Assessing Goal Disengagement Using a Digital, Card-Based Game: A Proof of Concept Study

Sebastian Unger[a], Hana Minařík and Thomas Ostermann[b]
Department of Psychology and Psychotherapy, Witten/Herdecke University, Alfred-Herrhausen-Str. 50, 58448 Witten, Germany

Keywords: Proof of Concept Study, Choice Behavior, Mental Processes, Experimental Game.

Abstract: The distinction between goal engagement (GE) and goal disengagement (GD) as central psychological processes is supported by several theories of developmental regulation. However, although there has been research on both, research on GD has been rather neglected, especially when it comes to behavioral methods for its assessment. The objective of this paper, therefore, is to evaluate the feasibility of such a behavioral method by placing a homogeneous group of participants in a situation where they need to distinguish whether the effort to solve a digital, card-based game leads to successful goal achievement or to frustration. The data from this group revealed no significant differences in the participants' behavior over the course of the game. Nonetheless, some tendencies in the number of repetitions and the number of cards collected until the occurrence of a GD could be found when differentiating between participants who adhered to their goals more persistently and those who disengaged more frequently. Overall, the game may have potential for both replacing previous assessment methods and identifying suitable individuals for long-term rehabilitation and behavioral therapies, but further research is required for application in a clinical setting.

1 INTRODUCTION

1.1 Background

Several prominent theories of developmental regulation across the life span distinguish between goal engagement (GE) and goal disengagement (GD) as key psychological processes (Haase et al., 2013). Both have been associated with indicators of successful aging, depending on individuals' resources, and opportunity structures (Heckhausen et al., 2010). However, while GE has been the subject of extensive research, research on GD has been rather neglected (Kappes & Schattke, 2022), despite substantial evidence that GD plays a central role in benefiting individuals' well-being (Tomasik et al., 2010; Wrosch et al., 2003).

Both GE and GD are usually assessed using self-reports, with their inherent advantages and disadvantages. Turning to more behavioral methods, GE is typically assessed by indicators such as persistence or aspiration level (e.g., DiCerbo, 2014). Few, if any, behavioral methods are available for assessing GD. One exception is that of Rühs et al. (2022), who tested how social rejection in a virtual ball-tossing game would affect participants' goal of becoming a member of a group. However, it must be pointed out that this method requires multiple individuals for a measurement, who must also get to know each other better beforehand to develop the goal initially. A notable method applicable to single individuals is that of Freund and Tomasik (2021). Its focus lies on the process of prioritization by inducing a goal conflict in a lab-based experiment, forcing participants to let go of one induced goal in order to pursue the other. This method, however, relies on the notion of limited resources in a multiple goal scenario and it is not clear whether it is useful for the assessment of an individual's propensity to disengage from a single goal. For a single goal scenario, an outstanding example is a method that analysed GD in the context of social relationships (Thomsen et al., 2017). Here, participants are asked to solve a puzzle after observing a familiar person attempt the task.

[a] https://orcid.org/0009-0000-6251-2923
[b] https://orcid.org/0000-0003-2695-0701

Unger, S., Minařík, H. and Ostermann, T.
Assessing Goal Disengagement Using a Digital, Card-Based Game: A Proof of Concept Study.
DOI: 10.5220/0013254100003911

In *Proceedings of the 18th International Joint Conference on Biomedical Engineering Systems and Technologies (BIOSTEC 2025) - Volume 2: HEALTHINF*, pages 698-704
ISBN: 978-989-758-731-3; ISSN: 2184-4305

However, because solving a puzzle requires a certain degree of logical thinking, it could introduce unwanted bias in individuals less proficient in this skill through various conditions (Baldo et al., 2015; Morris et al., 1995).

Taken together, the adaptive value of GD has been shown to be prominent when a goal is unattainable (Tomasik et al., 2010; Wrosch et al., 2003). Hence, an individual needs to distinguish between situations in which increased effort will turn into successful goal attainment and situations in which increased effort will only result in frustration. As there is no all-encompassing method yet, there is a need for an instrument that confronts individuals with both types of situations to assess their competence in distinguishing between them and drawing appropriate behavioral consequences.

1.2 Objectives of the Paper

The main objective of this paper is to evaluate the feasibility of a digital, card-based game developed to assess GD in a situation where increased effort is likely lead to frustration. To this end, the novel assessment method and its fundamental parameters are investigated using a small number of participants. However, the paper is not solely intended to present the research results, but also aims to determine whether further research with this game is worthwhile.

2 MATERIAL AND METHODS

2.1 Participants

For this proof of concept study, a homogeneous group of participants was recruited at the Witten/Herdecke University. The group consisted of 50 psychology students (41 women and 9 men), all of whom were over 18 years old and had no limitations in hearing or vision, nor acute or pre-existing mental health conditions. The age of the participants ranged from 19 to 48 years with a mean age of 23.52 ± 5.63 years.

All participants had to sign an informed consent form and received credit points for their studies as compensation. At the start of the study, participants were informed about the whole procedure, including the course of the game. They were told that they could earn points for completing the game's task. However, this was just a manipulation intended to encourage participants to persist in solving the task for as long as possible, as the game has no clear endpoint.

2.2 Game

2.2.1 Software

The game was developed with *PsychoPy* (version 2021.1.4), a free and open-source application for creating experiments in behavioral science with the programming language Python (Peirce et al., 2019). For this experiment, *PsychoPy* was installed on a Windows 10 operating system, which was used for both development and game execution. The game was built as a full-screen presentation, with most of it created via *PsychoPy's* integrated Builder interface.

The final game comprised six routines, containing components such as buttons and text fields, and two loops, repeating a single or multiple routines. Some routines also included custom Python code to meet the game's specific requirements, e.g., measuring GD.

2.2.2 Course of the Game

The game consists of three phases: the introduction (1), the game (2), and the ending (3). Phase 2 can be further divided into two subphases: the collection task (2a) and the follow-up questions (2b). The goal of the game is to collect as many sextuples of cards as possible, with no indication of the game's duration or number of rounds.

Phase 1 masks the start of the game. Here, the game's task and instructions (e.g., how to proceed or collect a card) are presented. This phase was implemented using three sequentially executed routines displaying the instructions via text fields. Participants could spend as much time as needed to read these instructions, as each routine concludes only upon pressing the space bar.

Following the introduction, Phase 2 begins (specifically Phase 2a), during which participants attempt to collect a sextuple of cards. This phase was implemented using a single routine repeated 32 times by a loop. The routine normally presents one of six different cards, distinguished by symbols from the board game Mahjong (i.e., bamboo, coins, leaf (autumn), striped (reverse side), white (dragon), and writing (north wind)). The card to be presented is specified in a file in a fixed order and the participant must decide for or against the given card. If a participant decides to collect the card, it must be moved into the empty field highlighted in the row below. The next card is then presented upon pressing the space bar. Alternatively, the participant can also skip the card. In this case, the space bar must be pressed without placing a card. This collection process continues until a sextuple of cards is collected or the 32nd repetition is completed. A part of this procedure is presented in Figure 1. However, if a participant disengages from the previously set goal by placing a different card, all already placed cards are removed and the collection process begins with the newly chosen card. Such event is interpreted as GD and is registered without the participant noticing.

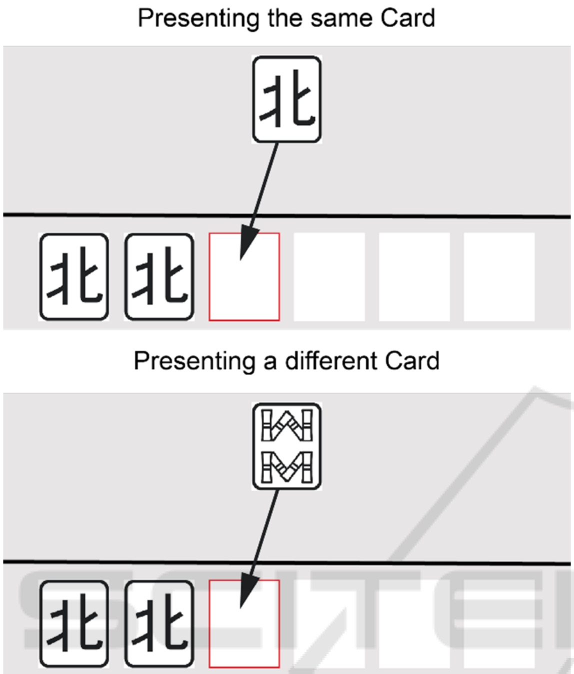

Figure 1: Example of the collection process in Phase 2a, highlighting the target field for card placement. On top, placing the card would initiate the next routine with three collected cards. On bottom, placing the card would initiate the next routine with only the newly chosen card.

Each instance of Phase 2a is followed by Phase 2b, which also consists of a single routine. Here, participants were asked three questions: "Which card was the last one?", "Which card was the most frequent one?", and "Which card will be the next one?". While the first two questions address short-term memory, the third question requires participants to make a prediction about the future. To answer the questions, all six cards and three empty fields are presented, as illustrated in Figure 2. As before, participants must move a card into a field and end the routine by pressing the space bar.

Using a second loop, Phase 2 is repeated between six and 300 times. Beginning with the 6th repetition, the loop terminates at the end of Phase 2b if at least one GD was registered. During each repetition, Phase 2b remains unchanged, whereas Phase 2a changes accordingly. The game is programmed such that the task can only be solved in the 1st and 5th repetition, because the 6th card of a sextuple cannot be found in the other repetitions.

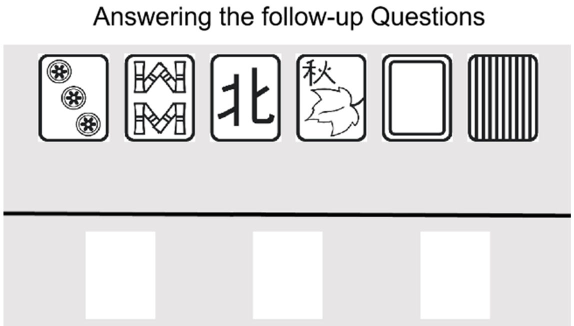

Figure 2: Illustration of Phase 2b, showing three empty fields for answers. For clarity, the mapping of questions to answer field has been omitted.

The final phase, Phase 3, has only the purpose of signalizing the end of the game. Therefore, a single routine displaying the message via a text field sufficed. Pressing the space bar in this phase closes the game completely.

2.2.3 Output Parameters

The game exports all parameters that *PsychoPy's* experiments provide by default. Additionally, there is three numeric, self-implemented parameters: GD count, collected cards, and repetitions. All three are initialized with the value zero.

GD count is the number of GDs a participant made during the game. The value is incremented by one whenever a GD occurs, i.e., if a participant disengages from collecting the chosen sextuple of cards.

Collected cards is the number of cards collected by a participant by the time a GD occurs. Since there could be several GDs, this parameter represents the mean. In case of the example in Figure 1 (bottom), the value would be 2 if no other GD occurs.

Repetitions is the duration by the time a GD occurs. As with the collected cards, it represents the mean. A characteristic of this parameter is that its value is only incremented by one during the initialization of the routine from phase (2a) if the first card was already collected. Otherwise, the value remains at zero.

2.3 Statistical Analysis

The analysis of the output parameters was conducted using the programming language R (version 4.4.1). Next to some basic functions, the investigation of parameters' primary characteristics required functions of the *ggplot2* package. To visualize the correlations between parameters in a 3-dimensional space, the *scatterplot3d* package that is built for multivariate data (Ligges & Maechler, 2003) was employed.

3 RESULTS

3.1 Key Results

The frequency distributions of the three outcome parameters in the form of histograms are illustrated in Figure 3. The top histogram indicates that most of the GDs occurred mainly within 100 repetitions. Other than that, there were only a few participants that disengage later, resulting in a mean of 113.57 ± 353.77 repetitions. One participant was particularly persistent in reaching the goal. It was not until the 2378 repetition that this participant changed to a different card.

The middle histogram of Figure 3 clearly shows that when participants disengaged from the goal, they did so preferably after the 1st or after the 5th collected card. Only one participant changed after collecting the 4th card. As a result, the participants collected 2.45 ± 2.9 cards on average.

When examining the bottom histogram of Figure 3, it is noticeable that there are similarities with the frequency distribution of the top histogram. On the one hand, the number of GDs a participant made tends to be in the lower spectrum. On the other hand, only a minority of participants disengaged more than five times, with one participant having 14 GDs forming the end of the spectrum. On average, participants made 2.54 ± 2.9 GDs during the game.

The correlations between the parameters are presented in Figure 4, with no obvious differences observed between females and males. When viewed together, it appears that two clusters have formed in the lower spectrum of GD count: a larger cluster in relation to a few collected cards (up to three) and a smaller cluster in relation to many collected cards (more than three).

The regression plane provides further information about the relationships between parameters. Based on the assumption that GD count is the predictor, the plane is a visual representation of the formula:

$$0 = a * x + b * y + c * z + d \quad (1)$$

The regression plane has an intercept of 3.35. There is a slight negative slope of < -0.001 along the x-axis and a slight negative slope of -0.29 along the y-axis, suggesting that participants who adhered their

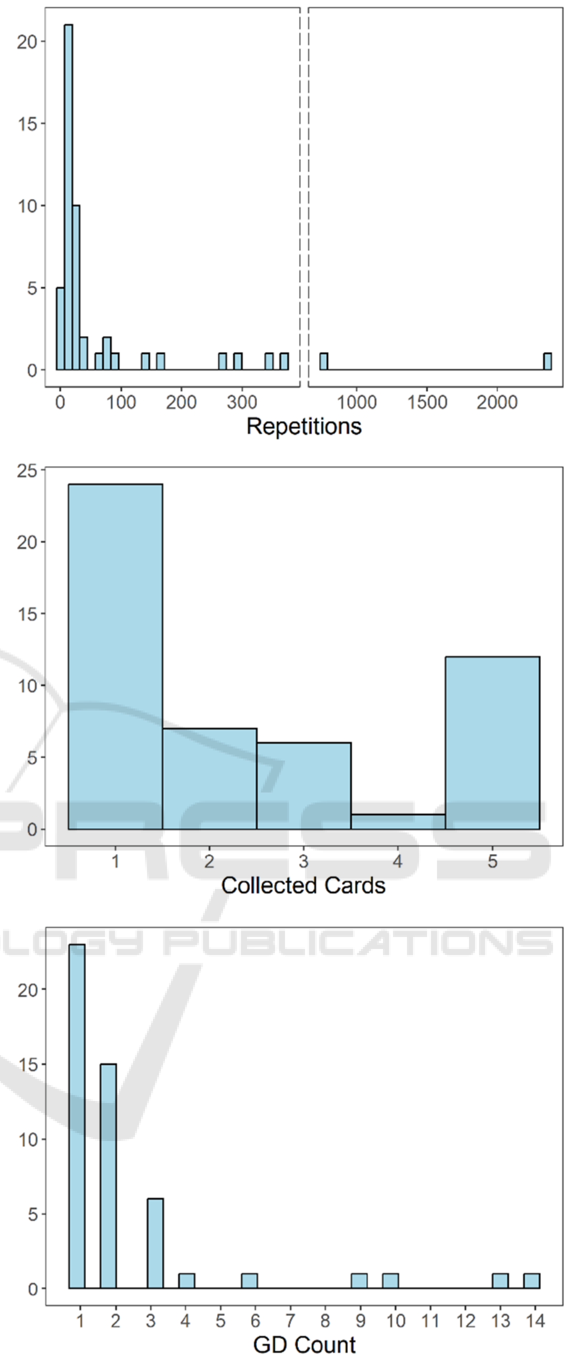

Figure 3: Histograms showing the frequency of output parameters across the curse of the game. The top one shows the repetitions until a GD occurred, the middle one the collected cards until a GD occurred, and the bottom one the number of GDs made during the game.

goals were slightly more willing to perform more repetitions and tended to collect more cards than those who disengaged more frequently. However, the correlations are not significant (*F(2, 47) = 1.21*,

$p = 0.31$). This also becomes clear when looking at Figure 4. The slope along the x-axis is only visible due to the broad spectrum covered by the parameter and the slope along the y-axis, even it is greater than the other one, is barely recognizable.

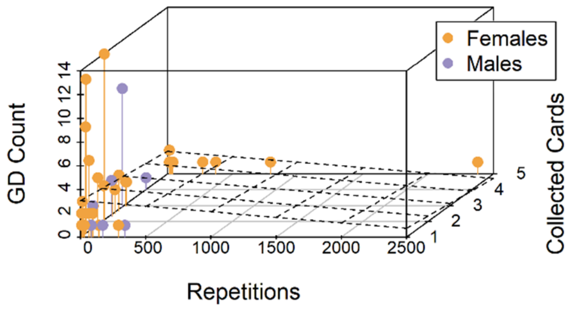

Figure 4: 3-Dimensional point cloud showing the relationships between repetitions (x-axis), collected cards (y-axis), and GD count (z-axis). For reference, a regression plane (dotted grid) is provided.

3.2 Secondary Results

The entire game, including the loading time of *PsychoPy*, took 9.73 ± 10.12 minutes on average. The fastest participant finished in 5.27 minutes, whereas the slowest participant, which was also the one with the most repetitions, took 1 hour and 14.55 minutes (74.55 minutes).

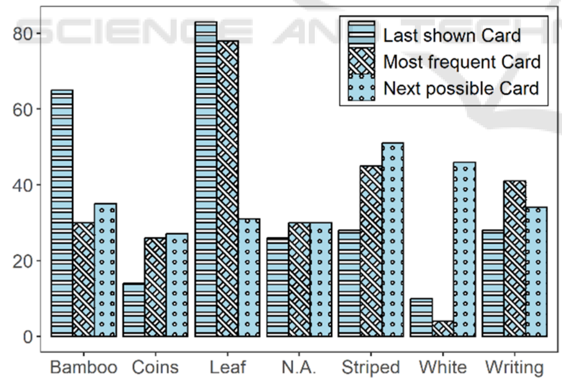

Figure 5: Histogram of responses to the follow-up questions. Since participants were allowed to skip the questions, a category for no answer (N.A.) is included.

When answering the follow-up questions about the last shown card and the most frequently occurring card, participants predominantly chose the card with the leaf symbol, as presented in Figure 5. Especially for the latter question, this card was chosen much more frequently than any other card. When asked which card would be shown next, the participants' responses varied considerably. Instead of having a preference, they choose each card almost equally often, except for the card with the coins, which was chosen far less frequently.

4 DISCUSSION

The results indicate that the participants generally exhibited homogeneous behavior in terms of both solving the game's task and answering the follow-up questions. In particular, no significant differences were found in behavior when solving the game's task. The two main clusters in the lower spectrum of GD count and the slopes of the regression plane could still reveal some interesting behavioral patterns. It appears that there are slight tendencies among the participants who adhered to their goals more persistently and the participants who disengaged more quickly and more frequently. Perhaps, participants who disengaged before collecting the 4^{th} card needed a short orientation phase, while participants who collected more than three cards approached the task in a systematic and profit-oriented manner. Overall, the adaptive value of GD under the circumstance that the goal is unattainable (Tomasik et al., 2010; Wrosch et al., 2003) appears to have been recognized either intuitively or intentionally. Only one participant demonstrated enormous persistence toward achieving the goal, which might have caused a similarly negative effect as a goal conflict, as the hope of achieving the goal could still have existed (Freund and Tomasik, 2021).

In the follow-up questions, it is particularly noticeable that the answers to the two questions on short-term memory were similar in the sense that the participants preferred to select a specific card. In contrast, there was no clear preference for the question on predicting the future, which in turn could reflect the group's individualism.

Regarding similar games, homogeneous behavior within homogeneous groups is to be expected. An example is the *Iowa Gambling Task*, a card-based game for decision-making (Bechara et al., 1994). An investigation of this game by Steingroever et al. (2013), testing the performance of a homogeneous group of healthy participants, demonstrated that although the participants showed individual behavior, they also shared a common characteristic: taking smaller risks during the course of the game. A study on another game for decision-making (Franckenstein et al., 2022) could also supports the feasibility of the novel assessment method presented here. In that study, a homogeneous group (students and staff from the same university) was first divided into two subgroups by manipulating the task. Thus, the common characteristic that the control group was more likely to use a safe strategy could be observed.

In technical respect, the implementation of the game via *PsychoPy* (Peirce et al., 2019) was quick and smooth. Except for a few features, the integrated Builder interface was sufficient for the implementation, so that the game could be rebuilt with little prior knowledge. The game's simplicity makes it even realistic to build the game with other applications or programming languages, which should increase its acceptance.

Despite all the positive aspects, some limitations must be mentioned. First, the number of participants was far too small to provide conclusive findings with this study. And second, the game requires testing on a heterogeneous group. While clearer generalizability can be achieved with a homogeneous group compared to a heterogeneous group, the results cannot be generalized to the entire population (Jager et al., 2017). Additionally, the group consists of psychology students who may have been aware of the concept of GD and thus may have influenced the results. A heterogeneous group is therefore needed to capture sufficient characteristic differences that may be helpful in a clinical setting, e.g., for the diagnosis of conditions such as pathological gambling or for the selection of rehabilitation and behavioral therapies. While in the diagnosis of gambling, high repetitions and a low GD count may indicate risky gambling behavior, in the selection of rehabilitation and behavioral therapy, these same values could represent an individual's persistence, suggesting the suitability of long-term therapies.

Altogether, future research should focus on an external validation of this game to strengthen the results of this study. The *Risk Tolerance Questionnaire*, the *Arnett Inventory of Sensation Seeking*, or the *Sensation Seeking Scale*, with which pathological gamblers achieve demonstrably high values (Powell et al., 1999), seem quite useful for this purpose in the form of a linear regression analysis, with one of these questionnaires as the predictor. Alternatively, this game could be compared to similar behavioral, gambling-related methods, for example, to the long-established *Iowa Gambling Task* (Bechara et al., 1994) or the recently published dice-based game for decision-making (Franckenstein et al., 2022). Such comparisons may help to identify the differences and similarities, allowing for more efficient application of these games and a better understanding of how they capture various aspects of decision-making and GD.

5 CONCLUSIONS

This proof of concept study aimed to evaluate the feasibility of a digital game for GD based on collecting a sextuple of cards. The results revealed that the behavior of the participants with regard to GD is comparatively similar. Only in the number of repetitions and the number of collected cards, participants seem to have had some different, albeit minor, tendencies at the time of a GD. In addition, there was no preference in response to the question about predicting the future, which in turn could reflect the group's individualism.

Due to its simplicity, the game is not only easy to replicate, but also easy to understand in its application. In addition, it is unaffected by external influences and could therefore serve as an alternative assessment method to previous ones, such as those relying on solving a puzzle (Thomsen et al., 2017) or becoming a member of a group (Rühs et al., 2022). However, it is recommended to investigate the assessment method in further studies with a more heterogeneous group or external validation using methods such as questionnaires or similar games. The final version of this game should provide a scoring system that uses GD to rate patient behavior. Such a score could help predict the potential success of long-term rehabilitation and behavioral therapies that depend on individual's persistence, such as therapies for Parkinson's disease (Pellecchia et al., 2004) or after a stroke (Dam et al., 1993).

ACKNOWLEDGEMENT

We extend our gratitude to Martin J. Tomasik (Institute of Education, University of Zurich) for his advice on the development of the game and on an earlier draft of this paper.

REFERENCES

Baldo, J. V., Paulraj, S. R., Curran, B. C., & Dronkers, N. F. (2015). Impaired reasoning and problem-solving in individuals with language impairment due to aphasia or language delay. *Frontiers in Psychology*, *6*, 1523.

Bechara, A., Damasio, A. R., Damasio, H., & Anderson, S. W. (1994). Insensitivity to future consequences following damage to human prefrontal cortex. *Cognition*, *50*(1-3), 7-15. https://doi.org/10.1016/0010-0277(94)90018-3

Dam, M., Tonin, P., Casson, S., Ermani, M., Pizzolato, G., Iaia, V., & Battistin, L. (1993). The effects of long-term rehabilitation therapy on poststroke hemiplegic patients. *Stroke*, *24*(8), 1186-1191. https://doi.org/10.1161/01.STR.24.8.1186

DiCerbo, K. E. (2014). Game-based assessment of persistence. *Journal of Educational Technology & Society*, *17*(1), 17-28.

Franckenstein, S., Appelbaum, S., & Ostermann, T. (2022). Implementation and Feasibility Analysis of a Javascript-based Gambling Tool Device for Online Decision Making Task under Risk in Psychological and Health Services Research. In *Proceedings of the 15th International Joint Conference on Biomedical Engineering Systems and Technologies (BIOSTEC 2022) - Volume 5: HEALTHINF* (pp. 469-474). https://doi.org/10.5220/0010826700003123

Freund, A. M., & Tomasik, M. J. (2021). Managing conflicting goals through prioritization? The role of age and relative goal importance. *Plos one*, *16*(2), e0247047. https://doi.org/10.1371/journal.pone.0247047

Haase, C. M., Heckhausen, J., & Wrosch, C. (2013). Developmental regulation across the life span: toward a new synthesis. *Developmental Psychology*, *49*(5), 964-972. https://doi.org/10.1037/a0029231

Heckhausen, J., Wrosch, C., & Schulz, R. (2010). A motivational theory of life-span development. *Psychological Review*, *117*(1), 32-60. https://doi.org/10.1037/a0017668

Jager, J., Putnick, D. L., & Bornstein, M. H. (2017). II. More than just convenient: The scientific merits of homogeneous convenience samples. *Monographs of the Society for Research in Child Development*, *82*(2), 13-30. https://doi.org/10.1111/mono.12296

Kappes, C., & Schattke, K. (2022). You have to let go sometimes: Advances in understanding goal disengagement. *Motivation and Emotion*, *46*(6), 735-751. https://doi.org/10.1007/s11031-022-09980-z

Ligges, U., Maechler, M. (2003). Scatterplot3d - An R Package for Visualizing Multivariate Data. *Journal of Statistical Software*, *8*(11), 1-20. https://doi.org/10.18637/jss.v008.i11

Morris, R. G., Rushe, T., Woodruffe, P. W. R., & Murray, R. M. (1995). Problem solving in schizophrenia: a specific deficit in planning ability. *Schizophrenia research*, *14*(3), 235-246.

Pellecchia, M. T., Grasso, A., Biancardi, L. G., Squillante, M., Bonavita, V., & Barone, P. (2004). Physical therapy in Parkinson's disease: an open long-term rehabilitation trial. *Journal of Neurology*, *251*, 595-598.

Peirce, J., Gray, J. R., Simpson, S., MacAskill, M., Höchenberger, R., Sogo, H., Kastman, E., & Lindeløv, J. K. (2019). PsychoPy2: Experiments in behavior made easy. *Behavior Research Methods*, *51*, 195-203. https://doi.org/10.3758/s13428-018-01193-y

Powell, J., Hardoon, K., Derevensky, J. L., & Gupta, R. (1999). Gambling and Risk-Taking Behavior among University Students. *Substance Use & Misuse*, *34*(8), 1167-1184. https://doi.org/10.3109/10826089909039402

Rühs, F., Greve, W., & Kappes, C. (2022). Inducing and blocking the goal to belong in an experimental setting: Goal disengagement research using Cyberball. *Motivation and Emotion*, *46*(6), 806-824.

Steingroever, H., Wetzels, R., Horstmann, A., Neumann, J., & Wagenmakers, E. J. (2013). Performance of healthy participants on the Iowa Gambling Task. *Psychological Assessment*, *25*(1), 180-193. https://doi.org/10.1037/a0029929

Thomsen, T., Kappes, C., Schwerdt, L., Sander, J., & Poller, C. (2017). Modelling goal adjustment in social relationships: Two experimental studies with children and adults. *British Journal of Developmental Psychology*, *35*(2), 267-287. https://doi.org/10.1111/bjdp.12162

Tomasik, M. J., Silbereisen, R. K., & Heckhausen, J. (2010). Is it adaptive to disengage from demands of social change? Adjustment to developmental barriers in opportunity-deprived regions. *Motivation and Emotion*, *34*, 384-398. https://doi.org/10.1007/s11031-010-9177-6

Wrosch, C., Scheier, M. F., Carver, C. S., & Schulz, R. (2003). The importance of goal disengagement in adaptive self-regulation: When giving up is beneficial. *Self and Identity*, *2*(1), 1-20. https://doi.org/10.1080/15298860309021.