. From this research, we selected 3 established theories that represent a broad range of similar theories and 3 newer theories of behavior change, that cover valuable, but underexplored aspects.

The overall process consists therefore of 2 parts:

1. We selected the theories from extensive literature research including the scoping review covering 82 Theories by Davis. (Davis et al., 2015)
2. Used PubMed, Web of Science and Google Scholar publication volume as objective markers for research interest and prevalence of these theories

5.2 Step 1: Selecting Health Behavior Change Theories from research

Three established health behavior theories also represent an entire group of health behavior theories as they have many structural similarities and often models are developed on the “shoulders” of more established theories.

- **“Continual Models”** are models where behavior change is explained as a continuum from intention to change to actual behavior. Most representative of this kind of model is the **Theory of Planned Behavior (TPB).** Many very similar theories have been developed alongside or based upon TPB such as the "Health Action Process Approach" (HAPA) by the German Prof. Schwarzer. (Schwarzer et al., 2011) Due to the higher popularity and greater evidence base, as shown in the quantitative PubMed data below, this thesis will focus on the TPB.

- **“Stages of Change Models”** do pose that behavior change happens in discrete stages. The **transtheoretical model (TTM)** is the most highly

developed form of theory in this field.

- **“Social Learning Theories”** are focused on the social aspects of behavior change and put modeling and observational learning at the center of it. The most dominant and foundational theory in this field is **Bandura’s Social Cognitive Theory (SCT)**, which is why this work will focus on the SCT to represent social learning theories.

The 3 new theories and models chosen from the research are Behavioral economics, the Fogg Behavior Model and Self Determination Theory.

- **Behavioral economics (BE)** is an interdisciplinary field of economics and psychology that offers a very valuable perspective on the “inbuilt” cognitive biases and irrational decision making. This unique perspective on behavior change offers explanations for seemingly irrational human behavior and produced many valuable insights for intervention design, which led to our selection of it. Methods from behavioral economics such as nudging have received a lot of attention in the past years. (Anderson et al., 2010) The work of Nobel prize winner Daniel Khaneman’s work on the psychology of decision making was foundational for this field. Khaneman summarized his research on human decision making in 2011 in his bestselling book “Thinking, Fast and Slow”. (Daniel Kahneman, 2011)

- **The Fogg Behavior Model (FBM)** has a clear focus on habitual behaviors (“habits”) and provides in conjunction with “Tiny Habits”, a behavior change method and program a practical implementation of its principles for long term behavior interventions. This focus on habits makes it highly valuable to this work and led to our decision to select it for further analysis. Habits recently experienced a lot of popularity. For example in his bestselling book “The power of habit” Charles Duhigg explains the high relevance of habit changes for long term behavioral changes. (Duhigg, 2012)

- **Self Determination Theory (SDT)** is the third selected theory due to its unique perspective on the quality of motivation and focus on autonomy in behavior change. (E. L. Deci & Ryan, 1985a, 2000; Ryan et al., 2008) These perspectives make it a very valuable additional candidate for analysis and comparison.

We excluded other popular theories such as the “Health Belief Model” (HBM), because it is more focused on short term and on-off changes such as going to screening appointments and this work is focused on long term lifestyle changes. (Hochbaum & Rosenstock, 1952)

Chosen Theories and Models in overview:

- **Theory of Planned Behavior (TPB)** for **continual Models**
- **Transtheoretical Model (TTM)** for **Stages of Change models**
- **Social Cognitive Theory (SCT)** for **Social Learning Theories**
- **Behavioral Economics (BE)**
- **Fogg Behavior Model (FBM)**
- **Self Determination Theory (SDT)**

5.3 Step 2: Proxy Markers

We used database results as a **proxy marker** for researcher interest, awareness and usage of the theory to validate the theory selection. For this end we searched Web of Science (WOS), PubMed and Google Scholar with exactly the same search terms. To collect the highest quality of evidence we limited the search to the full name of the theories and, if necessary, used the British and American form of "behavior". The search terms therefore were:

- "theory of planned behaviour" or "theory of planned behavior"
- "behavioural economics" or "behavioral economics"
- "self-determination theory"
- "transtheoretical model"
- "social cognitive theory"

PubMed and WOS searches do overlap, however they also have some distinct differences. PubMed covers medical and biomedical publications, whilst WOS also includes the social sciences. These differences can be seen in the journal counts - PubMed includes 6000 journals, compared with WOS's 8700 journals. (Falagas et al., 2008) PubMed is publicly funded and run by the National Library of Medicine (NLM), whilst WOS is a commercial database. PubMed also includes very strict restrictions, whilst WOS indexes by less stringent criteria. Both databases are not automated entirely like google scholar, but include human editors in the approval process for indexation.

Other databases such as PsycINFO are too narrow in scope, which would have skewed the data. It includes approximately 3 million entries, compared to WOS's 90 million. (American Psychological Association, 2017) We therefore excluded these from the process. Less broad and more specialized databases were excluded to prevent bias in publication numbers, which could happen due to a high degree of specialization for example on exercise science, psychotherapy or nutrition.

The data was limited to a 20-year timeframe from 1997-2017 in order to make the data comparable across theories. This method also allows to show trends and changes of the importance of the theory over the selected time frame.

We did purposely not use acronyms, as this would decrease the quality of search results due to multiple possible meanings of the acronyms. For example, "SCT" could also stand for "French Medicinal Chemistry Society (Société de Chimie Thérapeutique)" or "stem cell transplant".

PubMed Proxy Marker

The PubMed search (https://www.ncbi.nlm.nih.gov/pubmed/) was used and the publication data exported on the right side as shown in the following screenshot.

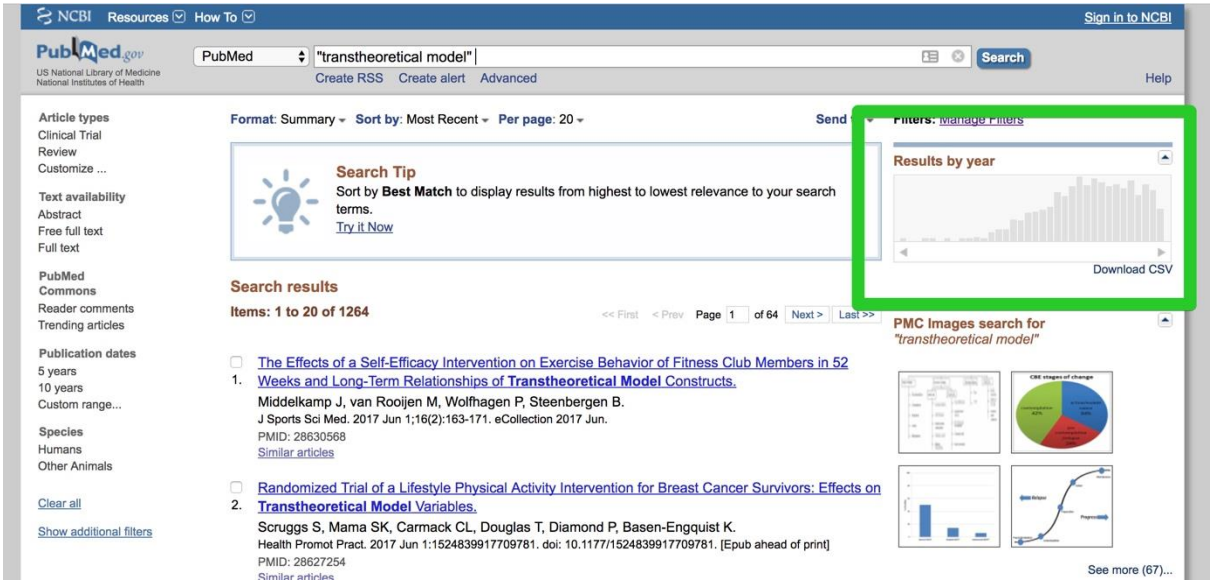

Figure 1: PubMed Screenshot

The search was not filtered to reviews as this could obfiscate the research interest. One review could cover 100 or only a few trials, which would make such restrictions problematic to evaluate overall research interest.

Total number of Publications for each HBCT:

- TPB: 2389
- TTM: 1261
- SCT: 1293
- BE: 942
- SDT: 954

Simply due to publication numbers, the "Health Belief Model" also appeared to be a candidate as "health belief model" produced 1847 publications in a PubMed search. However, we excluded it as explained above, because it is less suited to long term lifestyle changes. Other researchers also criticised the lack of rules and defined relationships between HBM constructs (Christopher J. Armitage & Conner, 2000; P Sheeran & Abraham, 1996) and the predictive ability of the HBM was found to be “low” by researchers in a meta-analysis on the HBM. (Harrison et al., 1992)

In conducting a proxy marker analysis for the FBM with the search terms "Fogg behavior model" or "Fogg behavior model", we only found 17 publications in

PubMed. However as explained above we decided to include the model in our analysis.

Searching for "Health Action Process Approach" by Schwarzer revealed a very limited number of only 125 publications. This supports the exclusion of this model for a further analysis in favor of the TPB.

All publications for the selected HBC theories in the PubMed database over a period of 1997 to 2017 are graphically illustrated in the following chart (Figure 2).

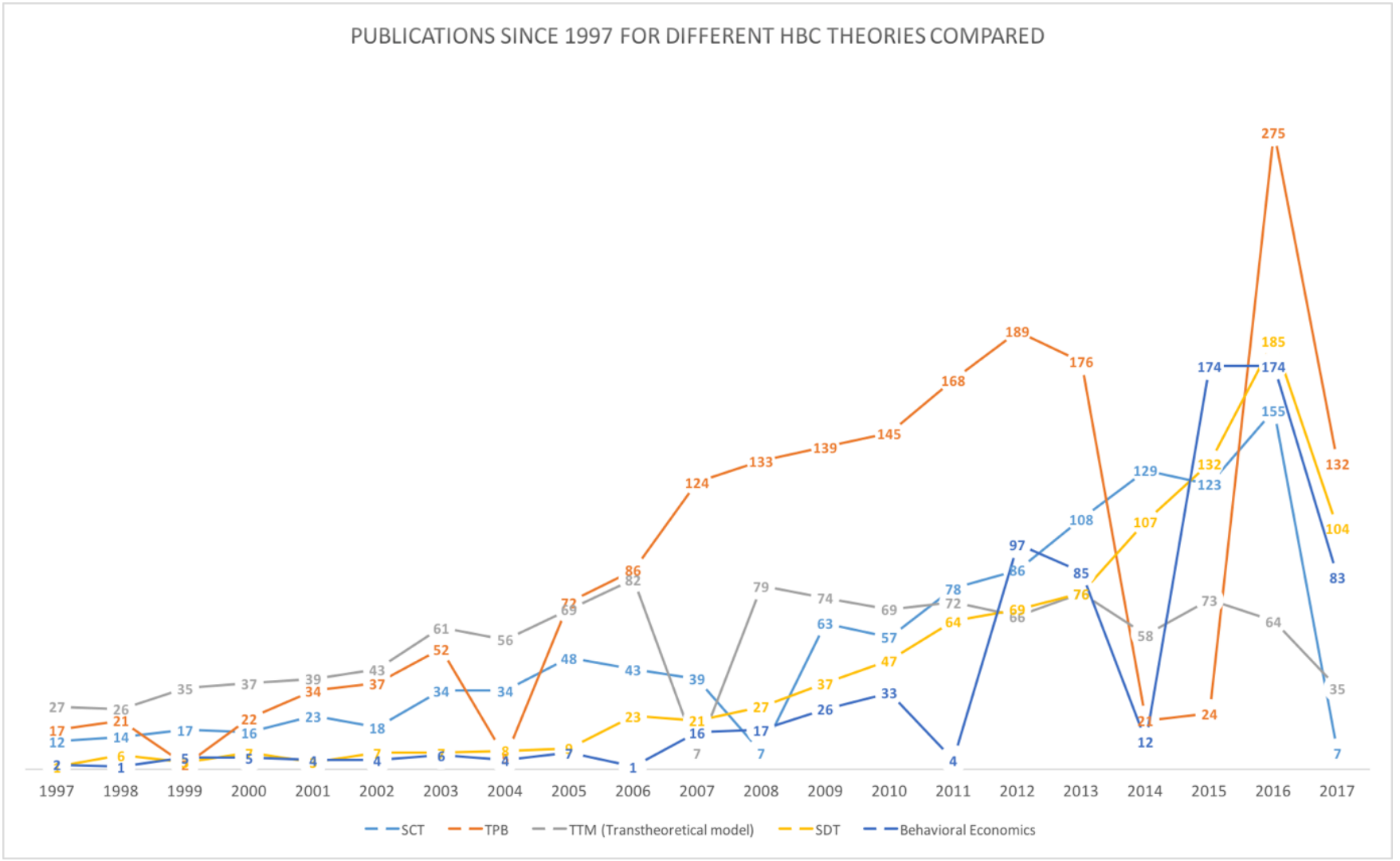

Figure 2: Publications since 1997 for individual HBCTs in PubMed

Year	SCT	TPB	TTM	SDT	BE
2017	7	132	35	104	83
2016	155	275	64	185	174
2015	123	24	73	132	174
2014	129	21	58	107	12
2013	108	176	76	76	85
2012	86	189	66	69	97
2011	78	168	72	64	4
2010	57	145	69	47	33
2009	63	139	74	37	26
2008	7	133	79	27	17
2007	39	124	7	21	16
2006	43	86	82	23	1
2005	48	72	69	9	7
2004	34	5	56	8	4
2003	34	52	61	7	6
2002	18	37	43	7	4
2001	23	34	39	3	4
2000	16	22	37	7	5
1999	17	2	35	3	5
1998	14	21	26	6	1
1997	12	17	27	1	2

Table 1: Publications since 1997 year by year for individual HBCTs in PubMed

Web of Science Proxy Marker

We used Web of Science (WOS) because of its content of 90 million publications. To conduct the analysis, we used the WOS search (https://apps.webofknowledge.com/WOS_GeneralSearch_input.do) with the same terms as the PubMed database searches.

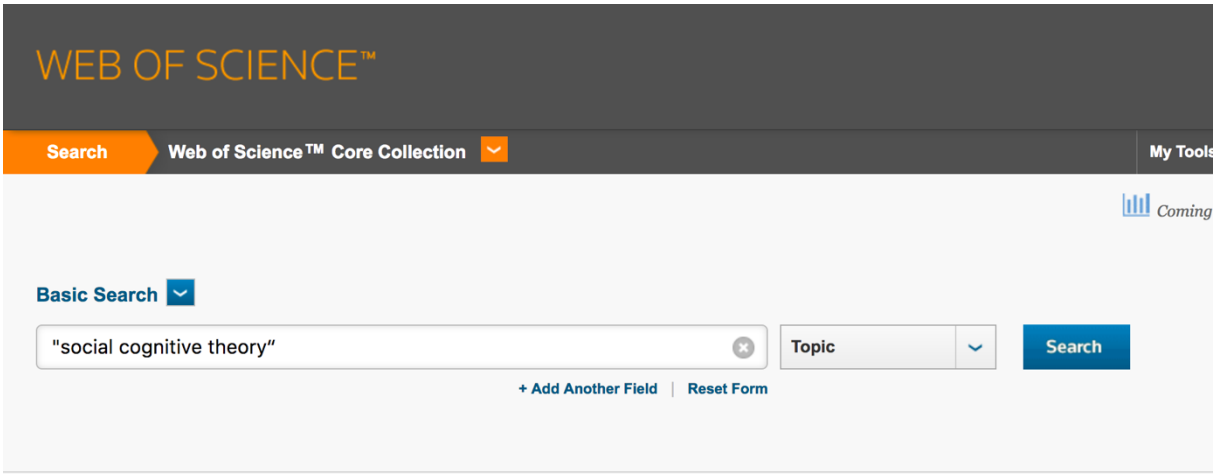

Figure 3: WOS Screenshot of search field

After conducting the search for the appropriate term, we selected "Analyze Results".

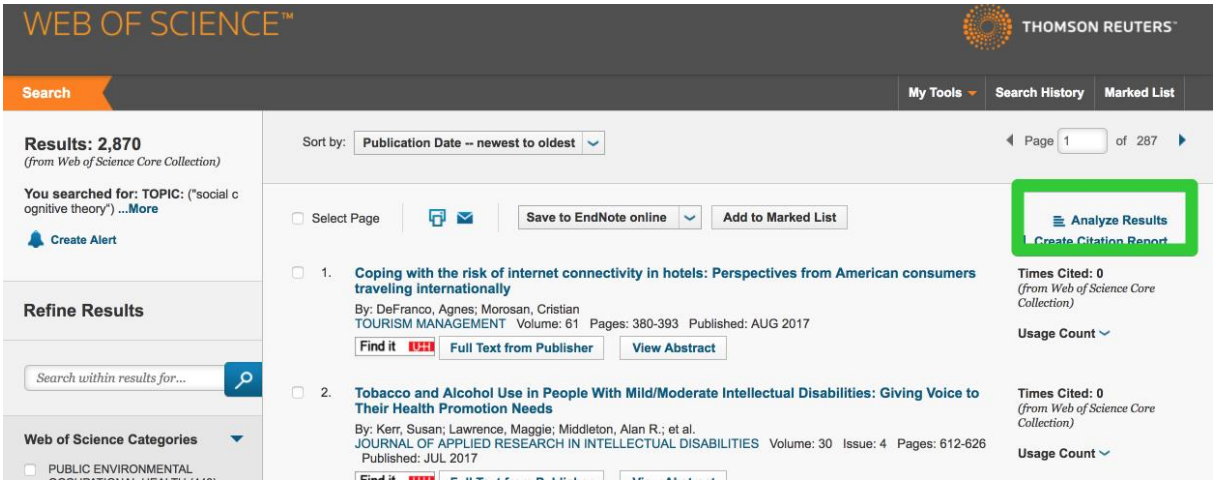

Figure 4: Screenshot of the Process in WOS to analyze results

Finally, we saved analysis data to file for further analysis in an excel database.

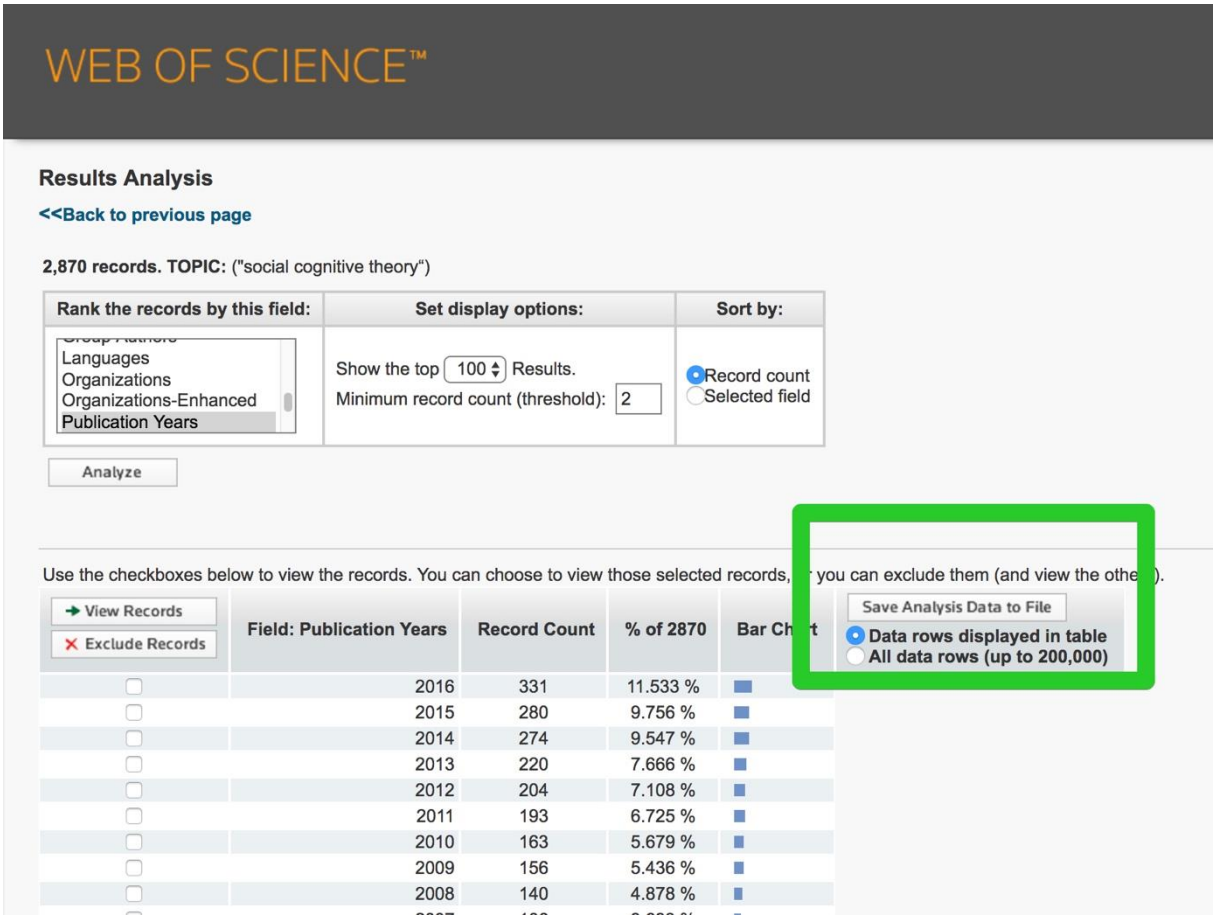

Figure 5: Screenshot of data export in WOS

From this we could create a graphical representation and a year by year tabular comparison.

All publications for the selected HBC theories in the Web of Science database over a period of 1997 to 2017 are graphically illustrated in the following chart. The FBM is not included in the table due to the low amount of results. We found 3 publications in WOS with the search terms "Fogg behavior model" or "Fogg behavior model".

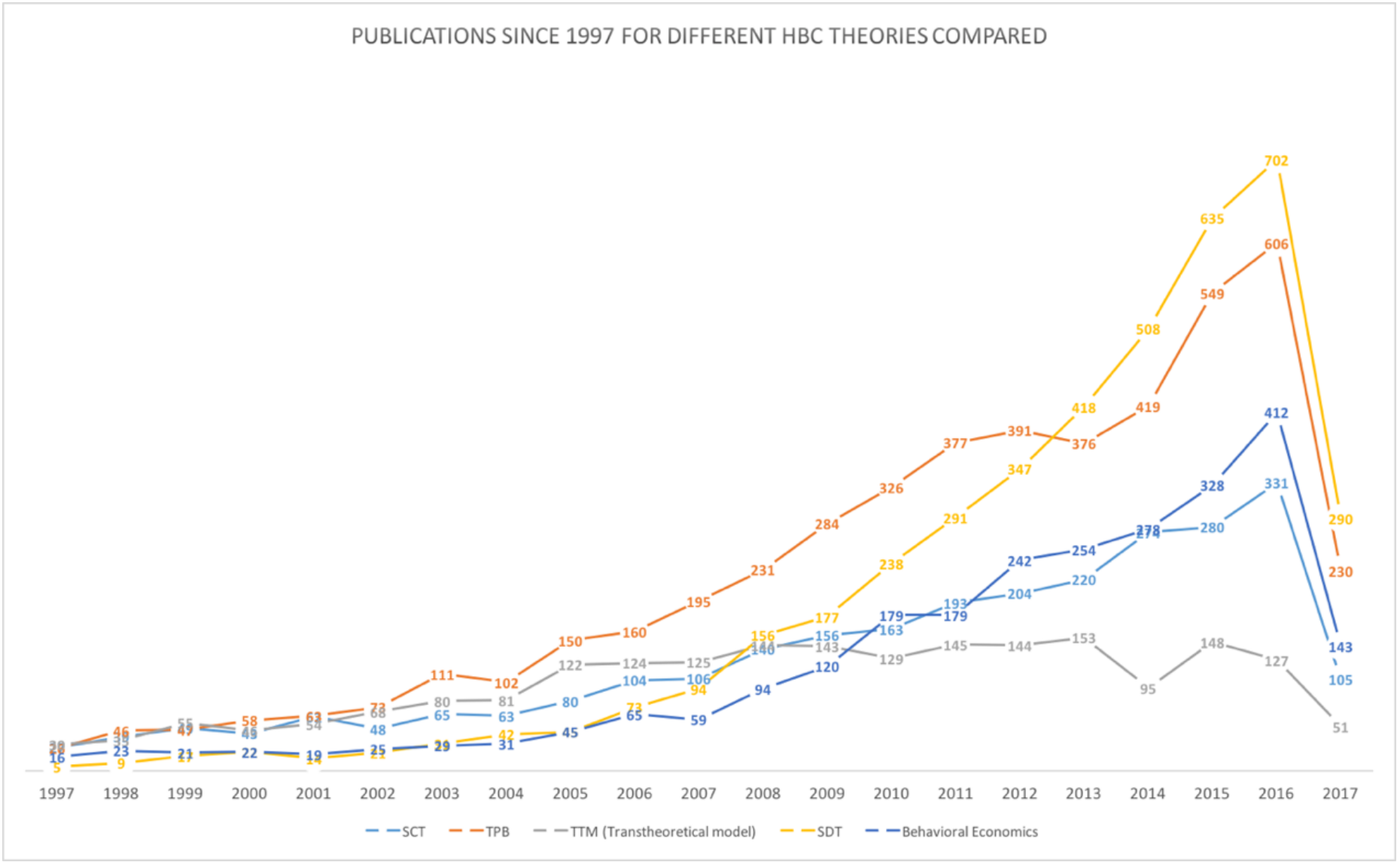

Figure 6: Publications since 1997 for individual HBCTs in W

Table 2: Publications since 1997 year by year for individual HBCTs in WOS

Year	*TPB*	*TTM*	*SCT*	*BE*	*SDT*
2017	230	51	105	143	290
2016	606	127	331	412	702
2015	549	148	280	328	635
2014	419	95	274	278	508
2013	376	153	220	254	418
2012	391	144	204	242	347
2011	377	145	193	179	291
2010	326	129	163	179	238
2009	284	143	156	120	177
2008	231	144	140	94	156
2007	195	125	106	59	94
2006	160	124	104	65	73
2005	150	122	80	45	45
2004	102	81	63	31	42
2003	111	80	65	29	31
2002	73	68	48	25	21
2001	63	54	62	19	14
2000	58	46	43	22	22
1999	47	55	49	21	17
1998	46	35	39	23	9
1997	26	30	27	16	5

To offer additional quantitative support for the validity of the WOS and PubMed data, we've also performed an analysis of aggregate search results on Google Scholar. We refrained from a yearly comparison and data analysis, due to the technical limitations of the database regarding this aspect.

Google scholar is a fully automated search engine, provided by Google and provides more data than PubMed at the expense of hand selection, broader inclusion across most scientific fields and through less stringent quality guidelines. In one direct comparison between PubMed and Google Scholar researchers found twice as many results in Google Scholar as in PubMed. (Shariff et al., 2013)

As Google Scholar is a far newer database (launched 2004) and likely to be less accurate for older publications, we've restricted the year range to a 10-year time frame from 2007 to 2017 as shown below.

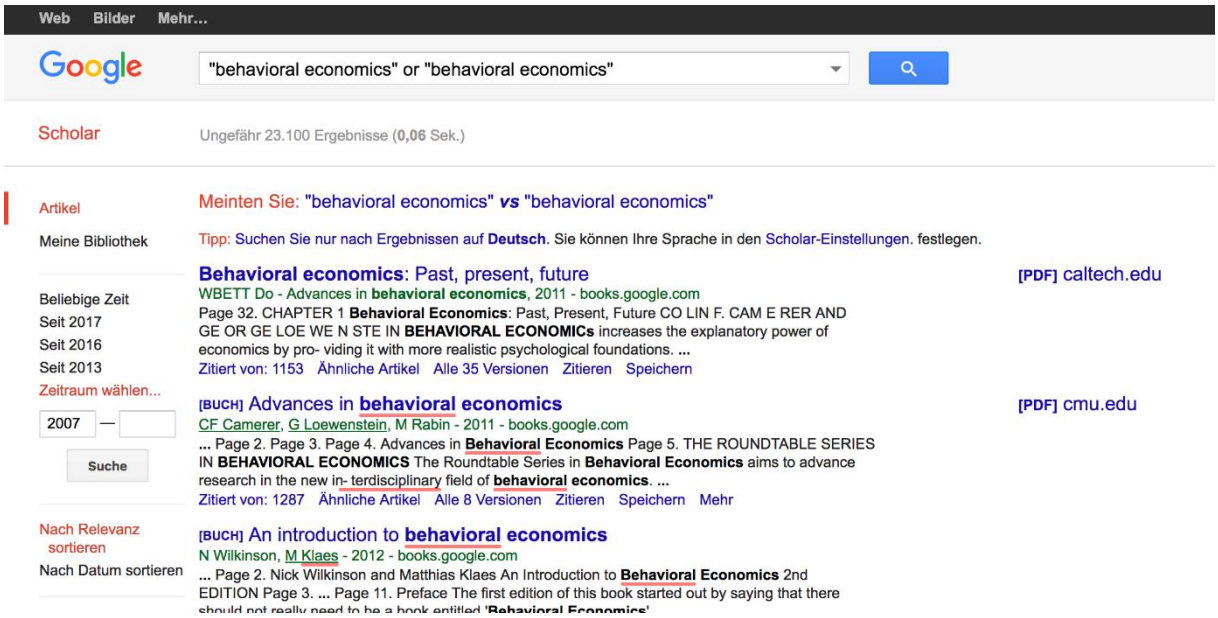

Figure 7: Screenshot of Google Scholar search

Table 3: Search terms and results for HBCTs in Google Scholar

Search terms used	Number of results
"theory of planned behavior" or "theory of planned behavior"	16 200

"transtheoretical model"	16 400
"social cognitive theory"	26 900
"behavioral economics" or "behavioral economics"	23 100
"fogg behavioral model" or "fogg behavioural model"	19
"self-determination theory"	23 400

The high amount of search results for the selected theories, excluding the FBM, offers additional quantitative support for the selection of theories. As shown in the following Table 4 of summed up results by each theory per database and by total sum across the 3 databases all selected theories exempt for the FBM have received great research interest in the past 20 years.

Table 4: Accumulated analysis of all database searches

	Pubmed	**WOS**	**Scholar**	**Sum across Databases**
TPB	1921	4820	16 200	22 941
TTM	1185	2099	16 400	19 684
SCT	1145	2752	26 900	30 797
BE	785	2584	23 100	26 469
FBM	17	3	19	39
SDT	954	4135	23 400	28 489
Sum by Database:	6007	16 393	106 019	

5.4 Evidence from a scoping review

The most often utilized theories according to the number of articles found from 1977 and 2012 in the scoping review were (number of articles for corresponding theory in brackets):

- Transtheoretical Model (TTM) (91),
- Theory of Planned Behavior (TPB) (36),
- Social Cognitive Theory (SCT) (29),
- Information-Motivation-Behavioural (IMB) Skills Model (18),
- Health Belief Model (HBM) (9),
- Self-Determination Theory (SDT) (9),
- Health Action Process Approach (HAPA) (8)

The rather low number of articles included in the scoping review are due to the restrictive selection criteria such as the exclusion of articles with multiple behavior change theories, animal studies, single case studies, scale development, measurement or program development etc.. Of the 8680 articles found in all database searches 6620 were excluded based on the abstract, leaving 2060 articles. After full text screening of the 2060 articles, only 256 articles from the initial search thus were included in the review.

This scoping review offers additional evidence for our selection of SDT, SCT, TPB and TTM for further analysis in this work as explained in the following. We however excluded HAPA and HBM due to reasons explained above. The Information-Motivation-Behavioural (IMB) model was soley developed for the prevention of AIDS for example through increasing condom use and therefore does not fall into the scope of this work. (Fisher & Fisher, 1992)

5.5 Selected Theories

These are the theories and models that have been selected through the process above. They are supported by the quantitative data in form of the proxy markers from PubMed, Web of Science and Google Scholar. They will be also be covered in this order:

- Theory of Planned Behavior (TPB)

- Transtheoretical Model (TTM)
- Social Cognitive Theory (SCT)
- Behavioral Economics (BE)
- Fogg Behavior Model (FBM)
- Self Determination Model (SDT)

This order of the HBCTs is based upon the following rationale: TPB will be discussed first due to the prominence of TPB in HBC in general and as the most established continual modal with the concept of “intention” in the center. To contrast this theory we followed up with the most established stage based model: the TTM. SCT followed as the third of the established theories. The less established theories will be presented alphabetically.

6 Presentation of the HBCTs

In order to allow a comparison of the selected theories and models, these will be presented and analyzed sequentially. First the available empirical evidence supporting the theory or model will be presented. Then limitations will be discussed.

A short conclusion will be provided. The overall comparison of models and theories will be presented in tabular form in the “synopsis” section of this thesis.

6.1 The Theory of Planned Behavior (TPB)

The Theory of Planned Behavior (TPB) is a theory of (social) behavior that aims to explain human behavior and behavior change. (Ajzen, 1991) It is based on the Theory of Reasoned Action (TRA). (Ajzen & Fishbein, 1980) The TRA aims to explain behavior as the result of intentions.

Difference between TRA and TPB: From Intention to Action

The TRA states that positive attitudes towards a behavior (the behavior is perceived as useful) and positive subjective norms (significant others see the behavior as positive) lead to higher intentions to perform the behavior, which in turn leads to a higher likelihood of actually performing the behavior.

The two constructs of “Attitude towards action”, which represents the beliefs about the behavior (“behavioral beliefs”), and “Subjective Norms” feed the intention to perform the behavior as illustrated by the following diagram.

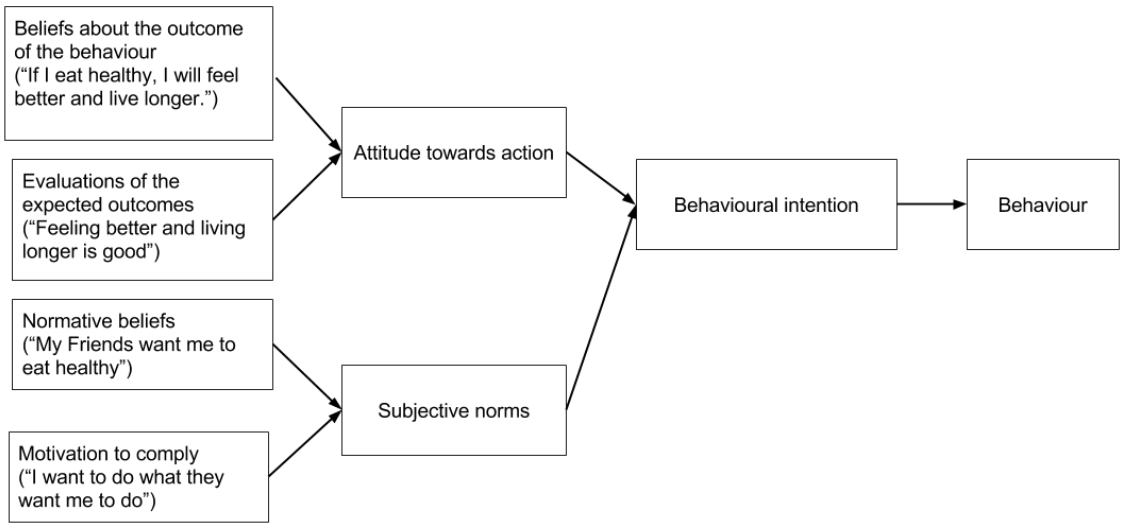

Figure 8: The Theory of Reasoned Action illustrated with the example of "healthy eating" based on Ajzen, 1980

But behavior is not always under volitional control, therefore the TPB was developed. For this end the TRA was extended with the concept of “Perceived Behavioral Control” (PBC), resulting in the TPB.

PBC is the belief to what extent one is able to change the behavior and can be equated to the concept of self-efficacy (see the chapter about Social Cognitive Theory for a definition). It is made up of control beliefs (beliefs about factors that facilitate or hinder performance) weighed by the perceived power of the control factor (how much these factors impact the behavior).

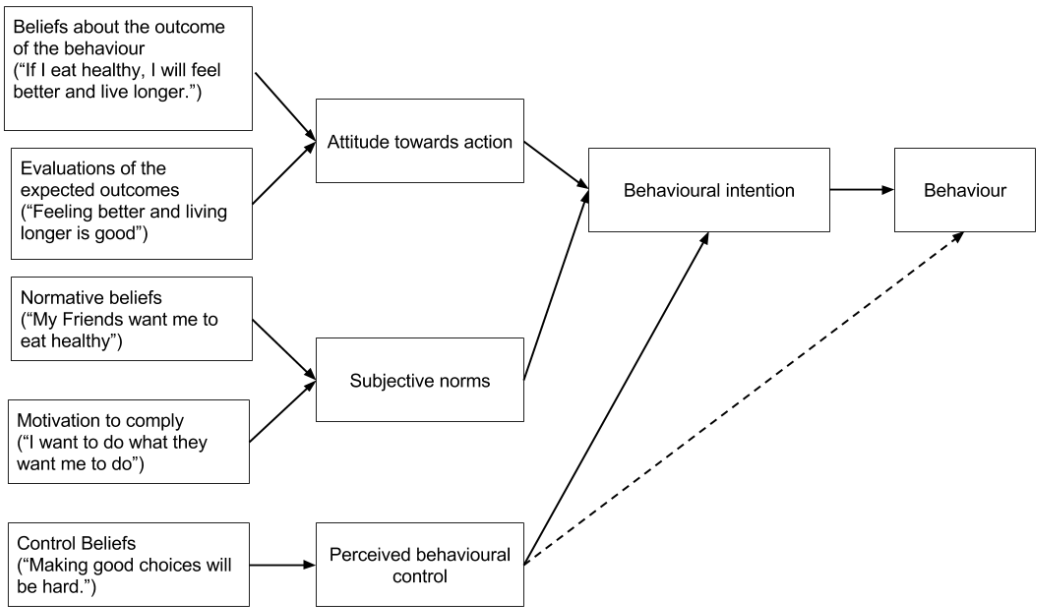

Figure 9: The Theory of Planned Behavior illustrated with the example of "healthy eating" based on Ajzen, 1991

6.1.1 Usefullness of the TPB

A multitude of research has been performed on the TPB in the field of health behavior change.

A 2001 Meta-Analysis on the TPB could predict about 39 % of variance in intentions, but only account for about 27 % of behavioral variance. (Armitage & Conner, 2001) Explained behavioral variance refers to the percentage of the variance in observed behavior that is explained by the model. The same goes for explained behavioral intentions. The variance is measured by comparing the model of behavior and its results to the actually observed behavior. If the model predicts the behavior perfectly, there would be zero variance observed and 100 Percent of the behavior could be explained by the model. The meta-analysis covered 185 independent studies published up to 1997 and tested the

relationships between attitude, subjective norm, intention, perceived behavioral control and behavior.
A 2011 Meta-Analysis of the TPB did support a similar predictive power to the 2001 Meta-Analysis. (McEachan,et al., 2011) In this analysis, the TPB explained 23.9% of behavioral variance for physical activity and 21.2% for diet behaviors. The Meta-Analysis by McEachan et al. summarised 237 prospective tests of the TPB with a total number of 61,514 participants. The elements of the TPB such as attitude towards action, perceived behavioral control and intention were measured and analysed for their predictive value of observed behavior.
Longer term behaviors (vs. short term) and those behaviors assessed with objective measures (vs. self-reporting) were less reliably predicted. (McEachan et al., 2011)
This indicates that the TPB is more useful for predicting self-assessed behaviors, rather than objective measurements of behavior and predicts behavior better in the short term, than in the long term. These have been consistent findings in the analyses that have been conducted on the predictive power of the TPB.
Despite these constraints , some researchers argue that Interventions based on the TPB can be more effective than those without such a theoretical basis. (Webb et al., 2010) A sound theoretical basis can allow for a more deliberate targeting of theoretical constructs such as perceived behavioral control (PBC) and to directly target sub groups that stand to benefit the most (such as those with a severe lack of perceived self-efficacy).

The TPB is in part so popular, due to its clear operationalization. The guidelines provided by the authors regarding how to measure, analyse and develop interventions, do make the theory easier to adopt and test for researchers. (McEachan et al., 2011)

6.1.2 Limitations of the TPB

The TPB does have several weaknesses, such as limited predictive power, the intention-behavior gap and several missing components.

Limited predictive value

In experimental studies or studies where objective measurements of behavior have been used, the predictive value of the TPB appears to be considerably limited. (F. Sniehotta, 2009)

Some researchers even go as far as to question the role of the TPB in behavioral sciences in general. (F. Sniehotta, 2009)

Intention-Behavior Gap

Overall the TPB does not predict behavior as well as it does predict intentions. The TPB is primarily an intention theory. Intentions can be strong predictors of behavior, but no consistent and linear relationship between intention and behavior has been shown so far. The Extension of the Model through PBC does help to predict actual behavior, but a significant gap still remains.

In a Meta-Analysis of meta-analyses by Sheeran, the average correlation of intention to behavior was 0.53. (Paschal Sheeran, 2002) According to Sheeran, this can be considered as a “large” influence of intention over behavior. This of course especially varies according to how much control the person perceives to have over the behavior in question.

Depending on type of behavior, complexity of actions required as well as the context of the behavior, intention can be a strong or weak predictor for observed behavior.

A 2002 review by Sheeran proposes the following moderating factors between intention and observable behavior (Paschal Sheeran, 2002):

- **Amount of Control**: How much is the behavior under the control of those intending to act?

  A *single action* with a controllable outcome (take one dose of a drug) will be influenced more strongly by intention than a *goal* such as deadlifting 150 kg, which consists of several complex actions, that influence each other.

  Also factors, such as knowledge, ability, resources, cooperation by others and opportunity, can be necessary or helpful in translating intentions to action. All of these influence the amount of actual control one has over their

behavior independent of intention.

- **Intention Types:**

    - **Intentions vs. Expectations** – Expectations differ from Intentions by accounting for more factors that could make the behavior less likely to perform. Instead of asking study participants for their intention to do something, expectations are determined by asking for the likelihood of occurrence of the studied behavior. (Warshaw & Davis, 1985)

      Expectations have therefore been shown to have a stronger predictive power for behavior than intentions. However Prediction is not explanation. (Stephen Sutton, 1998) Explanation requires insights into causal determinants of behavior, which a better prediction method or variable does not provide.

    - **Implementation Intentions** are “extended intentions” as they require study participants to form intentions including time and place of their behavior. (Gollwitzer, 1999) Instead of “intending to do Z”, an implementation intention is “intending to do Z, if Situation Y occurs”. In most studies implementation intentions lead to a markedly increased performance, such as greater weight loss or increased consumption of fruits and vegetables. (Chapman et al., 2009; Hannan et al., 2000; Luszczynska et al., 2007; Paschal Sheeran & Orbell, 2000)

- **Properties of Intention**:

    - **Temporal Stability** – The stability of intention scores over time have been shown in research to be an important independent quality of intentions. Stability can be assessed over time by asking study participants how strongly they intend to stick to their behavior. (Paschal Sheeran & Abraham, 2003) Stability of intentions has been

shown to moderate the relationship between exercise intentions and exercise behavior (Conner & Godin, 2007; Godin et al., 2010), and health behaviors such as general “health protection” and physical activity (Conner & Godin, 2007). In research stability also shows protective utility to increase resistance to attacks through counterarguments. (Cooke & Sheeran, 2013)

- **Degree of intention formation** refers to how much the intention is “thought through” by considering the consequences of the behavior. A higher degree of intention formation does significantly strengthen the intention-behavior link. (Icek Ajzen, 1991; Bagozzi & Yi, 1989; Godin & Kok, 1996; Paschal Sheeran, 2002)

- **Attitudinally vs. normatively controlled Intentions** refer to the different “sources” of the intention. Attitudinally controlled intentions spring from an “internal locus of control” such as from personal beliefs. Normatively controlled intentions have been formed by subjective norms, such as approval, reward and punishment. They originate from an “external locus of control”. An attitudinally (“internally”) controlled intention shows a stronger intention-behavior relationship than an normatively (“externally”) controlled intention. (Paschal Sheeran et al., 1999)

- **Certainty** of intentions are measured by asking participants “how certain are you about your intention?” and measuring response latency to intention items (how many milliseconds participants need to answer e.g. “I will eat healthy foods in the next few weeks”). Greater certainty is related to a stronger intention-behavior relationship. (Bagozzi & Yi, 1989) (John N. Bassili, 1993) (Pieters & Verplanken, 1995) (Paschal Sheeran et al., 1999)

- **Accessibility** of intentions might also influence the relationship between intention and behavior. Several Studies support a positive relationship. (J. N. Bassili, 1995; John N. Bassili, 1993) Others

however show no such effect. (Doll & Ajzen, 1992)

- **Personal and cognitive variables:**

    - **Action Control** is a concept developed by Kuhl et al and sorts study participants in a continuum from “action-orientated” to “state-orientated”. (Kuhl & Beckmann, 1985; Kuhl & Beckmann, 1994)
      Action oriented people tend to focus on the actions they need to take to close the gap between the current state and their goals, whilst state focused people will dwell on their current situation or their visions of the future. The former tend to handle anxiety and set-backs better, whilst the latter conserve energy better.
      The evidence for action/state control moderating the intention-behavior relationship is mixed. Some research supports an influence (Kuhl, 1982; Schifter & Ajzen, 1985), whilst other researchers could find no such effect (Bagozzi et al., 1992; Kendzierski, 1990).
      These inconsistencies in the findings can likely be attributed to an opaque interaction between personality, intention and behavior. (Fuhrmann & Kuhl, 1998; Julius Kuhl & Fuhrmann, 1998)
      Overall a personality variable will have several complex interactions and there is a lack of research to allow drawing any more concrete conclusions.

    - **Anticipated regret** describes the amount of tension or regret people feel if they **do not** take action on their intentions. Research could show a moderating effect on the intention-behavior relation, independent of past behavior. (Abraham et al., 1999; Paschal Sheeran, 2002)

    - **Self-schemas** – These concepts refer to the self-definition of a person. One such self-schema could be “I keep in shape”. Such a schema would make a person to follow through on exercise related intentions more likely. (Kendzierski & Deborah, 1990) People with self-schemas that match to the intentions/behaviors in question, tend

to have more stable intentions. (Kendzierski & Whitaker, 1997)

- **Conflicting Intentions** – Some behaviors and intentions can conflict with each other, such as dieting and increasing sports performance. (Abraham et al., 1999; Paschal Sheeran & Orbell, 1998) In contrast to “competing” intentions, the behavior can still be conducted, but are negatively correlated. Depending on the number and strength of concurrent intentions, this will affect the likelihood of translating behavior into action.

- **Relationships between all of the determinants above** – All of these moderaters could influence each other in either direction and build a complex web of interactions that moderate the intention behavior relation.

Due to all of these complex and still under-researched interactions, it becomes clear that there is a significant gap between intentions and behavior.

The focus of the TPB on intentions, therefore, limits its use in designing and evaluating behavior change interventions, changing health behavior or in explaining it.

Possibly missing or insufficiently included components in the TPB

Several components that have been shown to alter health behavior are not part of the theory such as:

- **Habits**: The influence of strong, habitual behaviors (habits) is missing from the TPB. (Norman & Cooper, 2011)
- **The role of environment (physical and social)** (Sniehotta, 2009)
- **Past behavior** (Abraham & Sheeran, 2003; Norman & Smith, 1995)
- **Variability of personality and self-identity** – Individuals will behave differently in the same and in different circumstances depending on their personality profile and self-identity. (Hassandra et al., 2011)(Akbar et al., 2015)
- **Type of the health behavior** – depending on the type of health behavior studied, the predictive power of the TPB can vary strongly. (Akbar et al., 2015)

Fishbein and Capolla (the creators of the TPB) have attempted to address some of these weaknesses such as the influence of environment, skills or past behavior in their Integrated Model. (Martin Fishbein & Cappella, 2006) The integrated model does seem to be a significant improvement through the inclusion of these relevant factors.

Especially the factor of past behavior appears to be highly relevant for predicting future behavior. Past behavior has in extreme cases been found to be the only significant predictor of prospective behavior. (Norman & Smith, 1995)

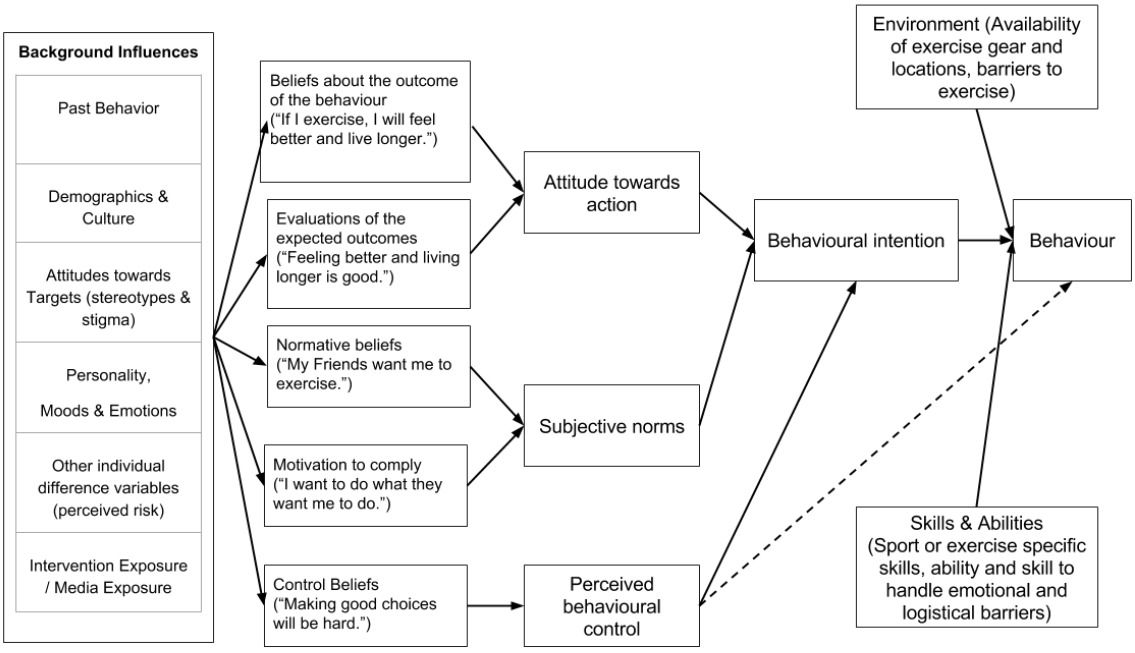

Figure 10: A scheme of the "integrated model" with environment and past behavior illustrated through "Exercise" adapted from Fishbein & Cappella, 2006

The effectiveness of the integrated model compared to the original model is still unclear. There has been no comparative analysis or extended testing of these models, yet. Further research is needed to allow for a grounded valuation.

6.1.3 Conclusion

Overall the TPB does have its strengths and does explain a considerable part of the variance in health behavior. However, it shows several limitations and weaknesses, that need to be addressed through further development of the theory

such as the “integrated model” or through an integration of the TPB into new theories of behavior change.

Whilst extending the evidence base of these newer models or integrated approaches, the continuous testing of the theory in the field and in clinical trials need to be of the highest importance.

6.2 Transtheoretical Model of Behavior Change (TTM)

The Transtheoretical Model (TTM) was developed to integrate components of other theories of behavior change into one widely applicable model, hence the name “transtheoretical”. It has been developed by Prochaska and DiClemente at the University of Rhode Island since 1977. (Prochaska & DiClemente, 1983; Prochaska, DiClemente, & Norcross, 1992) The researchers originally wondered, why some smokers could permanently quit on their own, whilst other patients struggled continuously. The TTM resulted from their research into this question.

The TTM is a theory of intentional, as opposed to reactionary, unintentional change. The focus lies on the individual decision and action process in change rather than on social or environmental causes of change.

At the center of the model lies a number of sequential stages of behavior change (5 or 6 depending on the variation). People move through this series of stages from “precontemplation” to “maintenance” or “termination” (in the case of addictions). Hence the TTM is a “**stage based**” model of behavior change.

The stages are:

1. **Precontemplation** – not interested in a behavior change in the next 6 months
2. **Contemplation** – deciding upon the behavior change in the coming 6 months
3. **Preparation** – intending to change; planning and collecting information about the change
4. **Action** – behavior changed within the last 6 Months
5. **Maintenance** – maintaining the behavior change for more than 6 months. It is important to note that few people enter the maintenance phase in their first try of behavior change.
6. **Termination** – no desire to return to the old behavior (Not part of the original model and most useful for addictive behaviors such as smoking)

It is also important to note that behavior change is not a straight line. Relapses into old behaviors are a component of the change process in the TTM.

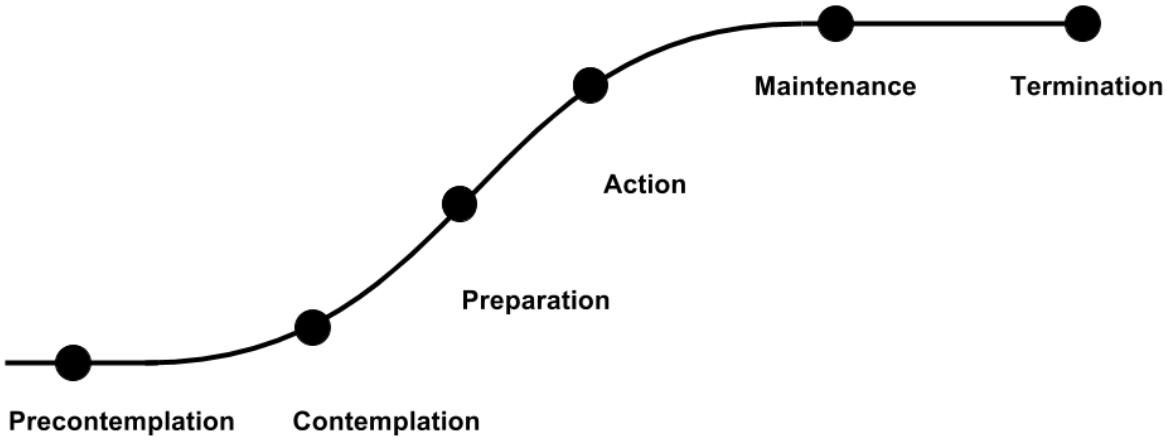

Figure 11: Transtheoretical Model in Graph Form

In the original model the TTM stages included: precontemplation, contemplation, action, maintenance, and relapse.

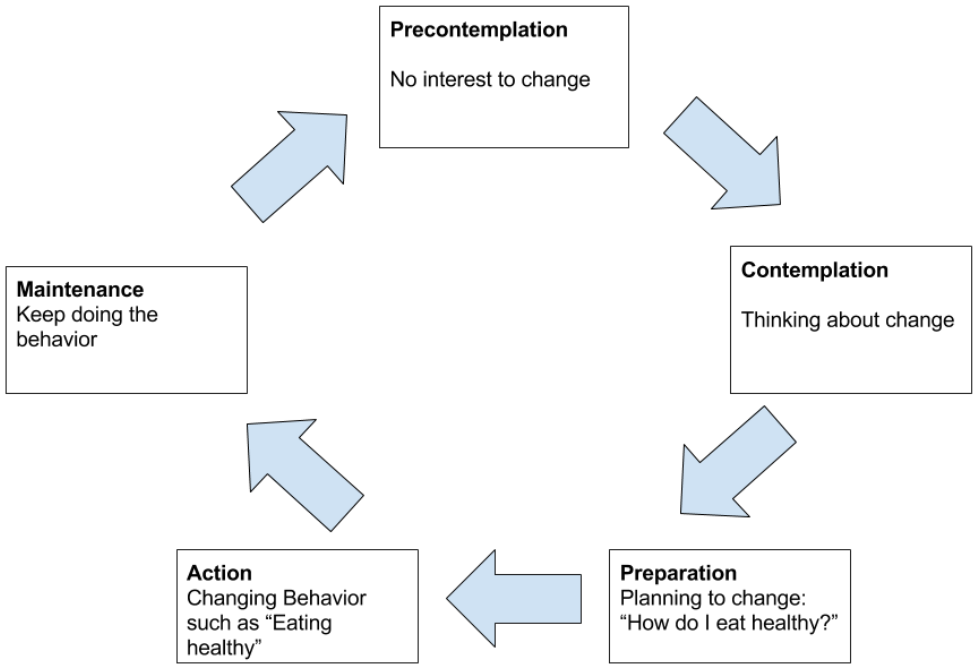

Figure 12: Circular graphical representation of the TTM

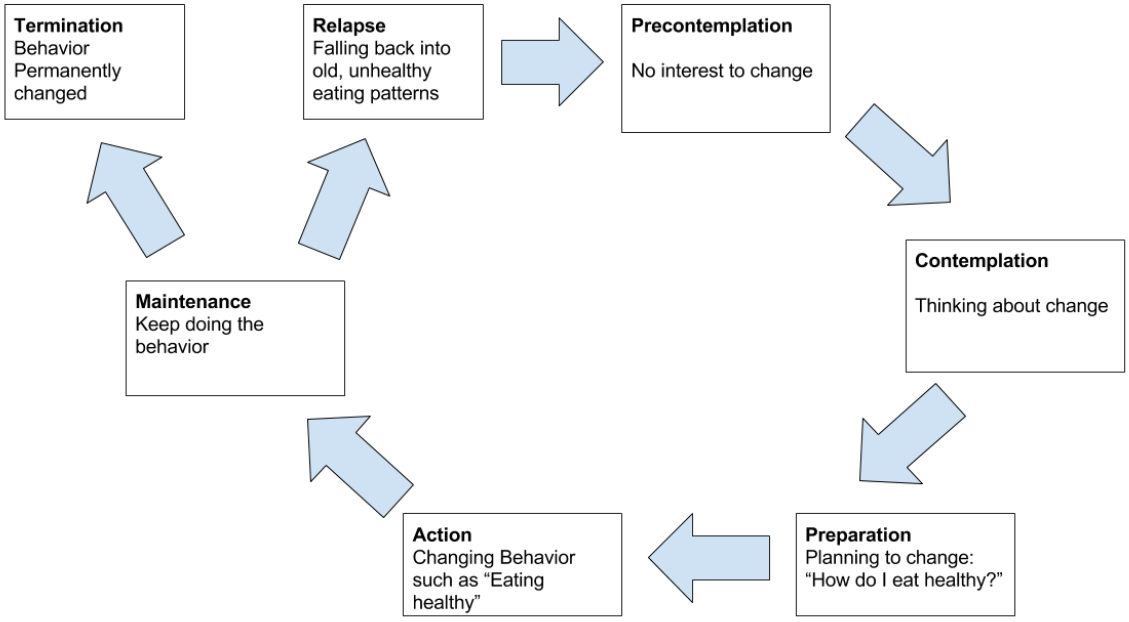

Figure 13: Circular graphical representation of the TTM with Termination and Relapse included

The TTM also includes ten so called “processes of change”, which can be divided into five “experiential” and five “behavioral” processes. These processes need to be engaged to facilitate behavior change

The experiential processes are postulated to occur on a cognitive and affective level and include:

1. **Consciousness Raising** – Learning about the self and the problem.
2. **Dramatic Relief** – Expressing and experiencing the emotions related to the change.
3. **Environmental Reevaluation** – Noticing how once own behavior affects the environment, such as effects of living unhealthy as role-model for own children.
4. **Self-Reevaluation** – Reevaluating the self-image created with the past behavior and the future behavior.
5. **Social Liberation** – Noticing available public support for the new behavior, such as changes in the way exercise or healthy eating are publicly encouraged.

The behavioral processes are as follows:

1. **Self-Liberation** - Making a Commitment.
2. **Counter Conditioning** – Substituting old behaviors with new behaviors, such as smoking with chewing gum.
3. **Helping Relationships** – Finding supportive people and communities.
4. **Reinforcement Management** - Use rewards or being rewarded to increase the desirable behavior.
5. **Stimulus Control** – Managing the environment, such as restricting available foods in the house.

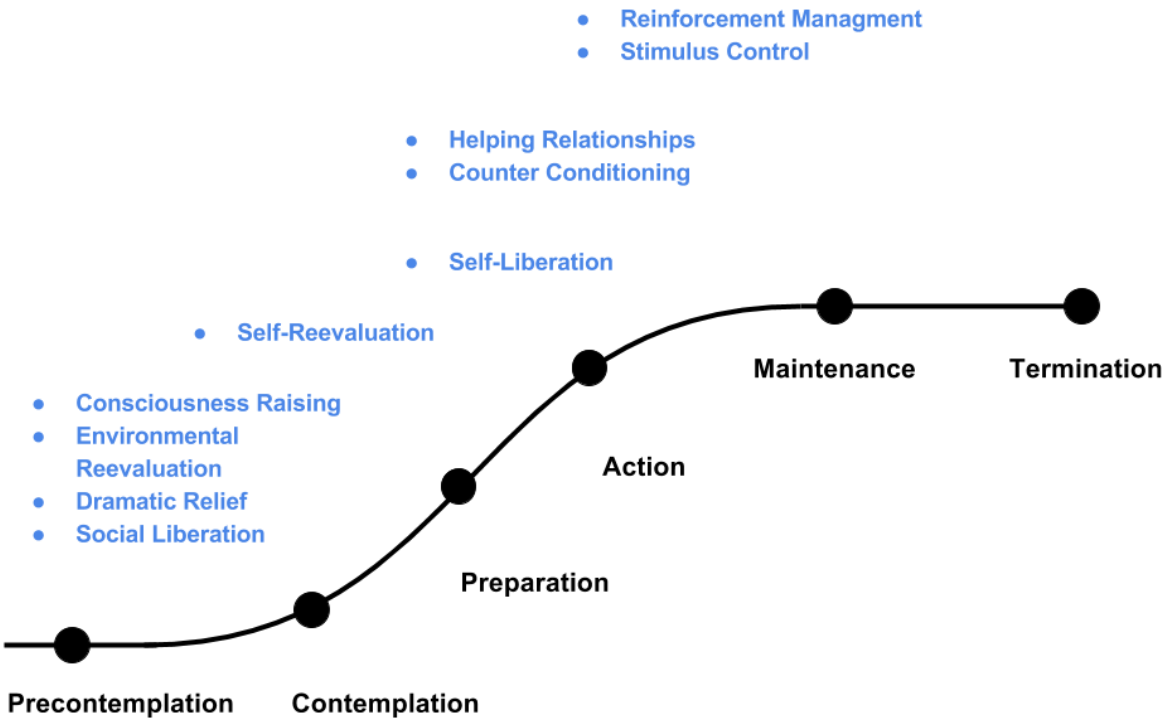

Figure 14: TTM Model with the 10 Processes of Change at their approximate place in the timeline of change

Other components of the model include self-efficacy, decisional balance and temptations. These concepts are however not part of the graphically illustrated versions of the model.

Self-Efficacy refers to the extent that an individual feels in control of the behavior and plays a significant role as in the TPB and SCT Models. As stages progress, self-efficacy increases. (Marshall & Biddle, 2001) Moving into action depends on higher levels of self-efficacy. (Lippke et al., 2009)

Decisional Balance is the weighing of pros and cons of the change by the individual and of high importance for behavior change according to the TTM. (J. Prochaska, 1994) As pros increase relative to cons, stage progression occurs. (Huang et al., 2009; Marshall & Biddle, 2001; Mori et al., 2009)

Temptations to engage with the problem behavior, are negative urges, such as the urge to not exercise. The degree and frequency of temptation is associated with a higher likelihood of relapse into old behavior. (Hausenblas et al., 2001) It

can be measured with different self-report measures and is especially useful for substance use problem behaviors. Temptation decreases as stage progression occurs.

6.2.1 Usefullness of the TTM

The TTM has very popular amongst health practitioners as it offers an intuitive framework to understanding and influencing behavior change. (Brawley & Culos-Reed, 2000) Patients can be sorted into stages with staging algorithms in form of questionnaires or verbal questions.

Once knowing which stage a patient belongs to, practitioners can tailor their advice and support to the stage the patient is believed to be in. If for example a patient is still in precontemplation, the goal becomes moving him to the next stage of contemplation, instead of working directly on action.

Besides the model offers many ways of supporting behavior change through the processes of change. It also does normalize behavioral relapses, which are otherwise often seen as indicators of failure by practitioners and patients.

On a public health level, the model also explains the low rates of behavior change in most programs intended to change health behavior. According to the TTM the patients are in an earlier stage of behavior change and therefore only a certain percentage of the participants will be perceptive to the intervention. One can only reach those that are “ready to change”.

Unfortunately, there is rather little evidence in form of meta-analyses available. However, some of the available results are encouraging.

In a meta analytic examination with nearly 50 000 participants in total, researchers showed a consistent validity of decisional balance and stages of change across 48 health behaviors. (Hall & Rossi, 2008)

In the realm of weight control there has been one promising randomized controlled trial conducted which tested a TTM lifestyle change intervention on a total of 1277 participants. (Johnson et al., 2008) In this trial significant treatment effects were found for healthy eating (TTM: 47.5% vs control: 34.3%), exercise (TTM: 44.90% vs control: 38.10%), managing emotional distress (TTM: 49.7% vs control: 30.30%), and fruit and vegetable intake (TTM: 48.5% vs control: 39.0%). All of

these effects were measured by the percentage of participants acting on the respective habits at the last follow-up at 24 months.

Most importantly there was a small advantage in weight loss in the TTM vs. control group. In the participants staged as being before the “action” stage, 30% in the treatment group lost 5% or more of their bodyweight, compared to 18.6% in the control group on a waiting list.

However, it is important to note that this intervention only allows to judge the effectivness of a TTM based intervention compared to no intervention. In order to measure the marginal effectiveness of employing TTM principles in interventions 3 groups would be necessary: a control group (no intervention and on a waiting list), an intervention group without TTM principles and a group that receives a TTM based intervention.

A meta-analysis by Noar, Benac and Harris on tailoring interventions, including 57 Studies with 58,454 participants across a wide range of behaviors, also showed an advantage in stage-matched treatments over non-stage matched interventions. (Noar et al., 2007)

A 2001 meta-analysis of physical activity and exercise studies found supportive evidence in the available research. (Marshall & Biddle, 2001) The direction of change in the trials included was found to be consistent with what the TTM predicts. For example, the authors found an effect size of 0.85 for behavior change when moving from “preparation” to “action”, which supports the postulated relationship between these stages and behavior.

However, they also found an effect size of 0.34 for the transition from Precontemplation to contemplation, which should not be expected according to the model. This stage change should be an internal process, that should not result in a change in behavior such as an increase in physical activity. This finding therefore also suggest some kind of effects or moderators not included in the TTM.

Overall, the evidence base supporting the model is quite limited, compared to practitioner support and the high frequency of citation amongst the available health behavior change models. (Brawley & Culos-Reed, 2000; Michie & Abraham, 2004; Whitlock et al., 2002)

6.2.2 Limitations of the TTM

The limitations of the TTM are most apparent in the trials testing their effectiveness. The TTM does not outperform chance in several reviews and meta analyses. This is especially relevant, as there are only few well controlled trials with significant number of participants available.

Lack of effectiveness

In the general context of different health behavior change models, the TTM performed worse with an overall effect size of 0.20 to the TPB based interventions with an effect size of 0.36. (Webb et al., 2010) It however still outperformed the SCT, which reached an effect size of 0.15.

In a 2010 Cochrane Review, the TTM failed to outperform non-stage based interventions in the behavior it was developed for: smoking cessation (Cahill et al., 2010)

TTM based nutritional counseling sessions also failed to improve diabetes outcomes in primary care as shown in a 2009 review. (Salmela et al., 2009)

For increasing physical activity with TTM based interventions a 2004 review also drew a negative resume. (Adams, 2004) Whilst short term (less than 6 months) results appeared to be promising, long term adherence (more than 6 months) was described as “disappointing”. The review states that TTM based activity promotion interventions have been no more effective than control in improving long-term adherence to increased activity levels.

In a 2005 systematic review the authors summarized 37 RCTs across multiple health interventions including dietary change, physical activity, multiple lifestyle changes and the uptake of unhealthy behaviors such as alcohol use. (Bridle et al., 2005) The authors conclude that there is little evidence to support the effectiveness of transtheoretical interventions and call for stronger evaluations of theory-based interventions.

A 2014 Cochrane review on the evidence base for TTM in changing dietary and physical activity describes the quality of evidence supporting the TTM principles as “low”. (Mastellos et al., 2014) Besides the rather low total number of 2971 participants in the 3 eligible trials, the authors found a lack in methodological

quality such as overreliance on self-reported measurements and imprecise staging algorithms.

Why is the evidence base for the TTM not stronger? It appears to be limited, due to testing issues, limitations of stage models in general and several specific limitations of the TTM.

Testing issues: One of the major obstacles in determining the value of the TTM in practice, as well as in improving it, are testing issues. In a review of the TTM evidence base, Sutton analyzed questionnaires that are used to determine stages in studies conducted on the TTM and found major inaccuracies. (Stephen Sutton, 2001) It was not possible to clearly sort people into a stage. This casts doubts upon the concept of altering interventions based on stages. Also stage progression can therefore be no reliable proxy for behavior change. This makes already performed studies less reliable, as stage progression is used as evidence of TTM based interventions producing behavior change. Also stage allocation can be misled by the current emotional state of participants and even if stages are correctly sorted, treatments could be ineffective, therefore showing no better outcome and obscuring the correctness of the stage matching. (Callaghan et al., 2007; Norris et al., 2000)

Precise Measurement, especially of outcomes rather than stage changes, clearer definition of the variables and causal relation of the constructs to each other, as well as standardized and properly validated questionnaires for staging would strengthen the theory significantly.

Also well-designed and properly implemented randomized controlled trials are lacking and would be an important next step in improving the evidence base. (Riemsma et al., 2003)

Limitations of stage models: Bandura, the developer of the social cognitive theory (SCT), criticizes stage based models in general. He stated, that human behavior is “too multifaceted to fit into separate, discrete stages” and argues that “stage thinking could constrain the scope of change-promoting interventions”. (A Bandura, 1997)

Also there are several uncertainties on the stages in TTM concerning the time periods proposed and whether the stages are actually a proxy measurement of intention.

The time periods of stages are arbitrary. There is no objective evidence available for the 6 month mark between action and maintenance, besides Prochaska's claim. (Stephen Sutton, 2001) Further, focused research would be needed to determine if there is an exact time period or a variable time frame, which might differ depending on personality, behavior and treatments.

Some research also argue that stages could simply be a linear measurement for readiness to change. Precontemplation, contemplation and preparation could be a continuum to arrive from intention formation to action. (A Bandura, 1997; Kraft et al., 1999; S Sutton, 2000; Stephen Sutton, 2001) Armitage and Arden also found a strong correlation of .78 between stages of change and intention, which further supports this perspective. (C. Armitage & Arden, 2008)

Similarly research by Courneya, Nigg and Estabrooks supports this hypothesis, by demonstrating that "intention to exercise" explained more variance in exercise behavior than the stage algorithm. (Courneya et al., 1998)

Behavior change components neglected by the TTM

The TTM is a model that focuses on personal motivation to intentionally change once own behavior. However, this neglects several critical factors for behavior change, such as complexity of behavior, behaviors influencing each other and biological, social as well as environmental influences.

The staging algorithms, that are employed in the research, do ask for behavior patterns such as "healthy diet" or physical activity in general. This however neglects sub behaviors (such as only walking and not proper strength training). (Adams, 2004; Adams & White, 2003) Also the TTM is focused around a single behavior, not taking into account how for example exercise behavior could influence smoking, sleeping hygiene behaviors or dietary habits.

Biological, environmental and social issues such as hormonal changes through behavior such as sleep, diet or exercise, socioeconomic limitations and influences, as well as behavior changes through affiliation with close peer groups are also entirely missing from the model.

6.2.3 Conclusion

The process outlined in the TTM is time consuming, complicated and costly for interventions. Therefore, it is critical that this stage based approach has inherent value, otherwise it would be a waste of resources. (J. Prochaska, 1994; J O Prochaska et al., 1992)

One of the strengths of this theory is personalization, as it allows interventions to be tailored to individual needs within the framework. This however is not unique to stage based interventions. (Donovan & Owen, 1994) Personalization in general is possible with any kind of intervention, theory based or not. One could imagine personalization based upon personality such as with the big five (Digman, 1990), external factors (employment, geographical) as well as physical attributes (body fat levels, grip strength and more).

The TTM is especially useful in a public health perspective, as it serves as a model to explain the low rates of behavior change in public health interventions. It also might be helpful to determine readiness to change, which can allow focused use of resources by filtering participants beforehand. Thinking about readiness to change is also a valuable enhancement in thinking about change in general.

However, it seems doubtful if these 5-6 stages actually exist, at least in the proposed form. There is a significant need to standardize the staging algorithms and questionnaires in interventions. Improving the algorithms and testing the theory whilst measuring actual behavior outcomes are necessary. This should be done individually for each health behavior, as there are constructs of the TTM that seem to hold true across many types of health behavior, whilst there likely are undiscovered relationships and mediators that could obscure the effectiveness. (Marshall & Biddle, 2001) Finding these mediators and integrating them into the model, would likely allow to improve the effectiveness of the TTM in interventions.

Overall the TTM is a influential model, of which parts have been empirically validated. It can be seen as a useful heuristic framework, that would be enhanced and improved through more rigorous research and development or by integration into another more complete model.

6.3 Social Cognitive Theory (SCT)

Bandura's Social Cognitive Theory (SCT) is centered around the role of social influences and cognition in forming behavior. (Albert Bandura, 1986) In SCT knowledge and skills are acquired through social modelling, which is the process of observation and replication of other peoples' actions.

At the time of SCT's development in the 1960s the prevalent school of thought was behaviorism. Behaviorism explains behavior through learning by direct experiences through paired stimulus and response consequences. It entirely neglected observational learning, because internal processes were seen as a "black box". (A Bandura, 2011)

Bandura's SCT represented a major move forward from behaviorism to cognitive processes. Observational learning would be impossible without such cognitive processes. This allowed internal behavior to be studied, rather than thinking of the person as a black box, merely reacting to a stimulus with a response.

Originally called "social learning theory", Bandura later on extended and renamed the theory to "social cognitive theory". (A Bandura & Walters, 1977)

Social learning theory was based on research in groups of children emulating behavior. These so called "bobo doll experiments" were therefore also the origin of SCT (BANDURA et al., 1961; A Bandura et al., 1963a, 1963b)

The origin of SCT: The Bobo Doll Experiments

In the Bobo Doll Experiments at Stanford children watched aggressive and non-aggressive role models of the same and different gender acting very differently towards a toy ("bobo doll"). This kind of toy gets up by itself after being knocked down due to its heavier base.

The aggressive role model hit and kicked the Bobo Doll whilst shouting "Hit it" and "Kick it".

Then the children had to wait in a room with toys, that they were not allowed to play with, thereby increasing their aggression levels ("Aggression arousal")

Children then emulated the aggressive behavior and even used objects such as toy guns to threaten the doll by which they showed learned aggressive behavior.

As explained above at the time the “behavioral” school of psychology was popular. Behaviorists proposed that all learning was a result of direct experience with the environment through the processes of association and reinforcement. Some kinds of learning however could not be explained through direct reinforcement.

Figure 15:Participants from the Bobo Doll study

The Bobo Doll study showed, that learning through modeling the observed behavior of others could result in behavior. Bandura called this learning through observation of other people, fictional characters or verbal instructions “observational learning”.

Core concepts of SCT

At the core of SCT is “**reciprocal determinism**”, which describes how the 3 components of personal variables, the expected outcomes of the behavior and environment (social as well as physical) interact and influence each other. (Bandura, 1986)

The 3 components

The Person: Personal variables are cognitive capacities such as intelligence, biological makeup and reactions to the behavior change, but also how one perceives the behavior.

The Behavior is what the person does and how behavior influences environment as well as the person.

The Environment is influenced by behavior and the personal components, but also influences the behavior and person itself in the ability to do something. This occurs through social norms, influence by peers or physical facilitators and barriers that make a given behavior harder or easier to do.

The 3 core components of SCT and their interaction is shown in Figure 16 below. SCT is therefore a theory that proposes a bidirectional relationship between components, rather than an unidirectional, as common in other theories such as the TPB (Bandura, 1978)

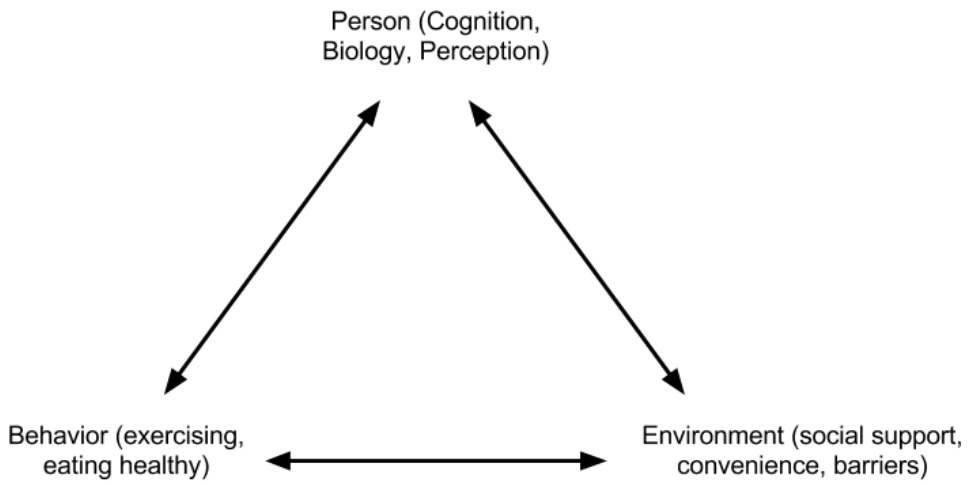

Figure 16: Reciprocal Determinism in the SCT

An example for reciprocal determinism: An overweight person does not like being overweight. Being overweight poses problems in social exchanges with peers and health professionals. Both groups might counsel and pressure the person to change their way. This leads to feelings of being more isolated and withdrawal from the aforementioned groups. Finally, this results in eating more to feel better, which just worsens the overall situation.

Other components of SCT

Other important components of how SCT explains behavior are goals, self-efficacy, outcome expectancies, modeling and sociostructural factors:

- **Goals** are the result that individuals want to attain.

- **Self-efficacy:** According to SCT “self-efficacy” lies at the center of behavior change. Bandura defines it as “people's beliefs about their capabilities to produce designated levels of performance that exercise influence over

events that affect their lives” (A Bandura, 1994, p. 2)

The concept can be found in other health behavior change theories such as the TPB as "perceived behavioral control" or "self-efficacy/temptation" in the TTM. (Noar & Zimmerman, 2005) It is very task specific and not a global construct such as self-esteem or general “confidence”. (Noar & Zimmerman, 2005)

A major appeal of self-efficacy in health behavior stems from the fact that it is a modifiable factor that can be intervened on because sources of self-efficacy include modifiable factors such as personal experiences, persuasion, vicarious experiences learned from observing others and modeling.

- **Outcome expectancies** are another core construct in SCT. They represent the perceived desirable and undesirable outcomes of the behavior. The equivalent in the TTM would be the “decisional balance” (pros vs. cons), in the TPB it would be behavioral beliefs.

  Besides possessing self-efficacy, an individual needs to desire the outcome of the behavior. The more people desire the expected outcome, the more likely they will be to engage in the behavior. (Noar et al., 2007)

  If joining a sports club and training several times a week, is expected to cause an improvement in wellness and physical changes, the person will be more likely to do it. If they expect to be too exhausted, tired or are scared of going to the gym, they will be less likely to act.

- **Modeling / observational learning:** Watching other people performing the behavior and learning through observation (“Modeling”) is another central component of the theory.

  Modeling is how humans learn to talk, open doors, eat or cook. It is rooted in human capacity to learn from observing the behaviors of others and

enacting those behaviors or avoiding them in case of expected negative outcomes.

- **Sociostructural Factors** are the environmental factors which either facilitate or hinder the pursued behavior. These can be the effects of peer groups, family, physical environment or company rules.

The interplay of these components, which lead to the target behavior is shown in Figure 17 below. (Bandura, 2004)

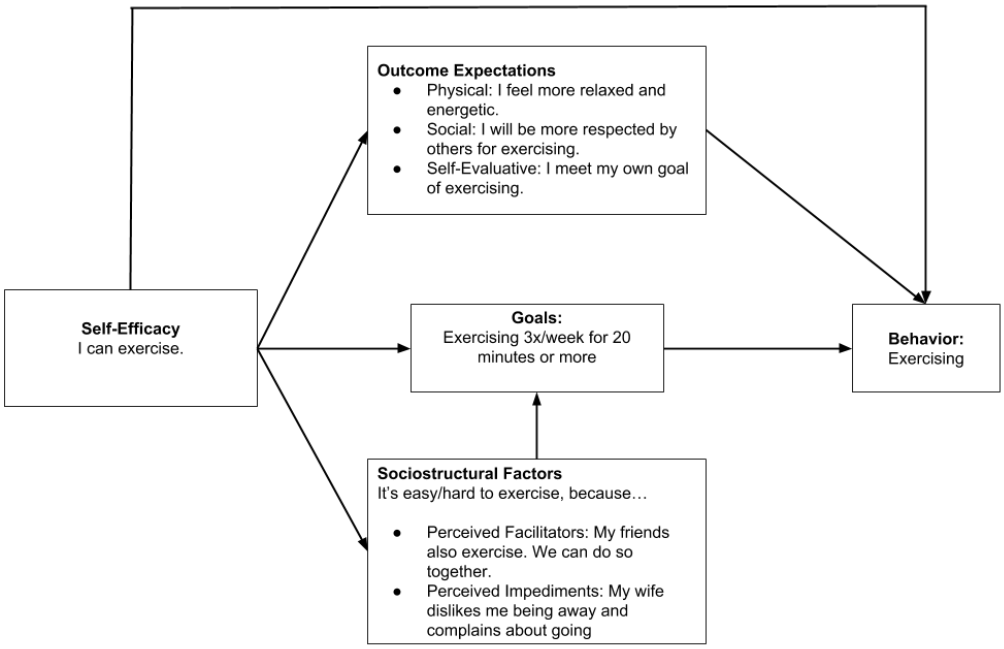

Figure 17: Interplay of components of SCT according to Bandura (Bandura, 2004) with the example of exercising regularly

Also of importance in health behavior change according to Bandura is **"self-regulation"**. It represents an internal process in changing health behavior, which consists of:

- **Self-observation**, which is also known as introspection.
- **Self-evaluation** (or Judgment), which is comparing oneself to one's own or a created standard.
- **Self-response**, which is the reaction to the observed outcomes and behavior by punishing or rewarding oneself.

6.3.1 Usefullness of the SCT

Many authors hold SCT in high regard for guiding health behavior change. (Short et al., 2013; Tierney et al., 2011) SCT's value lies in the explanatory power for behavior change, the well supported importance of self-efficacy in behavior change, as well as the existing broad range of empirical evidence for SCT constructs.

Explanatory Power

SCT can explain low rates of behavior change by a lack of self-efficacy or weak outcome expectations for the benefits of these changes, be it weight loss, changes in diet or exercise behavior.

Especially **self-efficacy** is a highly important construct in explaining behavior. In one review of exercise behavior, self-efficacy alone was able to explain up to 26% of variance in behavior. (Keller et al., 1999)

SCT interventions

According to SCT people need to be confident in performing the target behavior (self-efficacy) and belief that doing the behavior will overall benefit them (outcome expectancies). Interventions typically teach skills that help start and maintain PA behaviors, whilst also improving social and physical environment to facilitate rather than hinder the target behavior. (Glanz & Bishop, 2010)

The effectiveness of SCT based interventions has already been supported by multiple meta-analyses so far.

In a 2014 systematic review and meta-analysis the authors concluded that: "SCT is a useful framework to explain PA behavior. Higher quality models explained more PA variance, but overall methodological quality was poor. High quality studies of SCT for PA are warranted." (Young et al., 2014)

The researchers included 44 studies with 13 358 participants and despite the criticized methodological quality of the trials found that SCT explained 31% of variance in physical activity (PA) behavior.

A 2015 meta-analysis and systematic review of 18 studies on cancer survivors SCT based interventions were also effective in changing diet and physical activity

behaviors. (Stacey et al., 2015) The meta-analysis included observing 1107 participants over interventions lasting 6-12 months. An effect size of 0.33 could be shown for PA interventions immediately after the interventions.

SCT is an evolving theory, that is open to change as shown by banduras own development of SCT itself from social learning theory. Despite this openness for improvements several important limitations of SCT need to be kept in mind when evaluating the theory.

6.3.2 Limitations of the SCT

The effectiveness compared to other theories such as TPB or TTM does appear to be lower. The lack of operationalization limits utility in interventions as do neglected components of behavior change for prediction and application of HBC. In one review effect sizes in interventions were lowest for SCT based interventions with an effect size of 0.15 across 15 studies, compared to 0.36 for the TPB and 0.2 for the TTM. (Webb et al., 2010)

Reasons for this smaller effect size can be found in the wide-ranging nature of the theory. This makes SCT principles far harder to operationalize as there is no official or unofficial full systematized model and standard procedures for intervention design. As the extent of the influence of the proposed constructs is unclear, this leads to widely differing applications of the theory. A concrete operationalized set of tools for use in interventions would need to be developed to improve upon the current state of SCT.

Besides this very significant issue, several relevant HBC components are neglected entirely. SCT is highly focused on the individual, which leads to **group and environmental elements** only having a small role besides the “modeling” component of the SCT. Also **social, economic, and political factors**, so called “ecological factors”, are entirely ignored. (Bronfenbrenner, 1979)

Biological and hormonal predispositions are also not part of the model. These could influence behavior and lead to inter-individual variations of behavior patterns in the exact same context.

Variability in preferences is also an issue. SCT does not take in account that what one person views as punishment, another person may view as a reward.

This is especially important in interventions where very differing populations are targeted with the same intervention.

Also a lack of focusing on **motivation** and **emotions** in general before, during and after conducting the behavior is an issue in SCT that is likely to reduce predictive utility. Of course this neglect will also likely make SCT based interventions less effective than possible with the inclusion of them.

There is also a systematic problem in many of the trials conducted with or on the SCT. In these researchers claim to use SCT, even though they simply were measuring and aiming to enhance self-efficacy. To some SCT appears to be a “one construct theory”, even though SCT consists of several constructs with defined relationships as shown above.

6.3.3 Conclusion

Overall the SCT is a valuable theory, that predicts and explains health behavior change. It certainly provides principles with practical utility for interventions. Through its development and distribution, Bandura pushed the entire field of psychology forward by moving from simple behaviorism to more complex cognition based approaches. At the same time, it popularized **observational learning** and **self-efficacy**.

But it also remains important to improve and extend the model where needed. Biological factors, personality, as well as other “ecological” factors, such as politics (sociatal climate, legislation etc.), cultural or economic factors, could help in improving the predictive power and effectiveness of SCT based interventions.

At the same time additions and changes to the theory need to be tested properly with strong research designs and replicated independently.

Despite some of its flaws and possibly missing components Bandura’s SCT is generally held in high regard by many researchers and often used to guide HBC interventions. (Short et al., 2013; Tierney et al., 2011) SCT offers a valuable additional perspective on the Health Behavior Change literature.

6.4 Behavioral Economics

Behavioral economics (BE) is a field of economics that researches human irrationality in decision making and how to use it to change behavior.

Economics studies how individuals, groups and organizations make choices on allocating limited resources to satisfy their unlimited wants. Traditional economics states, that people are rational actors with fixed preferences and seek to maximize utility. (Levin & Milgrom, 2004; Matjasko et al., 2016) Humans are modeled as "Homo economicus". These presumably are rational agents that are determined on increasing their personal gain and reducing their losses.

However, the actual data on human behavior, especially regarding much of health behavior, does not agree with this framework. People are often irrational actors and consistently act in their (future selves) worst interest, such as through eating unhealthy, not saving for retirement or not exercising. (Milkman et al., 2008)

At the same time personal preferences also depend much on context of the decision. How choices are presented and the influence of peers plays a large role in decision making. People are "predictably irrational" as Ariely puts it. (Ariely, 2009)

BE studies this disconnect and provides models that joins economics, neurobiology and psychology to predict and explain deviations of individual decisions from the standard assumptions of economic theory. BE claims, that behavior is guided by biases and fallible heuristics and strongly influenced by environment and context of the choices.

Key principles at the center of BE are **the effects of framing, time inconsistent preference** and **the complexity of incentives.**

- **Effects of Framing:** "choice architecture" also called "nudges" are defined as "… any aspect of the choice architecture that alters people's behavior in a predictable way without forbidding any options or significantly changing their economic incentives." (Anderson et al., 2010, p. 2) This refers to presenting choices and designing contexts in a more helpful manner as explained below in the "framing" section. In BE these methods are used to

utilize this tendency for short sighted decision making for making better decisions.

- **Time inconsistent preferences:** We do not prevent today, what we do not want to happen tomorrow. A “present bias” leads to myopic decision making regarding healthy lifestyle choices. This is also called “hyperbolic discounting”, where one discounts the value of taking an action too much. This is especially valuable for health professionals who aim to help their patients by recommending and explaining lifestyle changes. For the patient, the benefits of change, as well as the harmful consequences of current behavior are in the future. However, the costs of following the recommendations such as lifestyle changes are in the present. These costs are overvalued in the decision making process, leading to inertia.

- **Complexity of incentives:** In BE the effectiveness of different incentives and ways to communicate incentives are studied extensively. Going from traditional economics models with rational actors that act in their self-interest, incentives for healthy behavior or disincentives for unhealthy behavior should work very well to change health behavior. However, people do not seem to rationally weigh incentives and disincentives. For example, intermittent rewards tend to change health behavior more than continual rewards, given the same overall conditions. Also losses or the fear of losses have stronger effects on health behavior than gains, which behavioral economists call “loss aversion”. This “loss aversion” means preventing a loss of 100 € is more valuable and therefore more likely to change health behavior than a gain of 100 €. (D Kahneman & Tversky, 1979; Volpp, John, et al., 2008)

These principles have several uses such as explaining seemingly irrational behavior and have been tested for effectiveness in several health behavior change interventions as detailed in the following section.

6.4.1 Usefulness of BE

One of the biggest uses in BE lies in its **explanatory power**. Concepts from BE can explain the disconnect between peoples' self-interest to not get sick vs. the reality of them suffering from and dying of lifestyle related diseases. Loss aversion for example explains why people tend to stick to the status quo. They would have to give up something they value, which leads to an irrationally high propensity to stick to their current behaviors, such as eating too much and sedentary activity level. At the same time alternative behaviors would be more beneficial for their health and well-being such as weight loss and regular exercise.

For example, if a patient wants to lose weight, he would need to eat less tasty foods. This leads to loss aversion and hyperbolic discounting kicking in. It "hurts" more to eat less and move more, than to die earlier and possibly suffer from severe consequences such as joint pain or amputations as a late complication of diabetes.

However, BE provides several tools that could help using these decision errors to counteract these tendencies.

Social Feedback, Incentives and Framing

Three of the most important and best researched tools in BE are **social feedback, incentives** and **framing** of decisions such as through defaults.

6.4.1.1 Social / Peer Feedback

"Social" or "Peer" feedback in BE describes the use of social influences for behavior change. According to BE people ask themselves: "Where do we stand compared to others? What do people like "us" do?"

Instead of seeing it as an additional influence, research in BE does provide a more pragmatic perspective and focus on how these effects can be utilized in interventions to improve behavior.

Giving social feedback can help in creating a desire to change and more effort towards change. This could be done by showing how intervention participants are doing in a group compared to other teams and how they are themselves

progressing compared to their peer group or a similar age cohort. For example this technique has been used to convince patients to quit smoking, by giving them feedback on the conditions (“age”) of their lungs in comparison with a similar group of non-smoking individuals. (Parkes et al., 2008)

Even medical doctors are more likely to change the way they prescribe drugs, if they see that their colleagues changed practice, rather than if they see data on the effectiveness of treatment options. (Meeker et al., 2016) In marketing this is often employed as so called “social proof”.

In interventions this could also be used by moving from individual achievements to group based achievements. For example, in an intervention aiming to increase physical activity, practitioners could provide a total pooled step goal for a group vs. using individual goals. Social feedback within the group and in-between groups would then increase overall efforts to reach the goal.

6.4.1.2 Incentives

Incentives and disincentives are forms of punishment and reward to change behavior. They are not a restriction of the choices, just as defaults or nudges, but rather serve make the healthier choice more attractive.

Several trials on the effectiveness of incentives as described in BE have been conducted and are described in the following. The method of using incentives are also often called “commitment devices” in BE.

Three main types of rewards are employed in BE interventions, as explained above: Continual Gain, Loss aversion and Intermittent rewards. Trials have been conducted on health behaviors such as gym attendance, medication adherence, smoking, financial incentives for weight loss and physical activity.

Commitment contracts for gym

In one trial researchers could show increased regular gym attendance in formerly non-regular visitors, when incentivizing them financially. (Charness & Gneezy, 2009)

Two studies were performed which varied in the ways participants were payed to control for payment modalities. 200 college students were included in the first trial,

168 in the second trial. Each trial was split into 3 groups: the control group, a group that was payed for attending the gym once and one group that also was payed for attending the gym an additional 8 times in the 4 weeks after their first visit. Evidence was found for habit formation in the form of regular gym visits, defined as attending the gym at least once per week. In study 1 44 percent and in study 2 43 percent of non-regular gym goers started visiting the gym regularly as shown in Figure 18 and Figure 19 below.

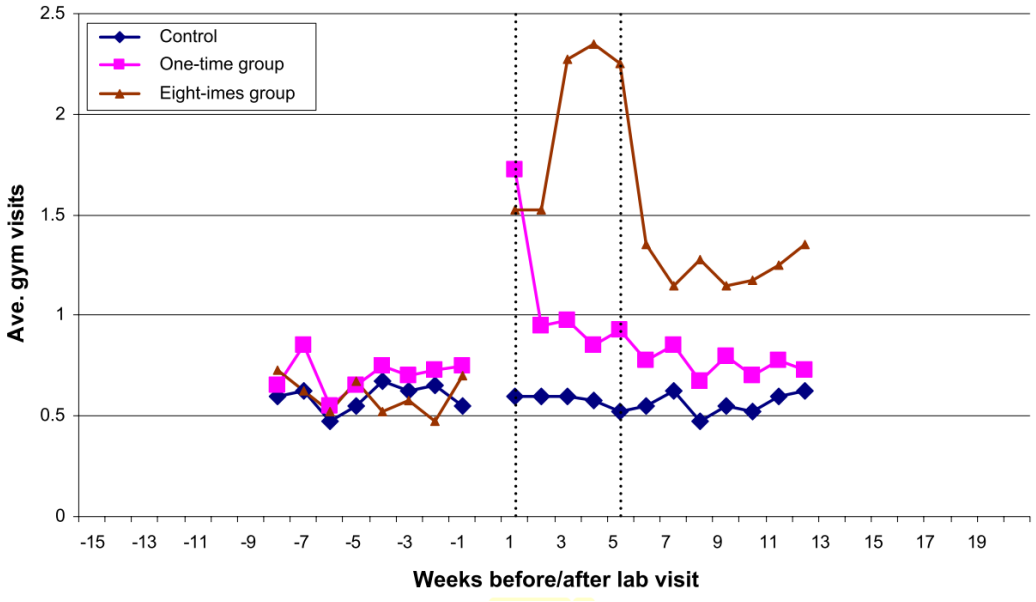

Figure 18: Average gym visits in Study 1 per group before, during and after the intervention from *Charness & Gneezy, 2009*

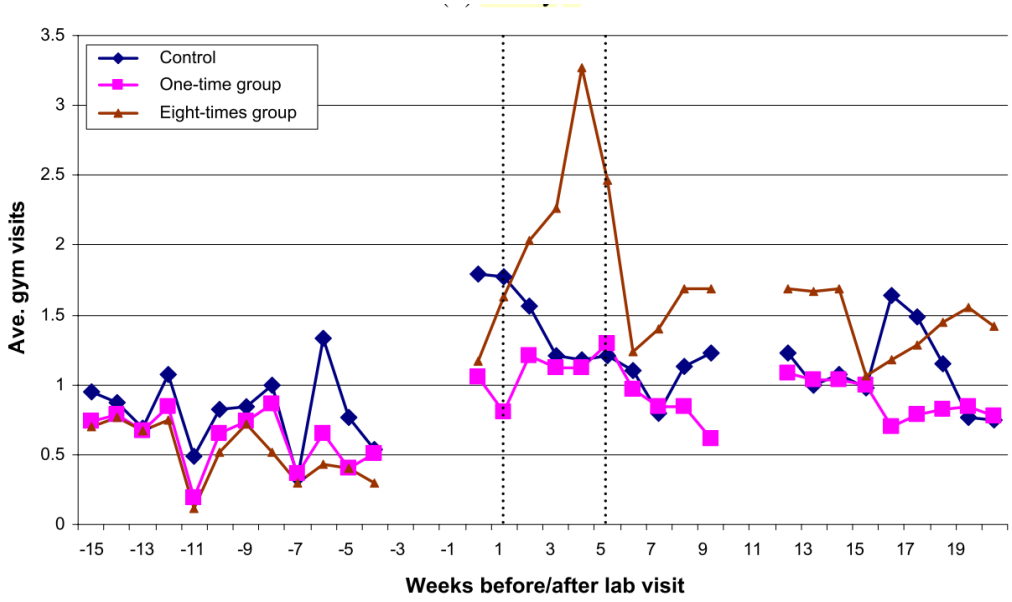

Figure 19: Average gym visits in Study 2 per group before, during and after the intervention from *Charness & Gneezy, 2009*

Stop Smoking through loss aversion

In a trial conducted on the effectiveness of commitment devices to stop smoking in the Philippines smokers were 3.3 to 5.8 percent more likely than control to pass an objective urine test of smoking abstinence at the 6 month mark (Giné et al., 2010) This increase in absolute percentage might sound low, however as the control group showed 12-month cessation rates from 8.9 to 14.7 percent this constitutes a clinically significant improvement. The 3.3 to 5.8 percent increase in cessation rates on top of the control groups baseline of 8.9 to 14.7 percent would constitute an approximately relative increase of 30 % in effectiveness.

Participants had to put their own money on the line over the 6 months leading up to the test (on average 20% of their monthly income), which they only received back if they passed the urine test for cotinine and nicotine. After 12 months the researchers conducted another urine test which showed that this advantage over control persisted long term.

It's important to consider that the test at the 12-month mark was not coupled to any incentive, therefore lacking any incentive to fraud. This lack of financial incentive to manipulate the urine test provides strong evidence for actual smoking abstinence. This trial therefore provides compelling evidence for the utility of using loss aversion as proposed in the BE literature to stop even highly addictive behaviors such as smoking.

Financial Incentives for Weight loss

In a 2008 paper researchers reported how they used financial incentive to help obese patients lose weight in a randomized trial. 57 obese Patients were given a financial incentive to lose weight over 16 weeks (Volpp, John, et al., 2008)

Patients were randomly sorted into one of three groups: only monthly weigh-ins, daily lotteries or deposit contracts. Deposit contracts describe a system where participants "bet" with their own money on their success. If they reached their weight loss goal, they were payed their own money back as well as receiving even more on top from the researchers.

The researchers found greater weight loss at the end of 16 weeks in both groups that were economically incentivized. At the follow up after 4 months the incentivized groups still performed better than the control group with only the

monthly weigh ins. However as explained in the section about BE limitations these differences between groups vanished at the 7-month follow-up.

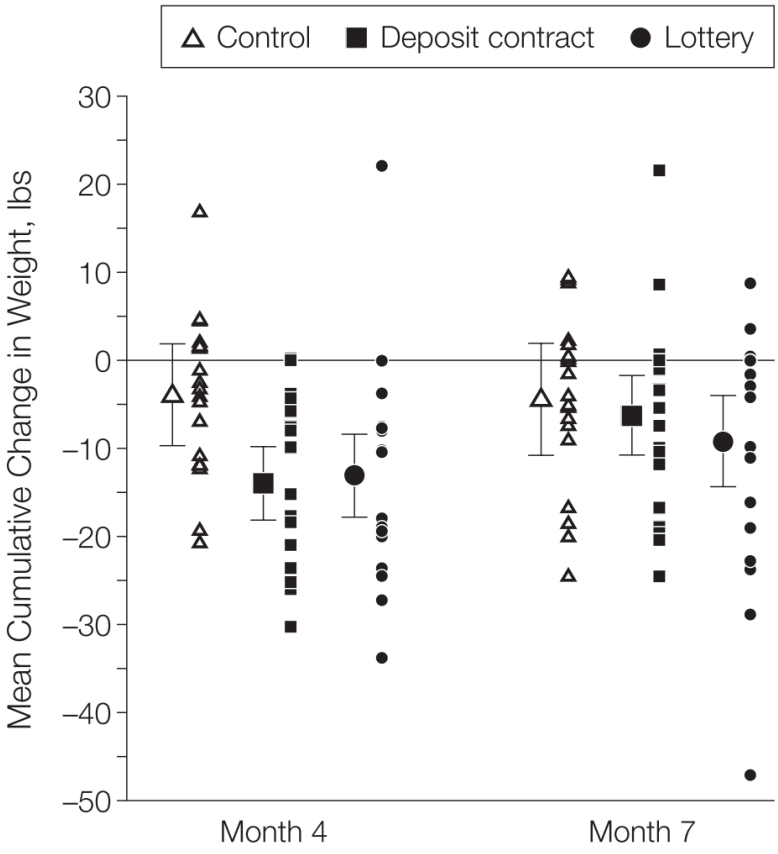

Figure 20: Weigh change in pounds compared between the 3 intervention groups at 4 and 7 month follow up *(Volpp, John, et al., 2008)*

In a 2016 randomized trial using financial incentives to increase physical activity researchers could show a significant increase in daily steps. (Patel et al., 2016) 281 overweight adults were sorted into 4 groups: a control group and 3 different financial incentives group, which all mathematically achieved the same amount of financial reward for exactly the same goals of 7000 steps per day. The 3 intervention groups either received a daily continual payment if the goal was achieved, were evitable to win in a “lottery” or received a sum each month upfront and lost part of it every day that they did not meet the goal (employing “loss aversion”). Over the course of 13 weeks the gain group showed no difference to the non-incentivized control group, however the “lottery” group and the “loss aversion” group achieved their daily step goals more often than control. However, this improvement decreased to baseline after stopping the rewards.

Incentives in accordance to BE have also been tested with success on other health behaviors such as medication adherence. In one trial 20 patients on warfarin (a type of blood thinners post-stroke) were entered into a trial to improve their medication adherence through financial incentives according to BE principles. (Volpp, Loewenstein, et al., 2008) The 20 patients were randomized into two groups of 10 patients. Both groups were entered into lotteries that gave both the 1:100 chance to win 100$ if they took their pills correctly. However, the first group had a 1:5 chance to win 10$ (overall expected value of 5$) and the second group only a 1:10 chance (overall expected value of 3$).

Patients had an electronic pillbox with daily reminders in their home. Participants were randomly chosen to be the winner for the day, but they only received the reward, if they were compliant as tracked by the electronic pillbox. If they were not compliant they were told that they would have won, if they would have taken their pills correctly.

The historic mean of incorrect pill taking in the clinic population that the patients were selected from stood at 22%. In the first group of patients the value of the mean incorrect pill taking rate was found to be 2.3%, whilst in the second group it even dropped to 1.6% as shown in the following Figure 21.

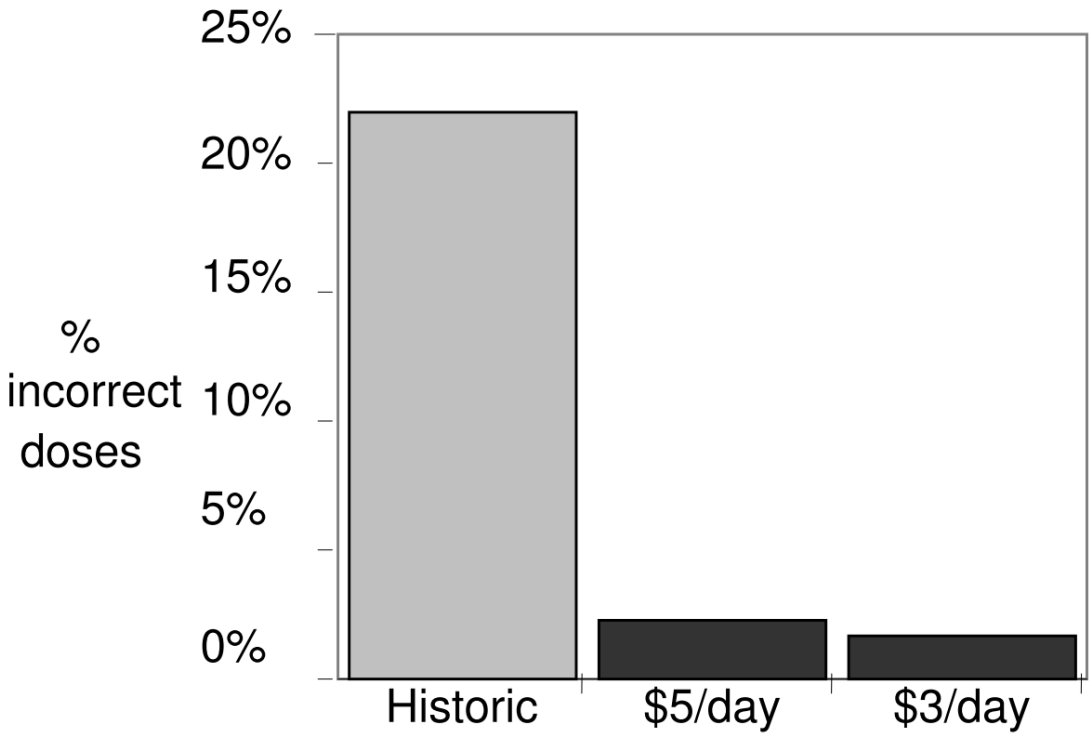

Figure 21: Historic vs. group 1 vs group 2 mean incorrect doses during the intervention from *Volpp, Loewenstein, et al., 2008*

This BE based incentive system therefore appears to be very effective to increase medication adherence. In accordance with BE principles saving themselves from brain damage was less of a motivational effect in these patients, than winning the lottery.

6.4.1.3 Framing and Defaults

"Framing" is the usage of presentation and accompanying information to alter the relative attractiveness of a decision. (D Kahneman & Tversky, 1979) This is also called "choice architecture", which is the method of designing decisions and their context in a way that people are "nudged" towards healthier choices. "Defaults" refers to the option in a decision that will be obtained if the chooser does not do anything. Making an option a default option tends to increase the likelihood of picking the option.

Defaults and choice architecture work by turning around common decision errors to benefit rather than harm people. Unhealthy behaviors are hard to change long term in part because of these systemic decision errors. However, this difficulty to

change behavior can be turned around to promote healthy behaviors by designing decision in a different way through framing and changing defaults. Common decision errors such as insensitivity to probabilities, procrastination, hyperbolic discounting and inertia can be turned around in interventions to promote healthy behaviors. (Loewenstein et al., 2007)

A very illustrative example for the effects of an opt-in vs. opt-out system are the differences in organ donation rates by country based upon the variance of the default decision to either opt into organ donation manually (“opt-in”) or by being enrolled in organ definition by default (“opt-out”). (E. Johnson & Goldstein, 2003, 2004) In Figure 22 below the seven “opt-out” countries, which operate under “presumed consent”, are on the right and the four countries on the left are “opt-in”, which operate under “explicit consent”.

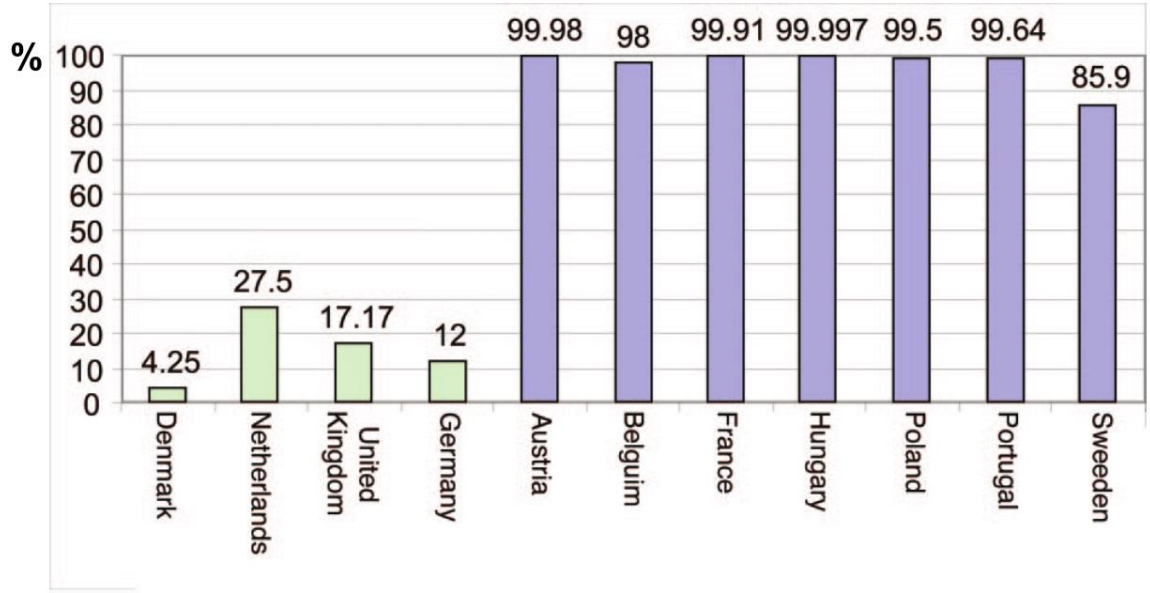

Figure 22: Comparison of organ donator rates in the population from 0-100% (left axis) in "opt-in" organ donation countries vs. "opt-out" countries from Johnson, E., & Goldstein, D. (2003). Do defaults save lives?

The difference between these 2 systems is drastic. 8 times more people in Austria donate their organs than in Germany, even though these countries are culturally quite similar and even geographically direct neighbors.

Another experiment illustrates that defaults even strongly influence how we chose to die. End of life care is heavily influenced by defaults. (Halpern et al., 2013) In this trial 132 terminally ill patients were randomly assigned to one of three groups

that had the following boxes for end of life care form pre-checked: “comfort-oriented”, “aggressive care” or “none” as shown in figure 23.

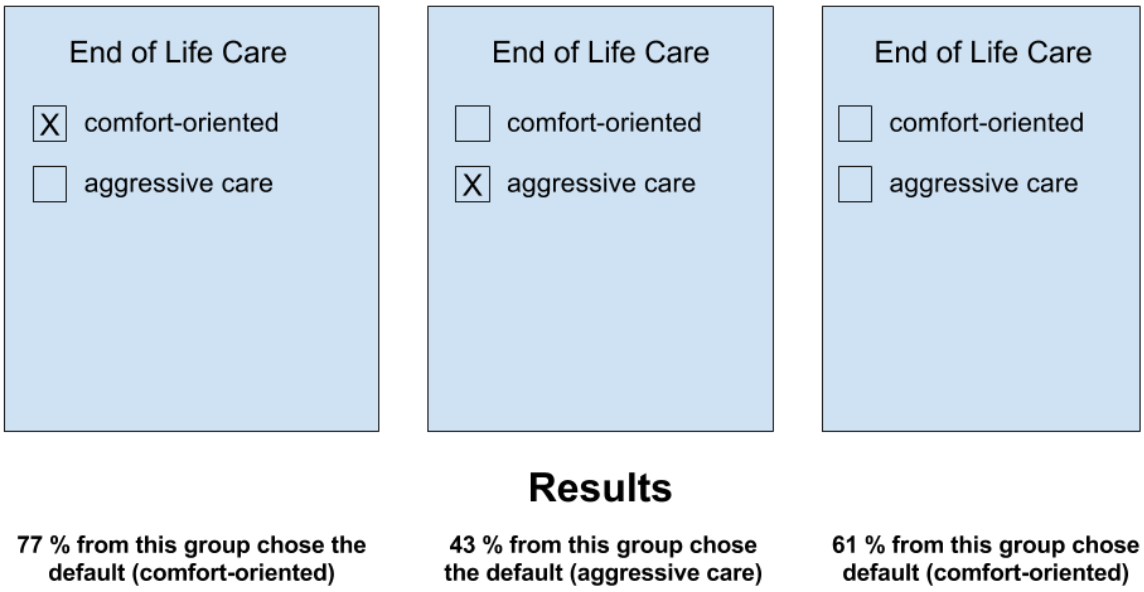

Figure 23: The 3 Variations in the end of life care defaults illustrated with results based on Halpern et al., 2013

Patients were free to override the default choice (first and second group) or chose one of the blank options (third group). In the “comfort” group 77 percent chose the prechecked option, when only 43 percent of the “aggressive” group did. 61 percent opted for “comfort-oriented” in the “none” group. Defaults had a significant effect on patient choices for end of life care, as the outcome between groups varied strongly.

There is also evidence available supporting the effectiveness of a choice architecture intervention on nutrition. Researchers tested such an intervention in combination with food labeling over a period of 6 months in the main cafeteria at the Massachusetts General Hospital. (Thorndike et al., 2012)

In “Phase 1” of the intervention all foods and drinks were labeled either red, yellow or green. This already led to a significant increase of sales of green items and a reduction of red items. In “Phase 2” (the choice architecture intervention) bottled water was added to the refrigerators on eye level and 5 additional baskets with bottled water were added throughout the cafeteria, as shown in Figure 24 below.

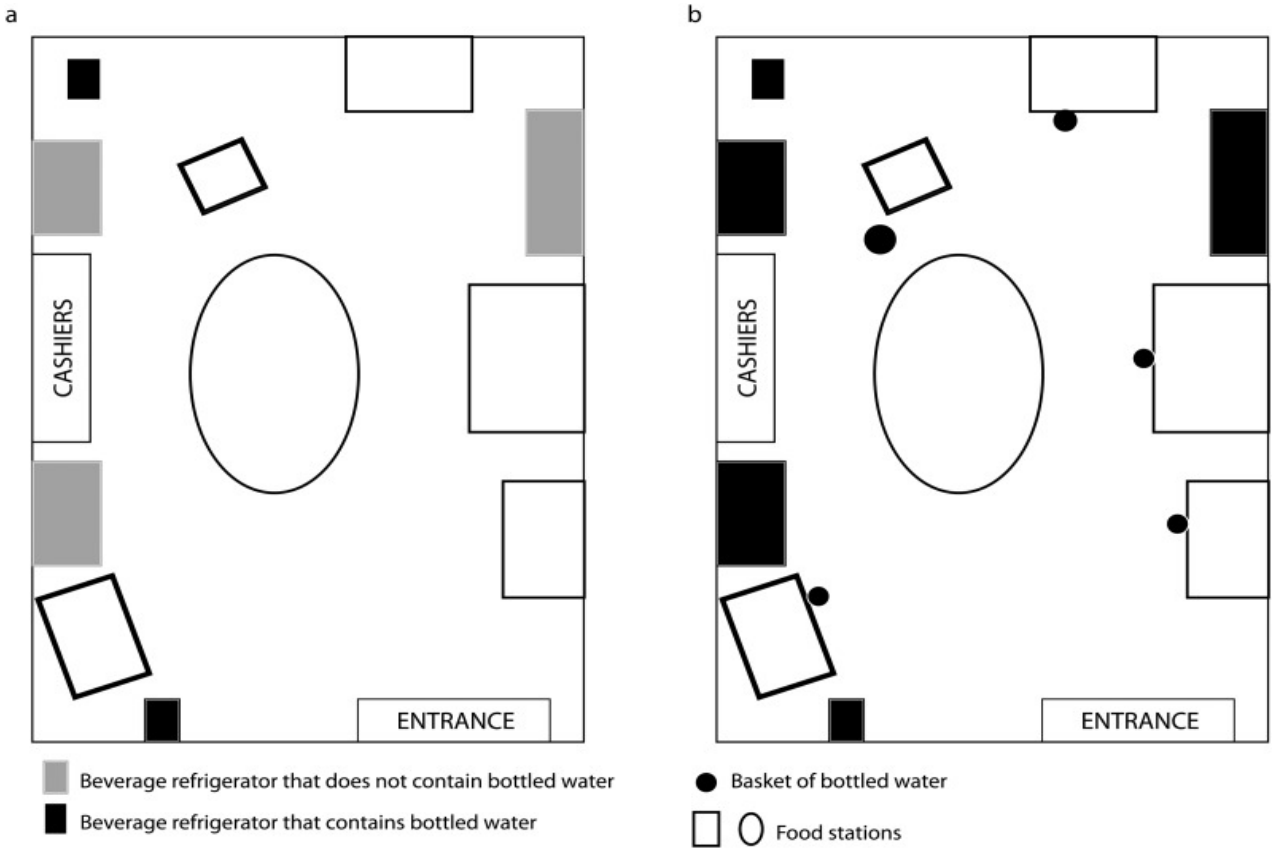

Figure 24: Diagram of the main cafeteria at the Massachusetts General Hospital – a: before the Phase 2 intervention, b: after Phase 2 intervention *(Thorndike et al., 2012)*

In Phase 2 Soda sales dropped by 11.4 % ($P < .001$), whilst bottled water sales increased by 25.8 %. Food sales were less affected by the choice architecture intervention.

Practical usage:

These results provide many possibilities for health behavior change interventions, such as:

- In restaurants (free) water could be served as default. Other drinks would only be served if explicitly asked for by the guest.
- Unhealthy foods need to be bought by cash, healthy foods can be bought with a credit card in populations that favor digital payments and vice versa.
- The placements of healthy vs. unhealthy food could be altered. Unhealthy food harder to reach and where one is less likely to walk through, whilst healthy option should be the choice easiest to reach.

However, despite all these potential benefits of BE methods for interventions, several limitations need to be kept in mind.

6.4.2 Limitations of BE

The limitation of BE can be broken down into ethical issues, the danger of incentives “backfiring”, possible disadvantages of using social feedback and defaults, as well as issues with the evidence base of BE.

Ethics

Is it unethical to “nudge”? Methods employed in BE are a form of asymmetrical or libertarian paternalism, which means they can **“**unduly infringe on individuals’ decision-making autonomy.” as many researchers warn. (Halpern et al., 2009; Loewenstein et al., 2007)

“Dark patterns” employed by many companies in their apps and websites are an example of unethical infringement. (Brignull, 2011) Companies use these patterns to trick people into taking actions against their own interest by aligning buttons counter-intuitively, intentionally mislabeling options or providing defaults such as spamming all personal contacts with a “personal invitation” as common on platforms such as LinkedIn. As shown below data tracking led to a group of over 714 people that the user might know. If one accidentally or mindlessly simply presses the big blue button, all of these hundreds of users will get a notification and/or email with seemingly personal invitation to join the users network.

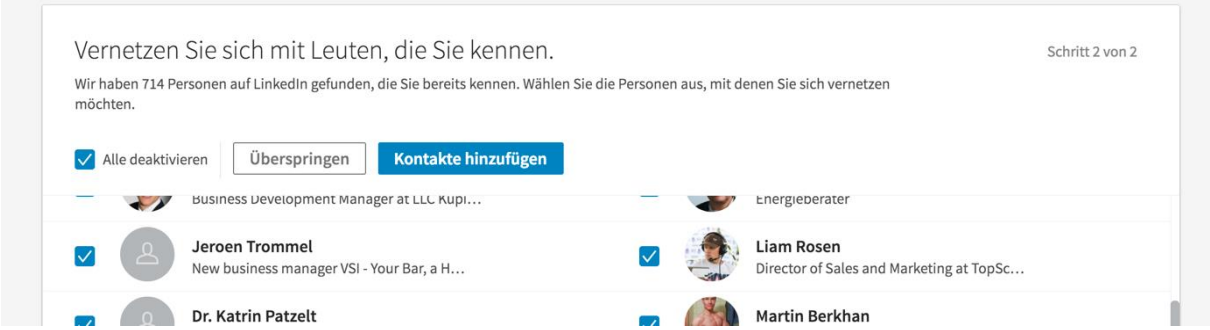

Figure 25: LinkedIn's user hostile defaults: auto-selection of all possibly contacts with a one click invitation

A more ethical approach would be to let the user manually select the contacts that should be invited, instead of manually deselecting or using the “deselect all” button on the left, which also is not labeled properly.

If used in an ethical manner, using defaults and framing are not a choice restriction, rather a form of libertarian paternalism. These methods also can be used in conjunction with clear communication and help, rather than mislead by counteracting self-defeating tendencies of seeking short term gratification. (Halpern et al., 2007)

Ethical considerations with this form of influence on individuals' autonomy also limits real world adoption due to strong political pressures. For example the Institute of medicine (IOM) evaluated the introduction of an "opt-out" organ donor system in the US and came to the conclusion that such a change would face too much public resistance. (Liverman & Childress, 2006)

Even though such a rather simple policy change would likely multiply the current organ donation rates in "opt-in" countries, the political backlash is expected to be too great. Similar backlash could be expected by other legislative measures such as food taxation or increasing the number of physical education classes at school as proposed by the German DANK (Deutsche Allianz Nichtübertragbare Krankheiten) for example. (DANK Allianz, 2014)

Incentives can backfire

While Incentives can increase extrinsic motivation, they also tend to reduce ("crowd out") intrinsic motivation at the same. (Heyman & Ariely, 2004) As extrinsic motivation is thought of being less stable (see the Self-Determination Theory Chapter), this could possibly make interventions less effective or even harmful. For example, using financial incentives to increase exercise behavior could backfire, as people might exercise less after the removal of the incentives than previously. In one study this effect could be observed in regular gym goers, who reduced their gym attendance below their pre-study levels once incentives stopped. (Charness & Gneezy, 2009) The researchers argue that the intrinsic motivation to exercise for health, well-being or enjoyment was replaced by "exercising just for the money".

In the above BE randomized trial, that tested financial incentives on 57 obese patients, researchers could not find a statistically significant weight loss after 7 months. Once incentives were dropped behavior reverted entirely and no long term effects could be observed as seen in Figure 20. (Volpp, Loewenstein, et al., 2008)

The same “backfire effect” could be observed in the trial aiming to improve warfarin adherence. (Volpp, Loewenstein, et al., 2008) Post-intervention the out-of-range INR increased even over the initial measurements. Within the first intervention group of out-of-range INRs decreased from 35.0% to 12.2% during the intervention, whilst in the second group it decreased from 65.0% to 40.4%. However post-intervention out-of-range INR increased to over 42% post-intervention in the first group (higher than baseline), whilst in the second group that received the lower overall possibility for rewards the post-intervention out-of-range INR remained under the baseline as shown in Figure 26.

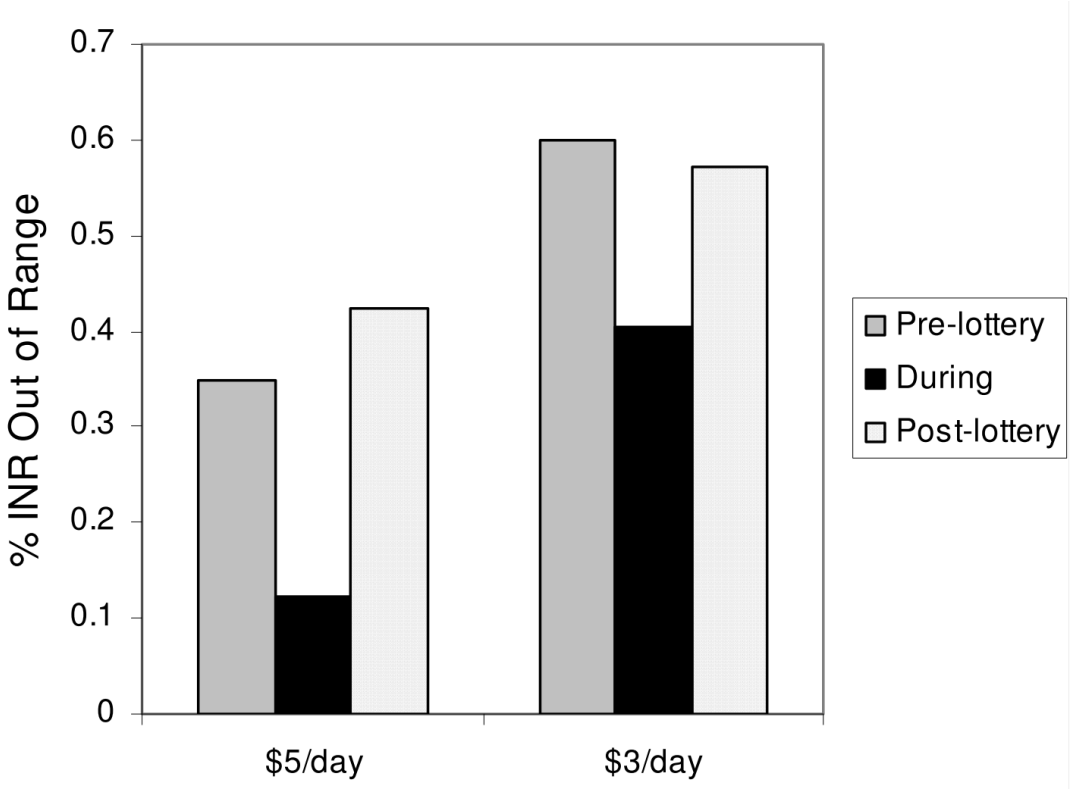

Figure 26: Percentage of out-of-range INR before, within and after the 2 interventions from *Volpp, Loewenstein, et al., 2008*

However, the effects of “crowding out” and successful habit formation are not mutually exclusive. As these work in opposite directions, the outcome of trials as the one above are hard to interpret. Incentives could work long-term, if participants would have habituated to the new behavior and therefore freely continued it due to strong habits, even when incentives are reduced or removed. However, there is no evidence available yet to strongly support either possible mechanism. Further research with long term incentives would need to be conducted.

Default problems

Defaults are likely most useful for decisions that people are not heavily invested in. As the researchers of the above trial discussed in their papers, this is one of the reasons defaults worked so well in this case. (Volpp, John, et al., 2008)

In a NJEM article the researchers provide three scenarios where defaults would be less effective or problematic (Halpern et al., 2007):

Defaults would be less effective:

- If people have **less trust** in the person providing the default option. An example would be treatment defaults given by a physician covering the shift vs. the recommendation of a doctor with a long term relationship with the patient.
- If **established contrary preferences** exist, such as for a low or no deductible in a health care plan in the US. Even though the default amount is set higher, most people chose a lower deductible. Deductibles refer to the amount patients would have to pay before their insurers cover healthcare costs. Higher deductibles would however lead to lower premiums that patients would need to pay for their insurance.
- If **practical barriers** exist, that for example might make the “opt-out” harder than an “opt-in” such as hurdles through additional required forms and approval processes. This would lead to an ethical dilemma as people will be coerced into a decision against their will.

Lack of standardization and overarching organization of BE

There exists no standardized intervention form or formulated overarching “theory of behavioral economics” yet. Therefore, researchers and interventions designers still need to pierce their own model together from the available trials and data.

Quality Issues: false data in a novel field

Some questionable research practices have come to light recently by one of the researchers publishing about nutrition and behavioral economics. More than 150 "Inconsistencies" were found in just 4 papers of Prof. Brian Wansinks lab at

Cornell university. (Zee et al., 2017) Even simple calculations such as averages were calculated wrongly, a failed study with null results was reanalyzed until coming to publishable results and data seemed to have been copied between supposedly independent studies.

6.4.3 Conclusion

BE offers many very valuable aspects for health behavior change, as it holds great potential to improve existing components of work/health behavior change interventions without requiring more resources to do so. Principles from BE such as incentive programs, decision framing and social feedback could be used in many interventions, which also could be informed by other theories of behavior change.

So far BE seems to be quite underappreciated amongst researchers and practitioners in psychology and medicine. This is likely the case due to the generally small amount of overlap with economists.

However there exists only a very limited evidence base in support of BE. Few trials are available and big RCTs are still lacking. Also BE does not provide a comprehensive solution to health behavior change.

BE does explain parts of behavior change that other frameworks cannot. For example, it explains why some decisions are regularly made against peoples own rational self-interest. It also provides an explanation for the disconnect between intention and observed behavior in many instances regarding health behavior such as time inconsistent preferences due to hyperbolic discounting. It therefore serves to fill in some gaps of understanding and offers a set of tools to improve the effectiveness of interventions.

However, to improve the evidence base and in order to understand drawbacks and the right context to employ such techniques, more trials would need to be conducted and analyzed rigorously in multiple meta-analyses.

6.5 Fogg Behavior Model and Tiny Habits

The Fogg Behavior model (FBM) is a theory of behavior change developed by Stanford Professor BJ Fogg. It explains behavior as a function of the constructs of Motivation, Ability and Triggers as demonstrated in Figure 27. (Fogg, 2009)

The formula according to Fogg is “B = mat” (Behavior = motivation x ability x trigger).

1. **Motivation**: Sufficient motivation to take the action is required.
2. **Ability:** Can the behavior be performed by the person or is additional training and learning needed to be able to do the behavior?
3. **Trigger:** Triggers are signals and cues that start the behavior.

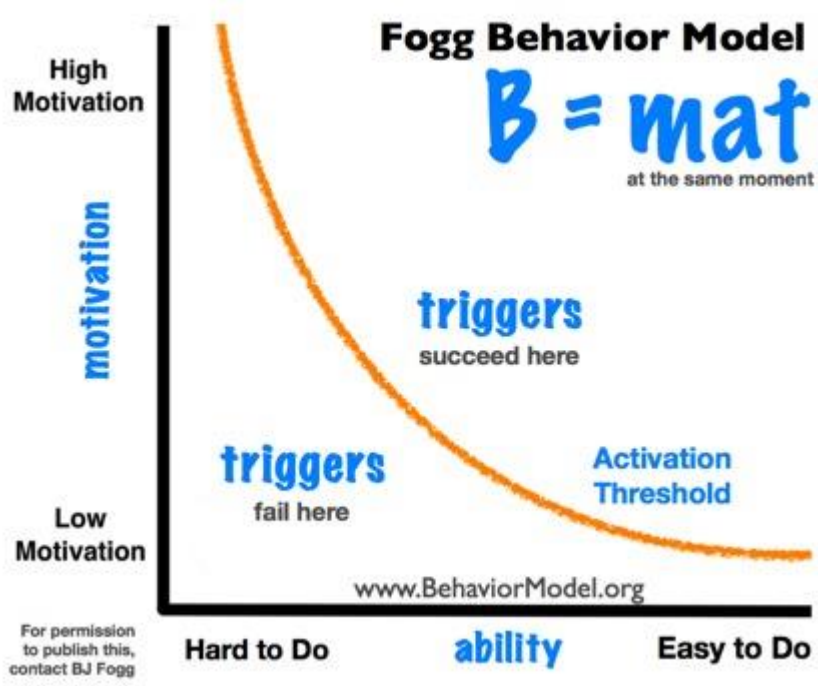

Figure 27: Fogg Behavior Model by BJ Fogg (Fogg, 2011a)

As shown in Figure 27 behavior only occurs above the orange/yellow line, which represents the so called “activation threshold”. Below the line the behavior does not occur, despite the trigger being present, as motivation and/or ability is insufficient.

The FBM is a theory that elegantly tries to explain behavior and how to change it with very few constructs. Its practical utility is best understood with the accompanying method, which Fogg calls “Tiny Habits”. (Fogg, 2011b)

The application of FBM: Tiny Habits

The concept of Tiny Habits is a promising approach to change health behavior by creating extremely small habits. This method was developed in 2011 by Fogg and bears some similarities to the model proposed by Duhigg (Duhigg, 2012; Fogg, 2011b). In Duhigg’s model a routine (the behavior) follows a cue and gets rewarded. This repeats as a “habit loop” and strengthens the habit with every repetition as shown in Figure 28. Duhigg proposes to replace habits by switching out the routine and building new habits by consciously attaching the behavior to a cue and reward.

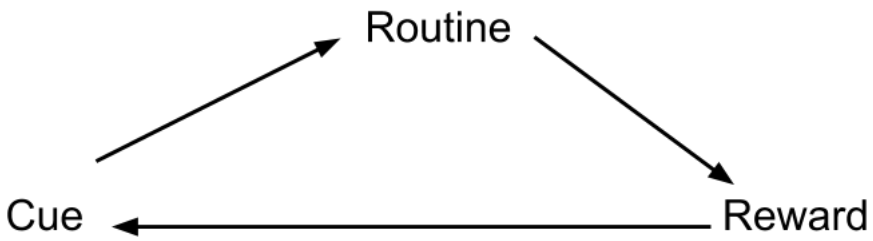

Figure 28: "Habit loop" as described by Duhigg, 2012

The Tiny Habits concept is also close to the common sense approach of “Baby Steps”. Changing Behavior by “Baby Steps” is the concept of incremental change in very small (“Baby”) steps, just like a human baby would have a very small stride first.

“Tiny Habits” however is more rigorously defined than simply doing a behavior in small increments (“Baby steps”) or the model proposed by Duhigg. It is more clearly structured, more actionable for participants and is currently tested in the field. Habits, that are learned within Tiny Habits can, once they are established, be expanded.

The main goal of Tiny Habits is in achieving automaticity for the practiced behavior. Once the Behavior is habitual it can be increased and expanded.

Fogg defines a “Tiny Habit” (the goal of the method “Tiny Habits”) as a behavior, that:

- is performed **once a day**
- takes **less than 30 seconds**
- requires **little effort**

“Celebration” as explained later is not part of a tiny habit itself, but rather a component of the “Tiny Habits” method.

The process of creating such a tiny habit is illustrated in the diagram below:

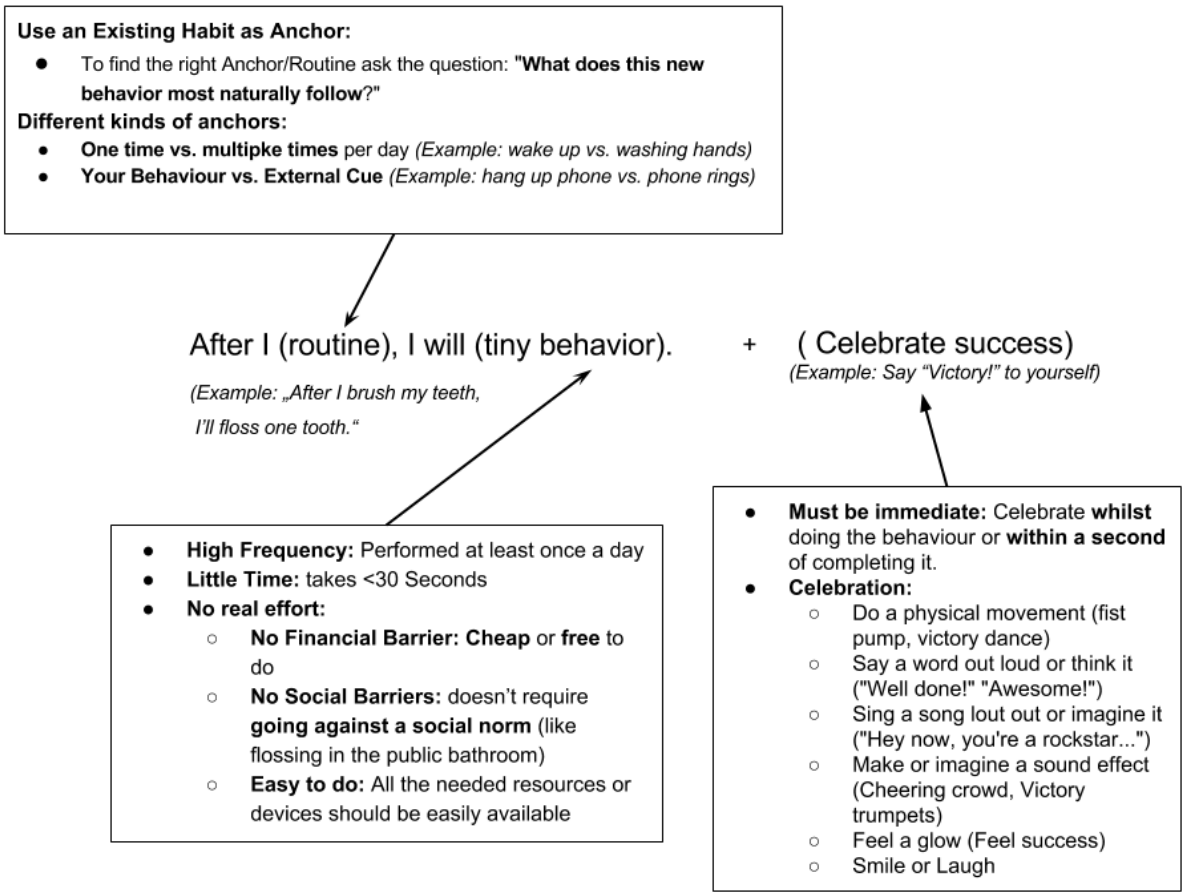

Figure 29: Diagram of Tiny Habits’ structure

Other examples of tiny habits:

“After my daily coffee, I'll take my Vitamin D Supplement.”

“After getting out of bed, I’ll do one Pushup.”

The main differences to other methods of behavior change, according to Fogg, lies in the tiny starting point and the sequence after the tiny behavior and celebration of successfully doing the behavior.

As this kind of behavior change only leads to small behavior changes, many of these habits would need to be "chained" together sequentially.

Fogg contrasts this Method of behavior change with two other options for changing behavior, which he describes as "having an epiphany" or "changing the environment":

> *Option A*: **Have an epiphany** – having a powerful insight that leads to a major overhaul of ones life and behaviors
> *Option B*: **Change your environment** – describes the practice of modifying the environment (social or physical) to influence future behavior in this context
> *Option C*: **Take baby steps (= Tiny Habits)**

The "Tiny Habits" method is implemented and taught in an online intervention by Fogg himself. He created it in 2011 to teach the method to a wider audience, conducted research by collecting actual usage and result data, as well as to refine the method itself over time. (Fogg, 2011a, 2011b, 2016, 2017)

The program is conducted as an online intervention with thousands of participants simultaneously using free tools such as Google Docs and automated Email Sequences. It can be accessed on TinyHabits.com.

6.5.1 Usefullness of FBM and Tiny Habits

The FBM provides a straightforward way to "design" behavior – making it simpler to find ways to change, start and stop behaviors. If one wants to start or increase a behavior, motivation and/or ability need to be increased. By reducing the scope of the behavior as far as possible less motivation and ability are needed and the behavior will be more likely to occur, according to the FBM.

This makes the FBM most applicable to changing clearly defined and small types of behavior: the "tiny habits". But how well does FBM explain and predict behavior as a theory of behavior change? How effective are tiny habits interventions?

Currently there are no meta-analyses and reviews available for the FBM or tiny habits. However, there are a few publications available that have used FBM and/or tiny habit concepts.

A 2013 study randomized 20 participants in a control and intervention group, providing the intervention group with a fitness tracker. (Maeyer & Jacobs, 2013) According to the researchers “small changes in behavior and attitudes were reported by most participants” such as “taking stairs more, park a bit further away or drink more water." However, these behavior changes were not quantified or measured specifically. They were simply self-reported by the participants during the trial. The follow up research that was proposed in the article cannot be found, even after extensive searches across multiple databases. Also there exists no mention of further research in the publication lists of the authors.

More promising appears to be a 2016 publication about a M-health program implemented based on FBM principles (“trigger centric” behavior change) for parents of overweight and obese children. (Militello, et al. 2016) In this study researchers recruited parents of 15 obese or overweight children for a 7-week intervention with in person meetings and SMS messaging.

This trial overall supports the efficacy of the simplicity proposed by the FBM as the researchers found a medium effect size (0.59) for changing parental health behavior. It is however important to keep in mind that this metric is based on self-reported data. The content of the intervention was also based upon Beck’s Cognitive Theory and therefore this trial cannot be evidence for the utility of a single theory.

The third available study that used FBM or tiny habits for health behavior change from 2016 observed 27 participants over 181 days. (Lieber, 2016) The participants self-reported behavior changes based upon the “tiny goals” they set within their usual routine such as “when I turn on the light, do 5 leg lifts” or “after I start cooking, drink one cup of water”. The researchers did semi-quantitative data collection of the behaviors. Self-report worksheets were utilized to collect qualitative post intervention responses of participants to the questions: “Do you believe that pairing new tiny habits with existing habits into your daily life is effective? Why or why not?”. The results were presented only in a very unconventional form: a word cloud where a higher frequency of word occurrence

in answers is represented by a larger font size as shown in figure 30. As answers were not supplied in full, presentation of the results is not fully comprehensible.

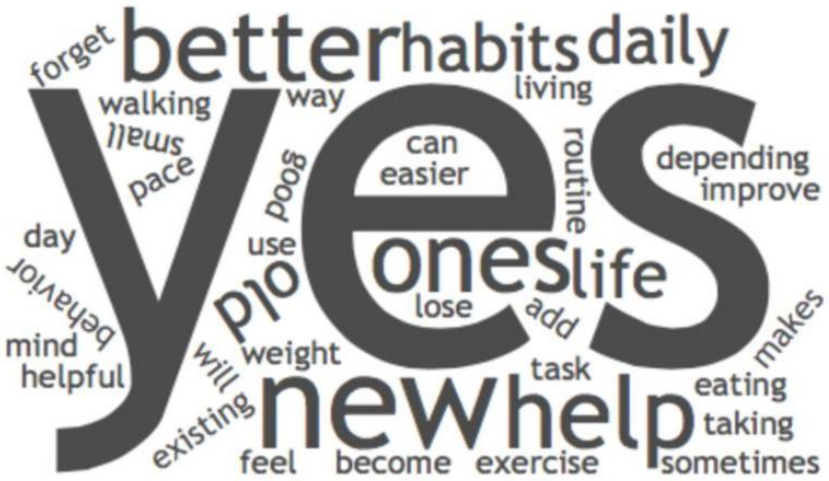

Figure 30: Word Cloud of participants' answers to: "Do you believe that pairing new tiny habits with existing habits into your daily life is effective? Why or why not?" from Lieber, 2016

Other Evidence supporting tiny habits

The results of Tiny Habits based solely on the feedback of participants from the tiny habit program does appear to be promising. However, the data is mostly anecdotal and the peer reviewed, published research on the method is limited to the few trials above.

When participants in Fogg's Tiny Habits online program were polled, whether the program created "ripple effects in other areas of their life", over 60% of participants answered with "yes". "Ripple effects" refers to the improvement of other life areas besides the one that participants explicitly worked on in the tiny habits program. However, this data is not yet published and peer reviewed or publicly accessible.

Even though the data on the intervention is still lacking, the potential for scaling Tiny Habits to change health behavior is vast. The program is already delivered in a very scalable fashion by using available and free (or very inexpensive) technology such as email, websites and web based software.

Furthermore, Tiny Habits can be used by a very wide variety of patients, because the behaviors are so small and require little skill, time or resources that few people will be excluded from such an intervention. Patients at very different levels of skill

(such as exercise technique), physical limitations (such as neurological disorders) or with different amounts of unhealthy habits (such as an obese, inactive, socially isolated and withdrawn smoker) can participate in the same intervention.

Different populations will of course advance at different speeds, as more advanced populations (such as patients with plenty of resources, time and healthier habits) most likely could make faster gains.

6.5.2 Limitations of FBM and Tiny Habits

The main limitation is also what can be seen as its strength: the small number of constructs. FBM and Tiny Habits are lacking elements required for long term behavior change that are of critical importance. There is little thought about behavior maintenance, prevention and solutions for “rebounds” and social aspects of health behavior change. It seems to only focus on starting to do the behavior, which is only the first step. Not every kind of behavior can become completely automatic and therefore habitual.

There are also several other missing constructs and issues, that likely limit the utility of the model and method. For example, the FBM provides no seperate construct for the effect of **environment**. In the FBM it can only be a trigger, but not a separate, additional construct as in TPB or SCT.

Another issue is the **circular, unmeasurable definition of motivation**. “Motivation” in the FBM basically refers to the sufficient general desire to do something and the possibility to measure it properly is still lacking. The only way to see if one is sufficiently motivated is observing whether or not one does the behavior. Being able to measure motivation properly would allow to better explain and predict behavior with the FBM and allow for more effective interventions based on the FBM. Ability of course can already be assessed through self reporting or observation of participants when aiming to perform the desired behavior.

Meaning and attitude towards the behavior are also not considered in the FBM, even though other health behavior theories do consider it, such as the TPB.

The nature of the tiny habits method, being focused on tiny, individual behavior change, comes with some obvious limitations. It makes FBM and Tiny Habits by

themselves likely **not a good fit for complex behaviors** such as addiction or changing an entire lifestyle.

Tiny changes in behavior would not result in changes that facilitate long term changes, such as great weight loss or noticeable large increases in physical fitness or wellbeing. On the other hand, participants of Tiny Habits can see their own behavior change, giving them a sense of control. This increased self-efficacy could lead to further changes in behavior and still make tiny habits a valuable tool in lifestyle changes.

Social factors are missing

As the FBM and Tiny Habits are focused on individual, small behavior changes, it excludes the effect of social factors and community. Community level change and the impact of community on behavior change, such as how individuals influence their health behavior, are not a part of the method. Social aspects of health behavior change are critically important as shown by other Health Behavior Theories and Methods (such as the SCT, TPB or SDT).

The effects of the social environment are however already integrated indirectly as effects on trigger, ability and motivation in the FBM. Social factors can “trigger” a behavior for example if patients can see other patients doing the behavior. Ability is also indirectly influenced by the people around the patient by either hindering or facilitating learning as well as doing the behavior itself. Motivation to do the behavior is also significantly affected by the social environment through increased rejection or acceptance. (Fogg, 2009)(Fogg, 2017) At the same time it would likely be beneficial if social influences would exist as a separate construct. This would allow to study effects and relationships separately as its own construct from trigger and motivation.

How does the overall evidence look for FBM and tiny habits?

Overall there is a significant lack of data for the FBM. Therefore, important questions such as predictive and explanatory utility cannot be assessed.

As Tiny Habits is also a very new method of behavior change, little evidence is available for its effectiveness and limitations. Fogg points to the large amount of data (over 500 000 data points), generated from the 36 000 participants of the online program, but this research is yet to be published.

It remains to be investigated how effective FBM and Tiny Habits are in changing health behaviors. Overall Tiny Habits does appear to be a promising method of health behavior change and FBM has a significant appeal through its elegant simplicity. Especially for initiating a behavior change tiny habits could be a very valuable tool.

Especially the possibilities to simply and cost-effectively scale tiny habits (reach and help many participants) to a wide audience, makes this kind of intervention a prime candidate for further research.

6.5.3 Conclusion

The FBM is a new and appealingly simple model of behavior change and even comes with a promising method (tiny habits).

However, this simplicity is also the biggest limitation of the model. There is a strong need for more and better research to provide an empirical base for the FBM.

Fogg's work will likely be especially valuable for people with low self-efficacy and low outcome expectations. Starting tiny would likely help these individuals to build up their self-efficacy and create positive expectations. The Model and Method could therefore be used as a part behavior change interventions, that also employ other theories and methods.

They could also serve to improve effectiveness of these interventions through offering an additional, valuable perspective for analysis. The FBM could also be integrated in other theories such as in the post-intentional or volitional section of other models of the TPB.

But irrespective of the ways that FBM and tiny habits could be employed, more and better research would be needed to provide a strong empirical evidence base.

6.6 Self Determination Theory

Self Determination Theory (SDT) is a Theory of Behavior that centers around the degree that a behavior is autonomously chosen and enacted. SDT was developed by Prof. Ryan and Prof. Deci at the University of Rochester. Deci and Ryan proposed it in 1985 in their book “Intrinsic motivation and self-determination in human behavior”. (E. L. Deci & Ryan, 1985b)

Self Determination Theory is primarily a theory of motivation. At its core SDT is about the distinction between autonomous (intrinsic) and controlled (extrinsic) motivation. (E. L. Deci & Ryan, 2000)
“Autonomous” motivation is of internal origins (by the self) vs. “Controlled” motivation (by external forces or intrapsychic forces) of behavior. This adds a qualitative component to the commonly employed quantitative perspective on motivation.
Intrinsic motivation refers to motivation generated without external pressures or incentives, such as punishments or rewards. It is purely generated by the self. This kind of self-driven motivation is thought to be more stable than the other driven extrinsic motivation. (P. J. Teixeira et al., 2011; Pedro J Teixeira, Silva, et al., 2012)
Intrinsic motivation can therefore be of particular importance in the maintenance of behavior change, which is one of the critical challenges in effective health behavior change. It does seem reasonable that internalizing the regulation of health-related behaviors improves the rate of long term behavior change. (Ryan et al., 2008)
SDT proposes that there exists an innate tendency toward growth, self-integration, and psychological consistency in every human being. (Baard et al., 2004) For this tendency towards growth and improvement 3 universal needs require to be satisfied.

These 3 universal core needs are: **Autonomy**, **Relatedness** and **Competency.**

1. **Autonomy** is the “universal urge to be causal agents, to experience volition, to act in accord with [our] integrated sense of self (i.e. their interests and values).” (E. Deci & Vansteenkiste, 2004, p. 25) It is the need

to feel in control of one's own actions.

2. **Relatedness** describes the need of belonging to a group. This however should be a group one freely choses to affiliate with. It describes the need for connection with other people, whilst feeling accepted and supported by them.

3. **Competency** refers to the need to feeling effective. This explicitly refers to the perceived level of competencies, not the actual, objectively assessed degree. For example, a person might be quite able and competent at doing a task, but feel so unconfident in their own abilities, that they don't perform the behavior.

The fulfillment of these psychological needs then leads to high quality, stable autonomous motivation.

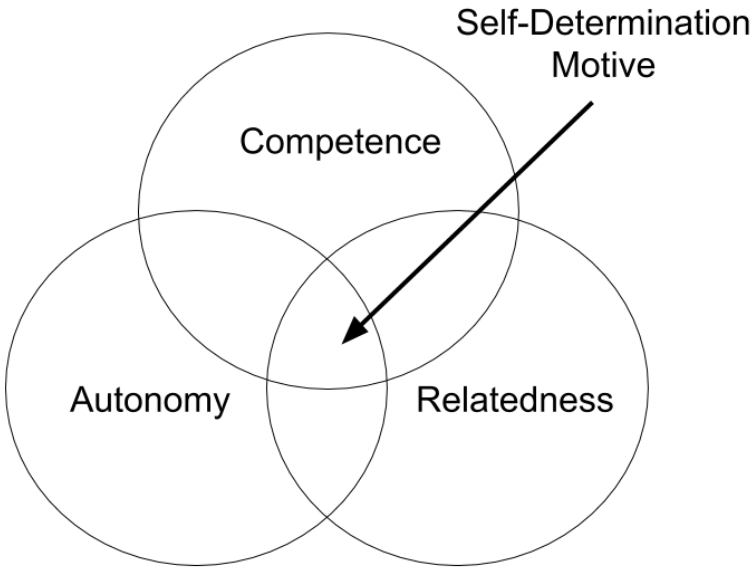

Figure 31: How the three constructs make up motivation based on E. L. Deci & Ryan, 2000

SDT in Health Behavior Change

How SDT and Health Behavior Change are related was explained by the authors themselves in a paper on SDT and health behavior. (Ryan et al., 2008) Figure 32 illustrates the relationship visually.

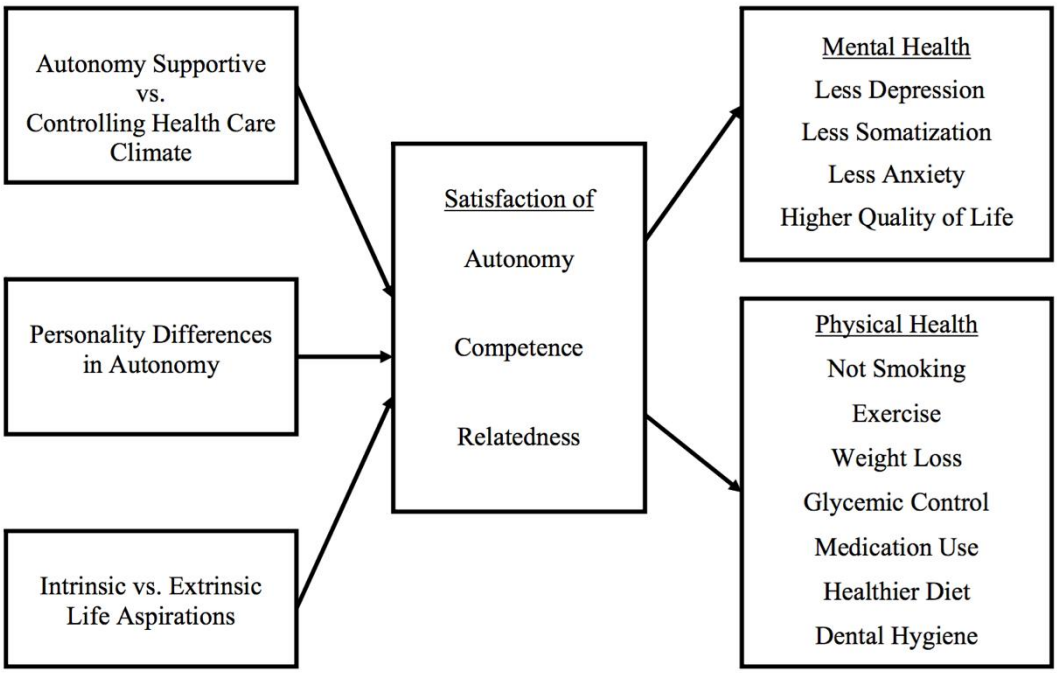

Figure 32: Relationship between SDT and Health Behavior (Ryan et al., 2008)

As seen above the relationships are straightforward: The constructs on the left influence, how well the 3 core needs are satisfied. Depending on how well the core needs are satisfied, health will either improve or worsen.

The three concepts influencing the satisfaction of the core needs are:

- **Autonomy Support: "Autonomy Supportive vs. Controlling Health Care Climate"** – An "Autonomy supportive health care climate" describes an environment, where patients feel supported to engage in healthy behaviors for their own reasons. Such a climate improves success by helping to deal with barriers to change, whilst conveying feelings of acceptance and respect. The opposite of this would be a "controlling health care climate". Such an environment exists, if the health care system aims to control patients' behavior through rewards or pressuring to confirm to behaviors valued by practitioners or institutions.

- **Life Goals: "Intrinsic vs Extrinsic Life Aspirations"** – intrinsic life aspirations describe inherently satisfying goals such as personal growth, meaningful relationships, contributing to the community and feeling fit & healthy, whilst extrinsic goals consist of the acquisition of wealth, fame and attractiveness (Kasser & Ryan, 1996). Focusing on extrinsic goals vs. intrinsic goals has been found to be associated with less healthy behaviors (Williams, Cox, Hedberg, & Deci, 2000).

- **Causality Orientations: Personality Differences in Autonomy** refers to differences in how people perceive, that their behavior is influenced by themselves, other people and/or the environment. There are three different types of causality orientations: the autonomous, controlled and impersonal type.

    1. **"autonomous"** type – the person is focused on the own interest in the activity and feels as the driving force behind their own behavior.

    2. **"controlled orientation"** type – the person is focused on external rewards and feels controlled by other people.

    3. **"impersonal orientation"** type – for this type it feels like the environment represents an obstacle to reach their goals. The person is unmotivated, anxious and doubts their own competence.

6.6.1 Usefulness of SDT

SDT Research has been expanding in the last decade. 53 of the 66 papers cited in a recent comprehensive meta-analysis were published in the last five years of the meta-analysis. (Pedro J Teixeira, Carraça, Markland, Silva, & Ryan, 2012) This is also evident from the step rise in publications seen in the PubMed Proxy Marker and WOS Proxy Marker shown in the method section of this thesis. Despite there not being a more up to date meta analysis available the proxy markers show a

continual rise in research interest. Many of the SDT constructs have therefore been tested in controlled trials.

Especially the significant effect of the difference between self-chosen goals and external goals has been shown in many trials. One example could be seen in Figure 33, illustrating the difference in repetitions done on a weight training exercise.

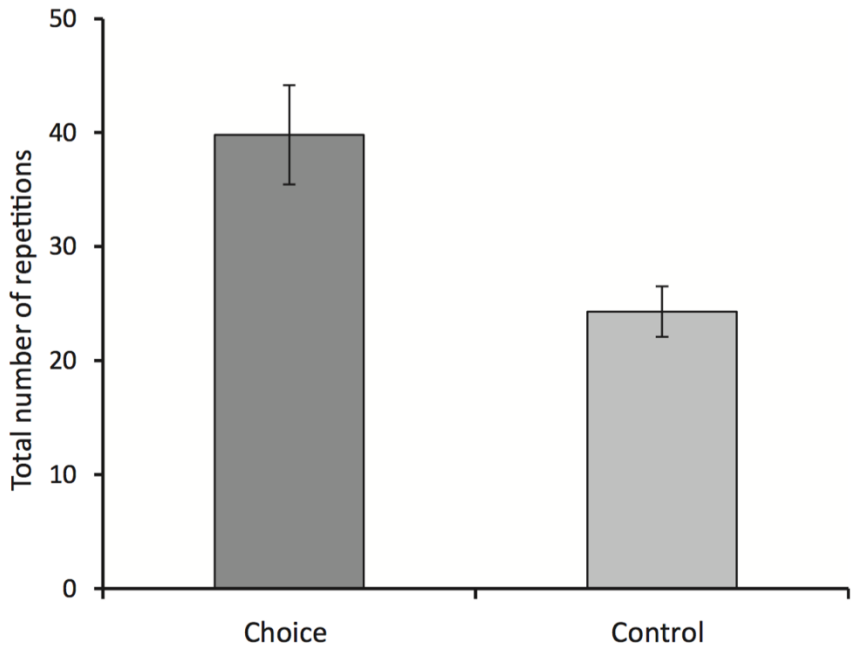

Figure 33: Average number of weight training repetitions done by participants, if self-determined (choice) vs. control (Wulf et al., 2014)

On the left the participants could chose the total number of repetitions themselves, on the right (control group) they were instructed to perform a set amount. This clearly shows some of the benefits of facilitating autonomy in intervention trials.

But besides single trials, there are already a few meta-analyses available, that summarize the extent of the evidence base for SDT.

One 2012 Meta-Analysis, that summarized the research on SDT and health behavior from 184 studies, came to an overall supportive conclusion. (Ng et al., 2012) It included trials on weight control, smoking, physical activity and medication adherence.

The three needs proposed by the SDT moderately to strongly predicted better health behaviors and better outcomes. Autonomy support also positively predicted greater levels of patient/client autonomy, competence, and relatedness. This provides evidence for the relationships proposed by the SDT and has important consequences for interventions, as these should be more successful by providing more autonomy support and reducing controlling elements.

A 2012 systematic review on the effects and predictive value of SDT on exercise and physical activity behavior also supported this conclusion: “Overall, the literature provides good evidence for the value of SDT in understanding exercise behavior”. (Pedro J Teixeira, Carraça, et al., 2012) The systemic review analyzed the available empirical literature of 66 studies for the relationships between key SDT-based constructs and behavioral outcomes. Intrinsic motivation was a better predictor of long-term exercise adherence than extrinsic motivation and the authors found a positive relation between more autonomous forms of motivation and exercise overall.

Another Meta-Analysis in 2014 with 46 studies and 15,984 participants (children and adolescents) was conducted to study the association between self-determined motivation and physical activity levels (B. Owen et al., 2014)

Self-determined motivation showed a weak to moderate, positive association with physical activity (effect size of .21 to .31). Autonomous forms of motivation also had moderate, positive associations with physical activity (effect size of .27 to .38), whilst the controlled forms of motivation showed weak, negative associations with physical activity (effect size of − .03 to −.17). Overall the meta-analysis therefore offered further support for the SDT.

6.6.2 Limitations of SDT

SDT however also comes with certain limitations, such as the relatively small number of participants in trials (small “n”) and others. The limitations of SDT can be broken down into the issues with the **evidence base**, the level of **standardization** and **the rational for only 3 needs**, as well as **cultural limitations**.

The evidence for SDT is still limited. Compared to established theories such as the Theory of Planned Behavior, there is a distinct lack of meta-analyses with a large number of participants. Larger trials on different kinds of health behaviors would be needed to strengthen the overall evidence base.

If more trials are conducted, better **standardization** needs to be considered. Better operationalization makes trials as well as their replications more reliable. There is no clear standardization of the intervention designs or tools, that could be used by researchers and clinicians.

The number of needs: Why only 3?

There are only three psychological needs (competence, autonomy, relatedness) proposed by the inventors of SDT. However, there could be a greater or smaller number of needs. Maslow described a multitude of needs, which he categorized into an entire hierarchy of needs with the five levels of physiological needs, safety, love/belonging, esteem and self-actualization. (Maslow, 1954)

Some researchers even claim that there exists only one basic psychological need: the hedonistic one. All needs and desires could be derived from this one. (Slote, 1964) Finding, testing and extending the theory with these would allow for better predictive and explanatory power as well as more effective intervention.

Also **cultural limitations** of SDT should need to be considered. Cross-cultural trials should be conducted to ensure that the model holds up in several cultures. For example, autonomy might be less relevant in asian cultures. These cultures tend to place less value on individualism and higher values on collectivism than western cultures.

6.6.3 Conclusion

Overall the SDT is a very valuable behavior change theory that offers many practical guiding principles for more effective health behavior change, especially in improving rates of long term behavior change.

According to SDT principles supporting and facilitating the autonomy of the patient or client should become the cornerstone of health behavior change interventions. This by itself is also a trend in patient care overall, as evidenced by the trend

towards "shared decision making" and away from a more paternalistic or authoritative model. (Lin & Fagerlin, 2014)

The SDT recommendations however are at odds with incentive programs and many of the “realities” of interventions. Often doctors or practitioners simply tell patients what they should do. Similarly, in many interventions patients watch presentations, where they are taught how to live healthy and what to do differently.

However, an intervention according to SDT should rather focus on what the patients want to achieve, what they themselves want to change and support them in their endeavors, rather than coercing them into behaviors that they “should” or even “must” do.

More Research is needed to determine before it can become clear whether or not SDT principles should be employed in behavior change interventions, as well as how to employ these principles more effectively.

7 Synopsis of theories

In summary several similar constructs and perspectives constitute the presented HBCTs . This overlap is a consequence of the purpose behind HBCTs. All theories aim to explain and predict behavior change. They are based on concrete observations of behavior and the search for variables influencing it. Therefore, similarity of constructs is reasonable. In the following these overlaps will be presented in multiple formats. Whilst HBCTs do contain many of these overlapping constructs, they also each present with unique aspects, which will also be summarized in the following. We will present our findings in the following order:

1. Overlapping constructs across HBCTs, which will be presented in tabular and graphical form.
2. Uniqueness: What makes each HBCT unique?
3. Finally, a comparison across HBCTs with regard to the degree of operationalization and the strength of evidence base are presented.

7.1 Overlapping constructs across theories

The results of the detailed analysis of the 6 theories and models are summarized in the following order:

1. First we offer a list of **definitions for the constructs**.
2. Then **a tabular form of overlapping constructs** will be provided.
3. Finally, the overlapping constructs will be **graphically** illustrated.

7.1.1 Definitions of constructs across HBCTS

In the following a list of definitions to the corresponding constructs can be found.

TPB Constructs

- **Behavior** refers to the target behavior: what the target population does.

- **Intention** describes the readiness of an individual to perform the behavior and is thought to immediately precede the behavior.
- **Attitude towards action / Behavioral Beliefs** describes the individuals beliefs about the particular behavior.
- **Subjective Norm** describes a person's social normative beliefs: what we think others want.
- **Perceived Behavioral Control** represents the person's perception of difficulty of performing the behavior.

TTM Constructs

- **10 Processes of Change**
    - **Social Liberation** is the process of noticing available public support for the new behavior, such as changes in the way exercise or healthy eating are publicly encouraged.
    - **Helping Relationships** is the process of finding supportive people and communities.
    - **+ 8 other Processes of Change:** Consciousness Raising, Dramatic Relief, Environmental Reevaluation and Self-Reevaluation (the experiential processes) and Self-Liberation, Counter Conditioning, Reinforcement Management and Stimulus Control (the behavioral processes)
- **Self-Efficacy** describes the extent that an individual feels in control of the behavior.
- **Decisional Balance** is the weighing of pros and cons of the change by the individual.
- **Temptations** to engage with the problem behavior, are negative urges, such as the urge to not exercise.

SCT Constructs

- **The Person**: Personal variables are cognitive capacities such as intelligence, biological makeup and reactions to the behavior change, but also how one perceives the behavior.

- **The Behavior** is what the person does and how behavior influences environment as well as the person.
- **The Environment** is influenced by behavior and the personal components, but also influences the behavior and person itself in the ability to do something such as through social norms or physical facilitators and barriers.
- **Goals** are the result that individuals want to attain.
- **Self-efficacy** is “people's beliefs about their capabilities to produce designated levels of performance that exercise influence over events that affect their lives” (A Bandura, 1994, p. 2)
- **Outcome expectancies** represent the perceived desirable and undesirable outcomes of the behavior.
- **Sociostructural Factors** are the environmental factors which either facilitate or hinder the pursued behavior such as from peer groups, family or the physical environment.

BE Constructs

- **Dis- / Incentives** are forms of punishment and reward to change behavior.
- **Social / Peer Feedback** describes the use of social influences for behavior change.
- **Framing / Nudging** are the usage of presentation and accompanying information to alter the relative attractiveness of a decision.

FBM Constructs

- **Motivation** is the sufficient general desire to do something.
- **Ability** refers to the ease of doing the behavior.
- A **Trigger** is a signal and cue that start the behavior.

SDT Constructs

- **Autonomy** is the need to feel in control of one’s own actions.
- **Competency** refers to the need for a perceived level of competency.

- **Relatedness** is the need for connection with other people, whilst feeling accepted and supported by them.

7.1.2 Overlapping constructs across HBCTs in table form

3 common groups of concepts were found across HBCTs. We classified these as “Result Expectancies”, “Self Evaluation” and “Social Factors”.

The group of “Result Expectancies” consists of TPB’s “Attitude towards action”, TTM’s “Decisional Balance” (also called “Behavioral Beliefs”), SCT’s “Outcome Expectancies”, BE’s “Dis-/Incentives”, FBM’s “Motivation” and aspects of SDT’s needs for “Autonomy” and “Relatedness”. These all describe beliefs about the behavior and expectations for the results of the behavior.

“Self Evaluation” covers the individual’s subjective evaluation of the amount of control and competency he or she possesses to engage in the behavior successfully. It consists of the following constructs: TPB’s “Perceived behavioral control”, TTM’s “Self-Efficacy”, SCT’s “Self-Efficacy”, FBM’s “Ability” and SDT’s “need for competence”.

“Social Factors” describes the influences of other people on behavior change. It therefore contains TPB’s “Subjective Norms”, TTM’s 2 processes of “Helping Relationships” and “Social-Liberation”, SCT’s “Sociocultural Factors”, BE’s “Social Feedback”, FBM’s “Trigger” and aspects of SDT’s needs for “Autonomy” and “Relatedness”.

In Table all of these constructs are listed in their respective group by column, whilst the theories are organized by row.

Table 5: Overlapping Constructs across HBCTs compared

	Overlapping constructs by 3 common groups		
Theories	**"Result Expectancies"**	**"Self Evaluation"**	**"Social Factors"**
TPB	Attitute towards action / Behavioral Beliefs	Perceived behavioral control	Subjective Norms
TTM	Decisional Balance	Self-efficacy	(Processes: Helping Relationships + Social-Liberation)
SCT	Outcome Expectancies	Self-Efficacy	Sociocultural Factors
BE	Dis-/Incentives	-	Social Feedback
FBM	Motivation	Ability	Trigger
SDT	Aspects of Autonomy + Relatedness	Competence	Aspects of Autonomy + Relatedness

7.1.3 Overlapping constructs across HBCTs in graphical form

In **Fehler! Verweisquelle konnte nicht gefunden werden.** a graphical illustration of t he overlapping constructs across HBCTs is presented. The theories are aligned left to right and their corresponding constructs are listed below. The lines between constructs represent the overlap of constructs such as the group of "Result Expectancies" as shown in Table . This overlap is illustrated by the connection between the following constructs: TPB's "Attitute towards action", TTM's "Decisional Balance", SCT's "Outcome Expectancies", BE's "Dis-/Incentives", FBM's "Motivation"

and aspects of SDT's needs for "Autonomy" and "Relatedness". In some cases one construct overlaps with 2 other constructs in other theories such as the aforementioned SDT's needs for "Autonomy" and "Relatedness", which is represented by two lines. This is also the case for the overlap and therefore graphical connection between TPB's "Subjective Norm", the 2 TTM processes of "Helping Relationships" and "Social-Liberation" and SCT's "Sociostructural Factors".

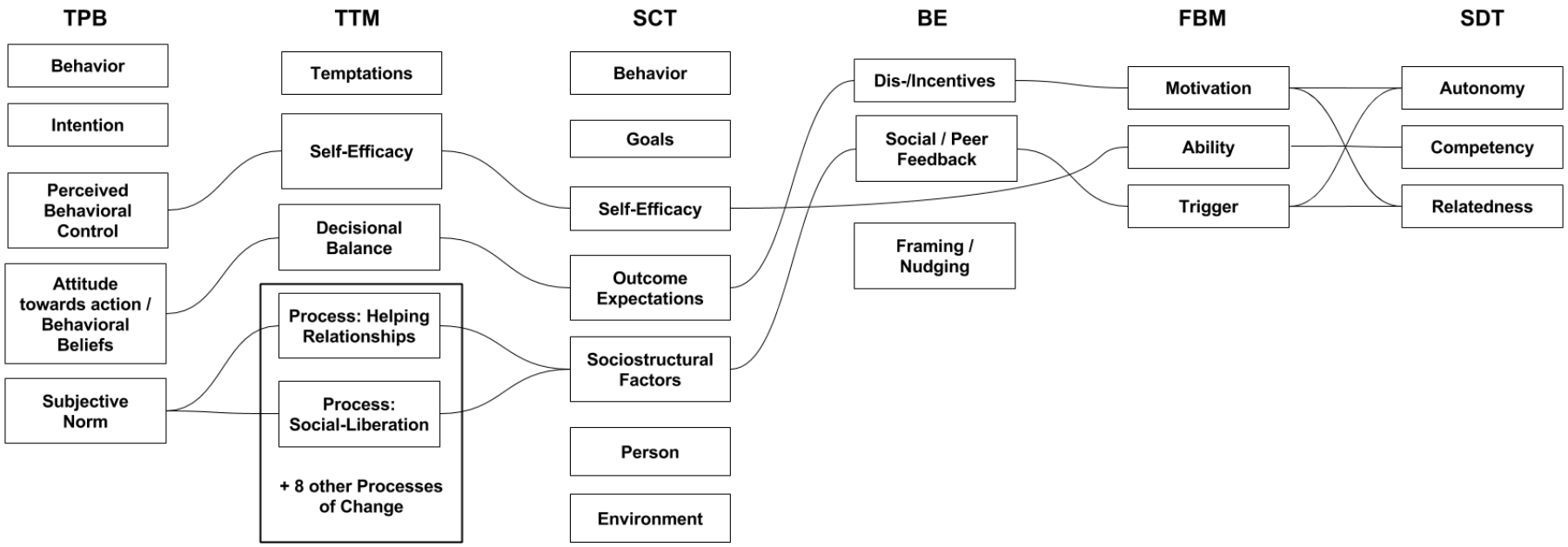

Figure 34: Overlapping constructs across HBCTs illustrated with connections

7.2 Uniqueness of HBCTs

Each HBCT differs from the other theories in unique ways such as through their core concepts or the way that their components are proposed to interact (relationships). We list differences in core concepts and the proposed relationships of the theory in Table 5, discuss them in more detail and also provide a graphical overview of the unique constructs for each HBCT in **Fehler! Verweisquelle konnte nicht gefunden werden.**.

Table 5: Unique Core Concepts of analyzed HBCTs

	Unique Core Concepts	Direction/Form of relationships
TPB	Intention	Unidirectional
TTM	Stages of Change	Circular / Spiral Staircase / Upward slope
SCT	Social influences and reinforcement	Bidirectional
BE	Systematic Biases	-
FBM	Behavior change in tiny increments	Multiplication
SDT	Fulfillment of 3 intrinsic needs to produce motivation	3 overlapping needs

The following list describes these core concepts in more detail:

- TPB places **Intention** at the core of health behavior change.
- TTM aims to explain and predict health behavior change through **stages of change**.
- Bandura's SCT offers a **Self-Efficacy** focus to health behavior change.
- BE provides a perspective that explains irrational behavior through **systematic biases in decision making and behavior** and provides tools such as framing, social influences and the presentation of incentives for positive change.

- FBM & Tiny Habits offer a theory and method for **habit change in tiny increments triggered by external factors such as social or physical environment.**
- SDT centers around the importance of the **fulfillment of inherent human needs such as autonomy** and **different qualities of motivation (“intrinsic” vs. “extrinsic”)**.

In Table 5 the unique core concepts to each HBCT are listed in the first column, whilst the form of relationships between core constructs are listed in the second column. TPB places **intention** at the core of health behavior change. It is a theory that explains behavior change resulting from a goal or intention, represented by a unidirectional relationship between intention and behavior. The TTM aims to explain and predict health behavior change through **stages of change**. The proposed relationship is a circular or spiral staircase one where people need to move through several stages and can regress as well as progress. Bandura’s SCT puts a strong emphasis on **social influences and social reinforcement** for behavior change. It also popularized **self-efficacy** as an important variable for behavior change, which contributed to its integration into other theories. However as other theories adopted self-efficacy (see the chapter on overlapping constructs), self-efficacy ceased to be a differentiator. The relationships proposed by SCT are bidirectional (so called ”reciprocal determinism“), as “person”, “environment” and “behavior” all influence each other as shown in Figure 16, which represents a stark difference especially to the unidirectional relationships of the TPB. BE provides a perspective that explains irrational behavior through **systematic biases in decision making** and provides tools such as framing, social influences and the presentation of incentives for positive change. As it is not yet a fully developed theory, concrete proposed relationships have yet to be created and researched. FBM & Tiny Habits offer a theory and method for **habit and behavior change in tiny increments triggered by external factors such as social or physical environment.** The relationships of the core concepts of Ability, Motivation and Trigger is illustrated in Figure 27 as a hyperbolic curve in a XY diagram. Behavior only occurs if sufficient motivation and ability are present in combination with a trigger. SDT on the other hand centers around the importance of the **fulfillment of intrinsic human needs such as autonomy** and **different qualities of motivation (“intrinsic” vs. “extrinsic”)**. The relationship between

these needs can best be described as three overlapping circles as shown in Figure 31.

These differences between HBCTs often lie in the origin of the theory such as basing it on conscious reasoning for the TPB or studying the relapse into addictive behavior (smoking) in the case of the TTM. The origins of SCT lie in the bobo doll studies where Bandura studied the learning of behavior through modeling. Thus the SCT focuses on the influence of observed behavior and role models.

BE on the other hand is the result of a marriage between economics and psychology to explain the observation of irrational behavior, that does not maximize utility for the actor. Such behavior would be an impossibility according to standard economic assumptions of self-interested actors, who aim to maximize their utility. The aim to understand these phenomena explains the focus on individual concepts such as “nudging” or incentives and the lack of proposed relationships within an overarching consistent theory, as the overarching framework is yet to be developed fully.

Fogg’s FBM was conceived from his research into the cross section of computer science and human behavior. The mathematical formulation for behavior “B = mat” (see FBM chapter) and the structure of tiny habits as “if/then-loops”, which are a foundational element in computer science and software engineering, are probably owed to this genesis. SDT however stems from motivation research and therefore centers strongly around the creation of intrinsic motivation for behavior change.

In **Fehler! Verweisquelle konnte nicht gefunden werden.** constructs across t heories are listed with one column for each theory, just as in Figure 34. The unique constructs are colored blue or green. The constructs in blue are unique constructs for each theory. “Behavior” is marked in green, as it is a construct shared between SCT and TPB. The 8 processes of change in the TTM are listed in the following chapter about the definitions of constructs across HBCTs.

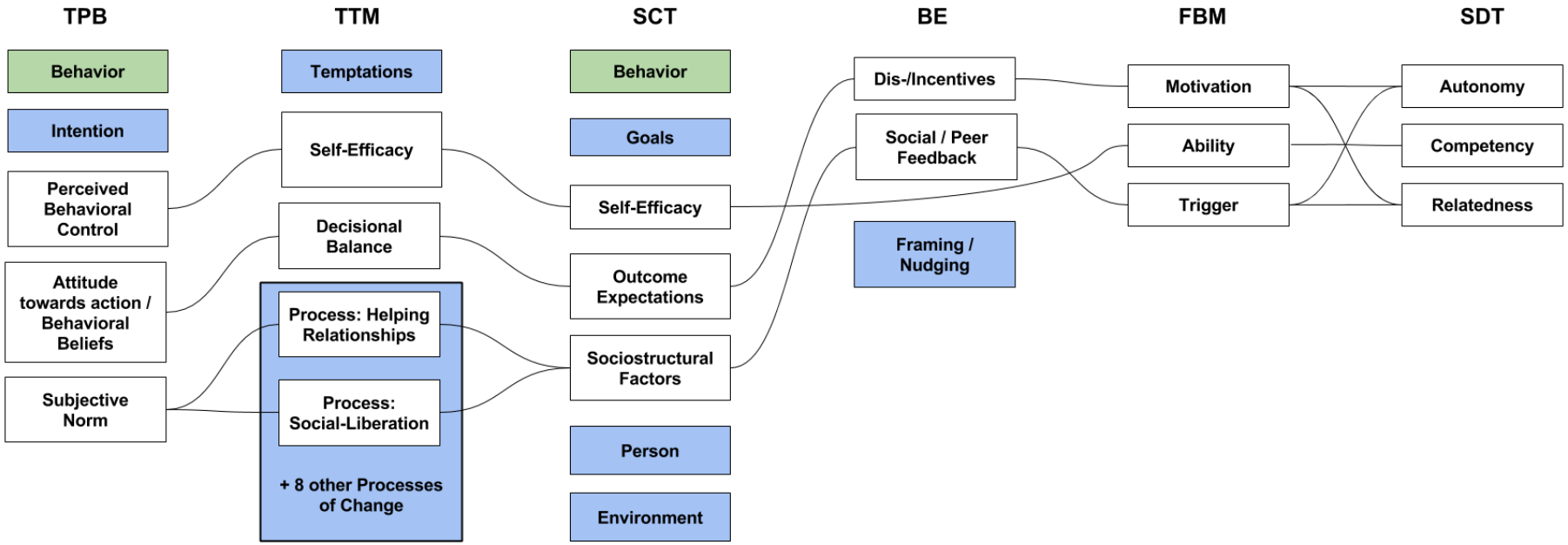

Figure 35: Constructs unique to the individual theories in blue, green for the shared construct of "behavior" for TPB an

7.3 A comparison of HBCTs by consistency of operationalization and strength of research

The following Table 6 provides a comparison of HBCTs by the degree of operationalization and the strength of available research through a quantitative grading.

Table 6: Direct tabular comparison of HBCTs

	Direct Comparison of Theories	
Theories	**Operationalization**	**Strength of Research**
Theory of Planned Behavior (TPB)	Consistent	5
Transtheoretical Model (TTM)	Inconsistent	5
Social Cognitive Theory (SCT)	Inconsistent	5
Behavioral Economics (BE)	Inconsistent	1
Fogg Behavior Model (FBM)	Consistent	1
Self-Determination Theory (SDT)	Inconsistent	4

7.3.1 Degree of operationalization

The degree of operationalization describes whether or not there exists a consistent operationalization of the theory or model for implementation in interventions. For example in the case of the TTM there exists only an inconsistent operationalization such as for sorting participants into their respective stages (see TTM chapter).

Operationalization is of cricital importance for the utilization of a HBCT in interventions, as it influences overall research quality conducted with the HBCT and usefullness for intervention design due to more variability in implementation parameters. This makes research with the same underlying HBCT less precise, harder to compare and can lead to inconsistent quality in implementations.

7.3.2 Strength of Research / Research Quality

The available research for the individual HBCT was rated based upon the widely established and utilized “levels of evidence” grading as developed by the Agency for Healthcare Research and Quality. (Berkman et al., 2015) We adapted this from Berkman to the HBCT research covered in this thesis as described in the following Table 7.

Table 7: Rating system of the available evidence for covered HBCT (adapted from Berkman et al., 2015)

Rating (0-5)	Available Evidence
5	Several Meta-Analysis with at least one with >1000 participants in trials
4	Several Meta-Analyses
3	At least one meta-analysis
2	Only Systematic Reviews
1	Single Trials (at least 2) using constructs from the theory
0	No trials

8 Discussion

8.1 Similarities and Differences

We have found similarities between the constructs in the different theories as shown in the corresponding Table in the results section. This finding has utility for theory developments as well as intervention design.

At the same time there are several major differences between the analyzed theories. Models such as the TPB and TTM presume that behavior is the result of intention. The TTM also aims to explain and predict the degree to which one is ready to change through stages of changes. The SCT also has a very individual focus with self-efficacy as its major contribution to the field of behavior change.

Newer models such as FBM, BE and SDT do contribute different approaches to behavior change. In BE common irrational decisions patterns are explained and even utilized for positive change. In the FBM and its corresponding method for change in tiny increments (“Tiny Habits”) the role of the environment and other external factors for “triggering” subconscious behavior (“habits”) are the focal point for behavior change. They also offer a method to change habits in tiny increments. SDT also offers a perspective focused on inherent human needs, which, once fulfilled, facilitate the desired health behavior changes. It also differentiates between different qualities of motivation (“intrinsic” vs “extrinsic”), which is an aspect that is missing in established theories.

8.2 New vs. established Theories

Therefore, newer theories can predict and explain behavior in certain aspects better than more established models. New theories cover aspects such as habit formation, economic incentives, environmental influences and heuristics, as well as possible core needs such as autonomy, which are neglected in older theories. Quantitative differences in predictive and explanatory power are not possible to assess based on the limited available data. Well controlled empirical comparisons between theories are still lacking.

Even with the help of these new theories and models, predicting and explaining behavior still presents a great challenge. Also the design of interventions based on evidence based theories remains a complex process, as some of these theories and models still conflict with each other. More research into the complexities and context dependencies of these components is needed to resolve these conflicts.

All theories and methods have weaknesses and no single one predicts or allows yet to change health behavior reliably. A very extensible framework (a “meta theory”) that takes into account all of the important variables for behavior change would be a beneficial strategy for further research.

8.3 Considerations for further research

One general issue throughout the analysis of the established and newer theories kept coming up: improper or low quality testing of the theories in trials. Most studies on theories and model do sacrifice external validity for internal validity. (F. Sniehotta, 2009) This means that whilst the model might be in itself coherent, it will perform worse when generalizing it to different individuals, settings and times. For example when testing a HBCT in a very controlled setting such as a laboratory environment, internal validity would be higher as many variables that would affect the experiment in the outside world were excluded. However external validity would be sacrificed as the environment is less similar to the outside world and results are therefore less useful in a clinical setting.

This is an especially important measure in the development of a meta theory, as improper testing will lead to much ineffecently used research resources down the line. It would also greatly limit quality and utility of the meta theory.

Overall it would be highly advantageous if researchers from different scientific areas and with different theoretical backgrounds would cooperate more. Often HBC researchers focus on researching their own theory or the one that they are most familiar with. There is however much to be learnt from other theories and even from adjacent fields, such as from Behavioral Economics. Developing a “meta theory” to

join these parallel research fields could be a valuable way forward. This would prevent much parallel research and allow to focus more of the available resources on important, under researched aspects. For this research with stronger designs, more rigorous theory implementation and higher quality testing is required.

8.4 **A Meta Theory of Health Behavior Change**

There are so many theories and models available, that many researchers have complained about the difficulty of choosing the most appropriate one. (Cane et al., 2012; Martinez & Lewis, 2014; Mitchell et al., 2010; Rycroft-Malone & Bucknall, 2010)

A desirable solution to the multitude of theories and models would be a single “meta theory” of health behavior change. Several integrative theories and models such as the TTM or the integrated Theory of Planned Behavior (see TPB chapter) have already been proposed by researchers. (M Fishbein, 2000; Martin Fishbein & Cappella, 2006) However as shown in this thesis, there are still missing or neglected components in each of these theories. For scientific progress in this field, it would be highly beneficial to create such an overarching theory.

This would facilitate theory based interventions as well as focus research on health behavior change, instead of diffusing the effort by many laboratories and researchers across many different, but similar theories and models. Ideally this “Meta theory” would take the constructs with the most support from the different theories and models. These would be then combined into a single theory. This theory can and should then be rigorously tested across different types of behaviors, context and continuously refined. However there would be many hurdles and problems to overcome for the development of such a meta theory. For instance, researchers would need to agree on common conceptualizations and terms for the agreed upon constructs, as well as find common ground regarding the relationships between these constructs. It’s doubtful that such a combination of every relevant theory can be realised.

Such a “Meta Theory of Health Behavior Change” should also be very extensible and consider individual differences such as psychological and physiological variation. It

should also be tailored for different kinds of health behaviors and consider interactions between the behaviors. Exercising, nutritional changes, sleep and other health behavior changes have different physiological and psychological effects and interact with each other. It is unlikely that one theory could predict all of these different kinds of health behavior changes as well as tailored versions.

Several important testing considerations should be kept in mind when testing and developing the meta theory. When testing the meta theory for predictive and explanatory power objective markers for data collection should be employed. In addition to questionnaires, “hard” markers such as Carbohydrate-Deficient-Transferrin (CDT) for alcohol consumption (Sharpe, 2001), grip strength (Syddall et al., 2003) and VO2max for physical fitness (Leite et al., 2009) should be employed.

Also much attention needs to be paid to developing proper measurements of the different constructs of such a meta theory. Predictions of the theory would need to be tested with strong research designs and replicated.

8.5 Limitations

Several important limitations need to be considered overall within the studied field, as well as for this thesis. In the field of health behavior change researchers rarely compare different theories in one trial and often improperly use theories in interventions. For instance, many researchers use the self-efficacy construct in trials and claim to have used SCT, even though SCT consists of several other constructs as explained in the corresponding chapter.

Much of the theory based intervention research available also does not report which theoretical base they used, only report it in part and do not publish enough of their methodology to analyze it retrospectively.

Likewise, many theories and models offer rather imprecise measurements and definitions of their constructs. This makes proper evaluation, further research and theory development harder.

At the level of this thesis, there are also several limitations that should be kept in mind. Due to the heterogenity of the available literature, such as in studied populations, intervention types, constructs and variables, it was not reasonable to

compare the predictive and explanatory power quantitatively. There exists too much research with highly variable quality and little proper comparisons across the same data sets such as the same populations, cultures and behaviors. All of these widespread issues in the literature make evidence based theory evaluation a highly challenging task.

Some researchers also propose a so called **"pragmatic nihilism"**. (Peters & Crutzen, 2017b) This refers to viewing psychological variables as metaphors not as actually existing entities. Peters and Crutzen base this view upon the principles of neuroscience. Neurons fire in distributed networks and, depending on the combination of neurons and activation patterns, this results in all types of behaviors. In Figure 36 the researchers illustrate how an attitude could be formed by a neural network.

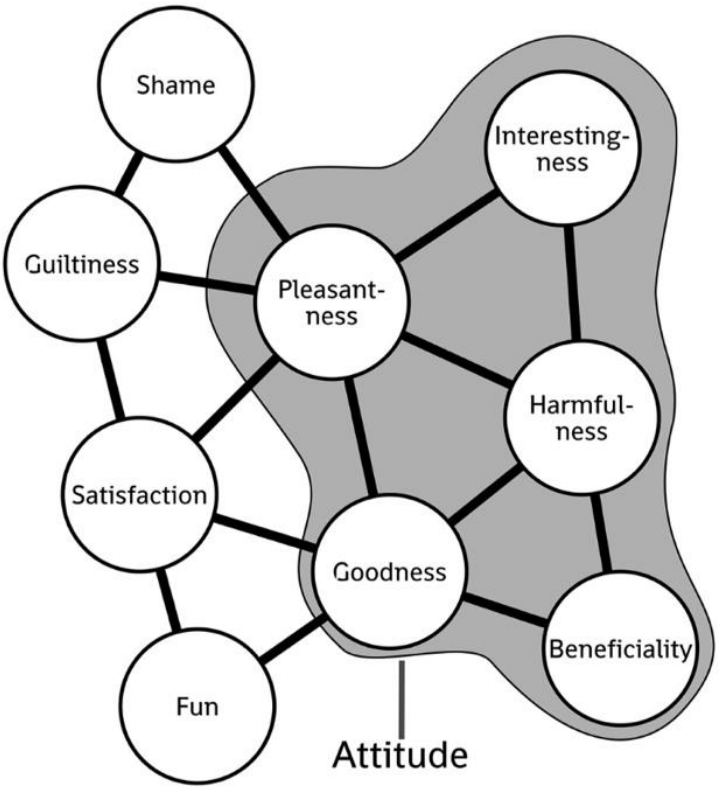

Figure 36: Diagram of neural network forming an attitude from Peters & Crutzen, 2017

Theories such as the TPB and its constructs could be understood as emergent properties of neural networks with overlapping biological origins as shown in the

figure 36.

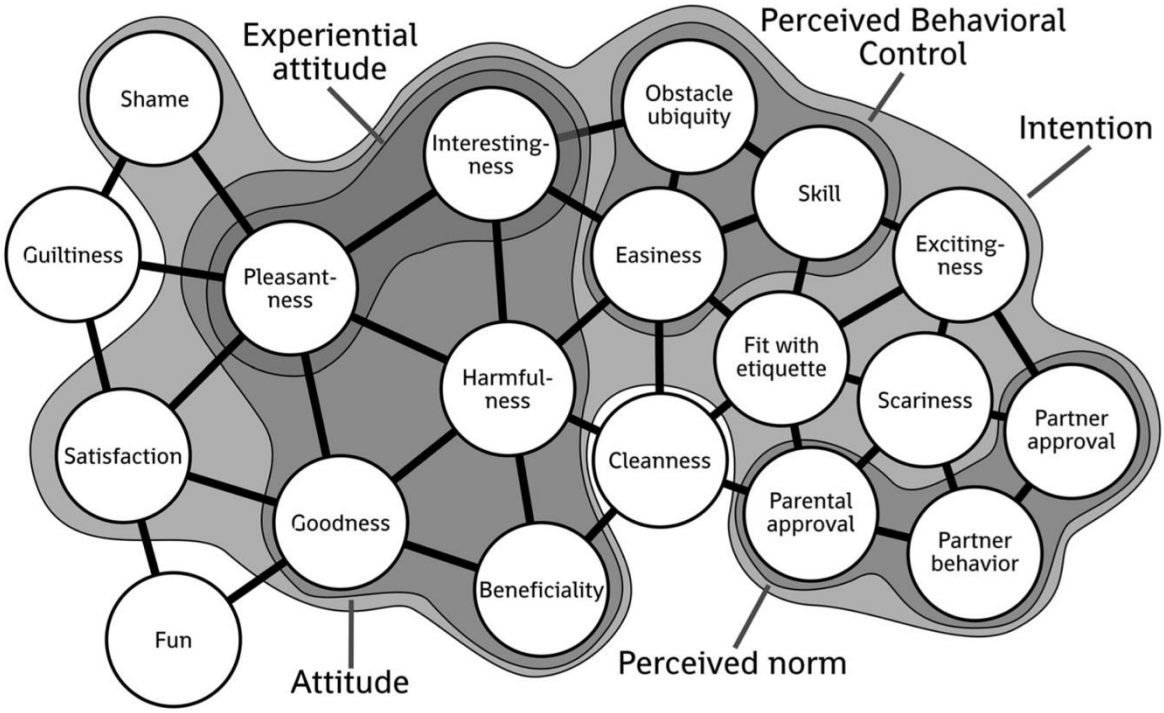

Figure 37: TBP and its constructs illustrated as neural network from Peters & Crutzen, 2017

HBCTs therefore might be inherently flawed models as they basically aim to describe complex and fuzzy neural interactions in too distinctive constructs. Developing a meta theory or integrative theory of HBCs would be a step in the wrong direction according to pragmatic nihilism.

Peters and Crutzen draw some critical practical suggestions from this concept. Researchers should not conduct interventions based upon one theory, rather they should research the target populations psychology. This would move from theoretical perspective to a more flexible integration of theories as illustrated in Figure 37, where SDT, RAA (“Reasoned Action Approach” developed by the creators of TPB Fishbein and Ajzen) and EPPM (“Extended Parallel Process Model” developed by Witte, 1992).

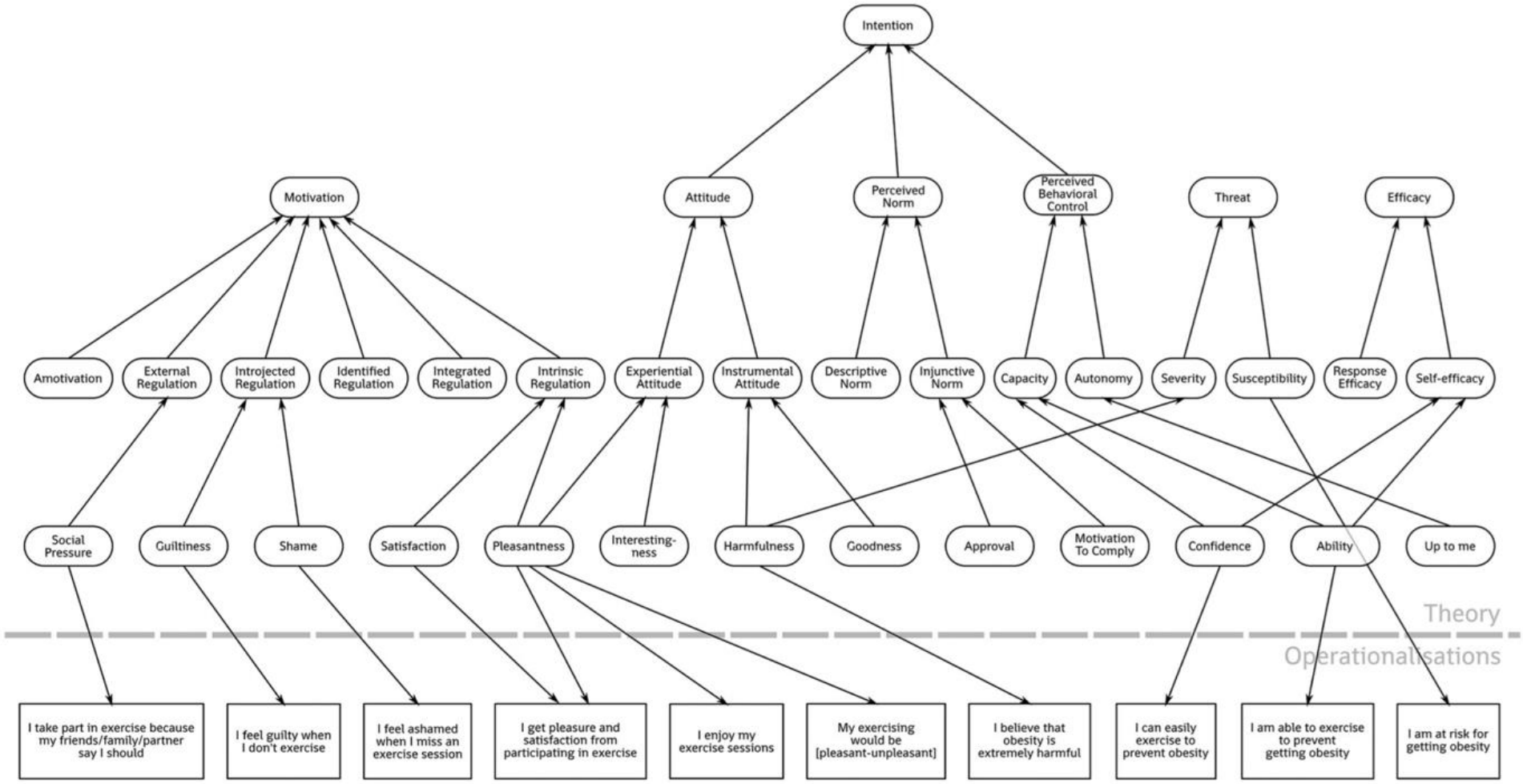

Figure 38: Example of an integration of SDT, RAA and EPPM (left to right) according to pragmatic nihilism from Peters & Crutzen, 2017

However, some researchers criticize pragmatic nihilism and propose other developments. Trafimow criticizes it by emphasizing the high importance of auxiliary assumptions in addition to simply applying the HBCT to interventions. (Trafimow, 2017) These assumptions are additional contextual variables that need to be combined with the HBCT constructs itself as many of the constructs cannot be directly measured and are dependent on context and target behavior. This lack of auxiliary assumptions would explain problems in applying and testing HBCTs according to Trafimow. (Trafimow, 2017) Gruitjers also criticizes pragmatic nihilism as neglecting the “why” of belief systems by not aiming to measure the reflections of beliefs as HBCTs do, such as the TPB with for example attitudes towards behaviors. (Gruijters, 2017) Not even aiming to understand the inner workings of the mind would constitute a regression to behaviorism.

But Peters and Crutzen defend their perspective of pragmatic nihilism as they do not aim to disregard the search for causal relationships, but aim for continuous multidimensionality rather than an unidimensional perspective when defining and researching psychological constructs. (Peters & Crutzen, 2017a) They also argue for pragmatic nihilism as a complementary, useful perspective rather than an alternative concept to the greater importance of auxiliary assumptions that Trafimow argues for. (Peters & Crutzen, 2017a) Overall pragmatic nihilism is a constructive additional perspective for intervention designers and researchers aiming to improve existing HBCTs or aiming to integrate them into one meta theory.

9 Conclusion

The goal of this work was to offer a comparison of the selected HBC theories. We assessed the evidence for their effectiveness in predicting behavior change and examined the usefulness of each theory or model for developing interventions to change long term health behavior. Similarities and differences between the selected theories and a comparison of the empirical support base were presented in table format.

As shown in the “synopsis of theories” section discussing the overlapping constructs, the analyzed theories do contain several similar concepts. Also newer theories of HBC cover other aspects of HBC than more established models. They offer valuable additional methods and perspectives for HBC. The development of a meta theory could be a very beneficial next step to consolidate and focus further research, in order to produce reliable health behavior change.

10 Literature

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11 Abstract (english)

Health behavior change is of critical importance for the prevention and treatment of today's most prevalent diseases and conditions such as obesity, diabetes and cardiovascular diseases. Interventions however often fail to reliably change behavior. Understanding and explaining behavior change through improved theories could provide actionable insights into the change process. These insights would allow to combat barriers and detractors to change, increase motivation and facilitate change. Many health behavior change theories and models have been developed and researched in parallel. Despite much research into individual theories, little is known about how these theories compare to each other.

In this thesis, we offer a comparison of the main constructs of the top health behavior change theories, their uniqueness and overlap, their degree of operationalization and their evidence base. We selected the most prominent and most promising, newer HBCTs through scoping research and validated the selection through quantitative analysis in 3 databases and search engines: PubMed, Web of Science and Google Scholar. We analyzed the available evidence for each selected theory and presented its usefulness and limitations for research and application. We summarized the findings of unique perspectives of each theory as well as presenting the commonalities across theories in tabular and graphical form.

The development of a Meta theory of HBC could be a useful next step. However, researchers and intervention designers should also note the complementary, neuroscience based perspective of "pragmatic nihilism", which proposes a behavior centric intervention design process. As psychological variables are metaphors for complex interactions of neurons within the brain, the format of theories could be too restrictive and a single meta theory would not be able to cover different kinds of behaviors that emerge from these interactions. According to "pragmatic nihilism" theory based interventions should flexibly integrate theories on a case by case per behavior and center around the participant's psychology. Irrespective of the way forward joining forces in health behavior change research would likely make the field of health behavior advance faster.

12 Abstract (german)

Zur Prävention und Therapie der häufigsten Volkskrankheiten wie Adipositas, Diabetes und Herz-Kreislauf-Erkrankungen sind Verhaltensänderungen von entscheidender Bedeutung. Interventionen zur Lebensstiländerung scheitern jedoch oft daran das Verhalten der Teilnehmer zuverlässig zu verändern. Ein detaillierteres Verständnis für den Prozess der Verhaltensänderungen durch bessere Theorien der Verhaltensänderung könnte nützliche Erkenntnisse liefern. Diese Erkenntnisse würden es erlauben, Barrieren der Verhaltensänderung abzubauen, Veränderung zu erleichtern und die Motivation der Teilnehmer zu erhöhen. Viele Theorien und Modelle der gesundheitlichen Verhaltensänderungen wurden bereits parallel entwickelt und erforscht. Jedoch wurden diese Theorien kaum miteinander verglichen.

In dieser Arbeit bieten wir einen Vergleich der Hauptkonstrukte ausgewählter Theorien der Verhaltensänderung, ihrer Einzigartigkeiten und Überlappungen, der Grad ihrer Operationalisierung und ihrer Evidenzbasis. Wir haben dafür die herausragendsten und vielversprechendsten neueren Theorien zur Veränderung des Gesundheitsverhaltens durch sondierende Recherche ausgewählt und die Auswahl durch quantitative Analyse der Suchergebnisse dreier Datenbanken bzw. Suchmaschinen validiert: PubMed, Web of Science und Google Scholar. Wir haben die verfügbaren Beweise für jede ausgewählte Theorie analysiert und stellen ihre Nützlichkeit und Grenzen für Forschung und Anwendung vor. Die einzigartigen Perspektiven und Gemeinsamkeiten der Theorien werden in tabellarischer und grafischer Form dargestellt.

Die Entwicklung einer Meta-Theorie für die Änderung des Gesundheitsverhaltens könnte ein nützlicher nächster Schritt sein. Allerdings sollten Forscher und Entwickler von Interventionen auch die komplementäre, neurowissenschaftliche Perspektive des "pragmatischen Nihilismus" beachten, die einen auf das jeweilige Verhalten zentrierten Interventionsentwicklungsprozess vorschlägt. Da psychologische Variablen Metaphern für komplexe Interaktionen von Neuronen im Gehirn sind, könnte das Format einer Theorie zu restriktiv sein. Eine einzige Meta-Theorie wäre nicht in der Lage, verschiedene Arten von Verhaltensweisen abzudecken, die aus diesen komplexen Wechselwirkungen hervorgehen. Nach dem "pragmatischen Nihilismus" sollten theoriebasierte Interventionen von Fall zu Fall je nach Verhalten Theorien flexibel integrieren und sich auf die Psychologie der Teilnehmer konzentrieren. Unabhängig von dem weiteren Vorgehen würde eine engere Vernetzung die Forschung zur Änderung des Gesundheitsverhaltens schneller voranbringen.

13 Appendix

13.1 Acknowledgements

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13.1 Curriculum Vitae (CV)

Lebenslauf aus datenschutzrechtlichen Gründen nicht enthalten.

13.2 Declaration of Authorship (Eidesstattliche Erklärung)

Ich versichere ausdrücklich, dass ich die Arbeit selbständig und ohne fremde Hilfe verfasst, andere als die von mir angegebenen Quellen und Hilfsmittel nicht benutzt und die aus den benutzten Werken wörtlich oder inhaltlich entnommenen Stellen einzeln nach Ausgabe (Auflage und Jahr des Erscheinens), Band und Seite des benutzten Werkes kenntlich gemacht habe.

Ferner versichere ich, dass ich die Dissertation bisher nicht einem Fachvertreter an einer anderen Hochschule zur Überprüfung vorgelegt oder mich anderweitig um Zulassung zur Promotion beworben habe.

Ich erkläre mich einverstanden, dass meine Dissertation vom Dekanat der Medizinischen Fakultät mit einer gängigen Software zur Erkennung von Plagiaten überprüft werden kann.

Unterschrift: .....

13.3 List of abbreviations

BE	Behavioral Economics
CDT	Carbohydrate-Deficient-Transferrin
DANK	Deutsche Allianz Nichtübertragbare Krankheiten
EPPM	Extended Parallel Process Model
etc.	et cetera
FBM	Fogg Behavior Model
HAPA	Health Action Process Approach
HBC	health behavior change
HBCTs	Health behavior change theories
HBM	Health Belief Model
IOM	Institute of medicine
NCDs	non-communicable diseases
NJEM	New England Journal of Medicine
PA	physical activity
PBC	Perceived Behavioral Control
RAA	Reasoned Action Approach
RCT	Randomized controlled trial
SCT	Social Cognitive Theory
SDT	Self Determination Theory
TPB	Theory of Planned Behavior
TRA	Theory of Reasoned Action
TTM	Transtheoretical Model
VO2max	maximal aerobic capacity
vs.	versus
WHO	World Health Organization
WOS	Web of Science

13.4 List of Figures and Tables

13.4.1 List of Figures

13.4.2 List of Tables