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POSITIVE TIME PREFERENCE FOR MONETARY SEQUENCES OF REWARDS: THE ROLE OF TEMPORAL SPACING

It is widely recognized that people have a general preference for improvement. In our study we demonstrate that the opposite can be observed if the consequences of our choices are dispersed over time. We address the problem of discounting of delayed sequences, in which hypothetical monetary rewards are arranged in deteriorating, flat, or improving sequences – in which the payments are separated from one another by a short (one month) or long (five years) internal delay. One hundred and twenty graduate students completed a dynamic multiple-staircase discounting procedure in a mixed factorial design. We predicted that deteriorating sequences of rewards would be preferred over their improving and flat counterparts. This prediction was confirmed when the internal delay between rewards was long. Participants not always chose the best for first, however. If the consequences of their choices were separated by small internal delay, participants were indifferent between three types of sequences.

Keywords: preference for improving sequences, positive time preference, delay discounting, deteriorating sequences, intertemporal choice

INTRODUCTION

Most people seek to improve the condition they find themselves in various areas of life. Clearly, when faced with a choice between two amounts of money, we choose the larger amount or, if these amounts are the same, we choose the one that is available sooner (Green, Myerson, & McFadden, 1997). Making such decisions seems obvious. The same should be true for rewards that appear in a sequence, e.g., earnings: we want to earn as much as possible and as fast as possible. In such situation we should prefer deteriorating over increasing sequences of rewards when both yield an equal total amount (Loewenstein, & Prelec, 1991). However, participant's choices in experimental tasks often deviate from this theoretical principle. We predict that one of the factors responsible for preference toward the type of sequence is how often we face the consequences of our choices. We base our prediction on the fact that delay has the same discounting function irrespectively of whether it refers to the time until a sequence is initiated or the time that separates each reward in a sequence. In other words, not only the delay until the sequence of events will discount the value of rewards, but also the delay that separates one reward from the other will have an impact on making a choice. This assumption is based on the finding that even though sequences can be treated as a single pattern (Rachlin, 2004), they can be also viewed as an array of rewards, which value is discounted in parallel fashion, separately (Kirby, 2006). In

the present study, we attempt to determine the preferences for flat, improving, and deteriorating sequences of rewards with different delay times between each reward within a sequence. We decided to study the discounting of sequences of rewards on an appealing account that behavior and its consequences may be considered as extended, molar patterns – and not only momentary events. Notably, behaviors and their consequences linked to contingencies of reinforcement in a work setting or in health-related behaviors seem to constitute patterns of behavior (Rachlin, 2004), and not isolated events.

A common view in the literature on the preferences for different types of sequences of future rewards is that improving sequences of rewards are preferred to deteriorating sequences (Ariely, & Carmon, 2003; Frederick et al., 2004; Loewe, 2006; Read, 2003; Ross et al., 2008; Simpson, & Vuchinich, 2000). This view is inconsistent with the microeconomic discounted utility theory, which assumes a positive time preference (Loewenstein, & Prelec, 1991). According to this theory, subjectively more valued should be deteriorating sequences, i.e., the sequences with higher rewards received up-front (closer in time) and with latter rewards decreasing incrementally in time.

Some studies suggest that the delay between each reward in a sequence can influence preferences for different types of sequences of rewards. Chapman (1996) reported results that indicate a partial preference for deteriorating sequences of payments. It was shown that when the sequences were distributed over a year, the participants preferred improving payments; however, when the rewards within sequences were available over 60 years, the differences in preferences blurred, with a slight preference for deteriorating sequences. In another study, conducted by Brunner (1999) on rats, the deteriorating sequence was operationalized in terms of increasing delays between consecutive rewards, and not their magnitudes. It was found that the animals preferred sequences in which the delay before the next reward increased in time, i.e., they preferred a deteriorating sequence over an improving one. However, no studies have been conducted on humans that have abstracted preferences from cultural influences or from the habits and expectations that the participants bring with them when they take part in an experiment.

The aim of the present research is to investigate the impact of temporal spacing of rewards in a context-free situation, i.e., whether changing the length of the internal delay between each consecutive reward within a sequence affects the participants' preferences for three types of sequences of hypothetical monetary rewards: (1) sequences with a positive linear trend in the values of consecutive rewards (improving sequences); (2) sequences in which all of the rewards are equal (flat sequences); (3) sequences with a negative linear trend in the values of consecutive rewards (deteriorating sequences). We verified how the subjective value of payments changed when the rewards within a sequence were separated by 1-month delays (all rewards were available over a period of 5 months) compared with 5-year delays (all rewards were available over a period of 25 years).

METHOD

Methodologically, the study employed a 2 x 3 x 6 factorial experimental design. The two-level between-subjects factor was the internal delay time between the rewards in a sequence: short (1-month delay between rewards in a sequence) or long (5-year delay between rewards in a sequence). The three-level within-subject factor was the type of sequence (flat, deteriorating, or improving). The six-level factor referred to the external delay, i.e., the time until the first reward in a sequence (corresponding to: 1 month, 6 months, 1 year, 2 years, 5 years, and 10 years). However, analytically, the study follows a 2 x 3 design – due to the use of area under the curve as a measure of the discounting rate (see "Measures and analysis" section).

Participants

A total of 120 students enrolled in the graduate programs at the University of Warsaw participated in the study. The subgroup that was exposed to sequences with short internal delay included 25 men and 35 women (21 ± 1.8 years, mean age ± SD), and subgroup exposed to sequences with long internal delay included 26 men and 34 women (22 years ± 2.9, mean age ± 2.9). The study was approved by the local Ethics Committee.

Procedure

We have used the dynamic multiple-staircase discounting procedure, based on the method proposed by Du, Green, and Myerson (2002) and adapted for the purpose of testing sequences of rewards. The participants chose in series between a given delayed sequence of rewards and a specific immediate reward that was adjusted to the prior choices made by a participant. The participants made choices by pressing the appropriate keys on the computer keyboard. After the choice was made, the values of the rewards disappeared for 0.5 seconds, and after this time period the immediate reward that appeared on the screen either increased or decreased. If the participant had chosen a delayed sequence, then the value of the adjustable (immediate) reward increased by half of the difference between the sum of rewards in the delayed sequence and the initial value of the immediate reward. The value of the immediate reward decreased if it had been favored over the delayed sequence in the participant's previous selection. As for the subsequent choices, the amount of the change was equal to half of the previous amount of change. This resulted in changes in the adjusting immediate reward after each choice by 11,250; 5,625; 1,875; 703; 188; 59; 13; and 4 (PLN) – added or subtracted depending on the choice of an immediate reward or a fixed delayed sequence. The number of choices that led to a single indifference point was set at eight. At the beginning of each trial, the value of the adjustable immediate reward was set at half of the value of the sum of the delayed rewards in the sequence (PLN 22,500 in this case). After the last choice, the value of the immediate adjustable reward served as an indifference point. For example, the first choice in an improving sequence condition would be between an immediate PLN 22,500 and a delayed improving sequence of rewards, starting with PLN 5,000 in 1 month and followed by PLN 6,000 in 2 months, PLN 7,000 in 3 months, PLN 8,000 in 4 months, PLN 9,000 in 5 months, and finally PLN 10,000 in 6 months (for a detailed description of this procedure, see Białaszek, & Ostaszewski, 2012). The time for this study was not limited, although the completion of the procedure took on average 14 minutes (SD = 3.5). The main procedure was preceded by a series of training choices, as described by Białaszek and Ostaszewski (2012).

Measures and analysis

The procedure aimed to find the indifference points indicating the subjective present value of a particular sequence of rewards. An indifference point refers to the immediate equivalent of a delayed sequence of rewards. For each of the conditions (i.e., deteriorating, flat, and improving) in both subgroups (i.e., long and short internal delays), six indifference points were estimated. Each of the indifference points represented subjective value of a sequence which was supposed to begin with delay of 1 month, 6 months, 1 year, 2 years, 5 years, and 10 years. The values of the rewards within the sequences in particular experimental conditions are presented in Table 1. The experimental conditions were counterbalanced across all of the participants using a Latin Square Design. In our experiment, the total nominal value of a sequence was equal in all types of sequences. The sequences differed only in the temporal arrangement of its elements.

Discounting rates were measured using the Area Under the Curve (AUC), as suggested by Myerson and collaborators (2001). The AUC

Table 1. The values of consecutive rewards for improving, flat, and deteriorating sequences. There was a 1-month delay between the rewards in one of the groups and a 5-year delay in the other group. The nominal sum of the rewards in all three cases was PLN 45,000. Participants chose between an immediate adjusting reward or a fixed delayed sequence of rewards in three experimental conditions.

Single immediate adjusting reward (PLN)		Number of the reward within the sequence	Values of consecutive rewards within sequences in three experimental conditions (PLN)		
			Improving	Flat	Deteriorating
22,500	OR	1	5,000	7,500	10,000
		2	6,000	7,500	9,000
		3	7,000	7,500	8,000
		4	8,000	7,500	7,000
		5	9,000	7,500	6,000
		6	10,000	7,500	5,000

refers to the area under the line connecting indifference points, as shown in Figure 1 – and was computed as described by Myerson and collaborators (2001). The larger the AUC, the slower discounting of delayed sequences of rewards.

RESULTS

As presented in Figure 1, in the sequences with short (left panel) and long (right panel) internal delays, median indifference points consistently decreased as the delay before the sequence increased. Moreover, visual analysis of the data suggests that when the internal delay was short, there were no systematic differences between the indifference points for the flat, improving, and deteriorating sequences. However, when the internal delay was long, the indifference points for the deteriorating sequences were above the indifference points for the flat and improving sequences. The visual inspection suggests that for sequences with long internal delays, deteriorating sequences are discounted less steeply than the other two types of sequences.

To determine the influence of the type of sequence and the internal delay within a sequence on the rate of discounting for sequences of delayed rewards, a 3 x 2 mixed model analysis of variance was used. The interpretation of the results was based on a multivariate model (MANOVA; statistic: Pillai's Trace). The analyses were based on the AUC values that were calculated for each participant.

The analysis revealed a significant main effect of the type of sequence ($F(2, 117) = 9.802$; $p < .001$; $\eta_p^2 = 0.144$), as well as a main effect of the length of the internal delay ($F(1, 118) = 24.705$; $p < .001$; $\eta_p^2 = 0.173$). Moreover, there was a significant effect of the interaction between the type of sequence and the length of the internal delay ($F(2, 117) = 3.585$; $p = .031$; $\eta_p^2 = 0.058$). The effect size of the interaction is small but statistically significant. Because the interaction effect was significant, further inferences were based on the analysis of simple effects with Sidak's correction.

The analysis of simple effects showed that in each of the three types of sequences, the AUC values for the sequences with short (1-month) internal delays were higher ($M = 0.490$, $SD = 0.298$; $M = 0.501$, $SD = 0.281$; $M = 0.511$, $SD = 0.285$; for improving, flat, and deteriorating sequences, respectively) than the AUC values for the

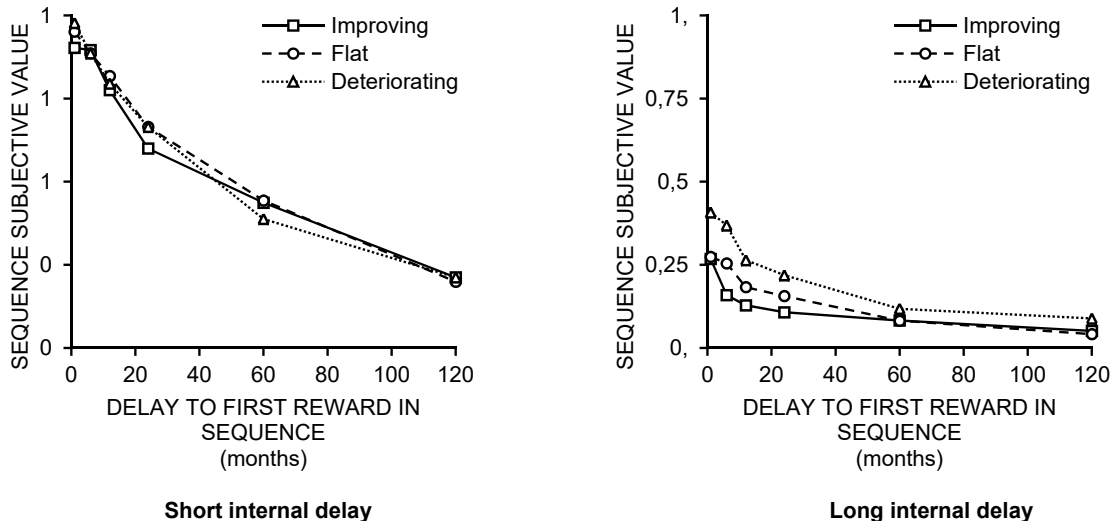

Fig. 1. The median indifference points for improving, flat, and deteriorating sequences of rewards. The left panel refers to the experimental group with the short (1-month) internal delay within the sequences. The right panel presents the median indifference points for the long (5 years) internal delay within the sequences. The lines connecting indifference points correspond to area under the curve.

sequences with 5-year internal delays (M = 0.228, SD = 0.258; M = 0.252, SD = 0.256; M = 0.308, SD = 0.270 for improving, flat, and deteriorating sequences, respectively) ($p < .001$). In addition, within the group with the short internal delays, there were no significant differences between the AUC values for improving and flat sequences ($p = .928$), for improving and deteriorating sequences ($p = .519$), or for flat and deteriorating sequences ($p = .906$). However, in the subgroup where there was a long (5-year) internal delay between the consecutive rewards, the AUC for the deteriorating sequences was higher than the AUC for the improving sequences ($p < .001$) and the AUC for the flat sequences ($p = .004$), but the AUC values for the flat and improving sequences were not significantly different ($p = .605$).

DISCUSSION

The main aim of this study was to determine whether we can induce the preference toward deteriorating sequences of rewards by introducing different values of internal delay. In other words, we investigated if deteriorating, flat, and improving sequences of rewards lose their value at a different rate, depending on the length of the delay between rewards in a sequence.

We found that when the rewards in a sequence were separated by a 1-month internal delay, there were no statistically significant differences between the discounting rates for improving, flat, and deteriorating sequences. However, when the delay between rewards within a sequence was set to five years, the participants preferred deteriorating sequences of rewards to flat or improving sequences. In addition, the study showed that the internal delay effectively changed the subjective values of the sequences regardless of the type of sequence: the value of the sequences with short internal delays was higher than the value of the sequences with long internal delays.

The most important finding of this experiment was that in certain situations people can indeed demonstrate a preference for deteriorating sequences of rewards, i.e., by increasing the internal delay between each reward

in a sequence, a shift in preferences towards deteriorating sequences is possible. This result seems inconsistent with the typical results of the studies where respondents usually preferred an increasing sequence of payoffs (e.g., Ariely, & Carmon, 2003; Frank, & Hutchens, 1993; Frederick et al., 2004; Hsee et al., 1991; Loewe, 2006; Loewenstein, & Prelec, 1993; Read, 2003; Ross et al., 2008; Ross, & Simonson, 1991; Simpson, & Vuchinich, 2000). We observed the preference for deteriorating sequences when the rewards within the sequence were separated by long internal delays (i.e., 5 years) and, consequently, the whole sequence was distributed over 25 years. It is possible that sequences of rewards with shorter delays are treated as a single reward rather than a series of rewards. That interpretation would be consistent with the conclusion reported by Białaszek and Ostaszewski (2012), who have shown that a single reward is discounted at a lower rate than a sequence with the same nominal value. When the internal delay within a sequence is short, the whole sequence may be considered a single reward and no significant preferences are observed regarding the arrangement of the rewards within the sequence. Furthermore, in our opinion, the change in preference from one type of the sequence to the other can be viewed as a quantitative, and not a qualitative process. That is, with an increase in the internal delay the gradual shift in preferences should be observed. For example, in the choice of a decreasing sequence: on one side of the internal delay continuum, i.e., when the internal delay is short, we can observe multiple rewards integrate into a single outcome. On the other side of that continuum, there is only the first reward that is relatively close in time – while the remaining rewards in a sequence are smaller and distant. In such case, when the internal delay is long, the decreasing sequence would be preferred.

Our findings are derived from a context-free situation. Existing literature suggests that specific contexts may have further influence on the preferences toward different types of sequences of rewards. For example, in a recent study, Duffy, Smith, and Woods (2015) have showed that the preference for increasing payments depends on the source of the payment. They demonstrated that the preference for increasing payments is more evident for wage payments than for lotto jackpot. This could be interpreted as situations in which wage payments are obtained as the only income and lotto jackpots constitute an additional source of money. In other words, the analyzed choices were made in a closed economy and open economy for wage payments and lotto jackpots, respectively. The distinction between an open and closed economy in studying behavior was adapted from economics and introduced into psychological research by Hursh (1980, 1984). In a closed economic system, income depends only on the magnitude of work, whereas in an open economic system, there are other supplemental sources of goods that serve as an addition to income. It is possible, that people would show a preference for deteriorating sequences if the rewards are framed as a pure open economy (eg., prize from a lotto jackpot), because in this situation, according to the theoretical approach, overall discounted utility is maximized. However, Duffy, Smith, and Woods (2015) used only one type of sequences (increasing) in their study. Also, such preferences might be connected to the fact that in open economies demand for reinforcement is flexible (Hursh, 1980). In such situation, increase in the requirement of obtaining a certain reward (i.e., longer delay for the largest reward) would result in decreased preference for improving sequences because they provide the largest reward at the end.

As pointed out by Frederick and Loewenstein (2008), the three main factors favoring the preference for deteriorating sequences are: (1) uncertainty about the future (occurrence of a future event is not certain); (2) the fact that delayed outcomes could have been invested (opportunity costs); (3) and pure time preference (utility decreases as time increases). These three fac-

tors can contribute to favoring a deteriorating stream of payments. Further research could focus directly on the mechanism underlying the preference for different types of sequences. One possible interpretation of our results can be based on the absence of the extrapolation effect (Frederick, & Loewenstein, 2008). In situations where sequences of rewards are framed as income from work, people can extrapolate such a sequence and, if it consists of for example rewards of 1, 2, and 3 monetary units, the next extrapolated element would be 4. In the case of a deteriorating sequence of 3, 2, and 1 monetary units, the next extrapolated reward would be 0. In our study, monetary outcomes were context-free and not framed in any particular way. Therefore, it can be hypothesized that the potential outcomes were treated as additional income and the extrapolation effect did not occur. Frederick, Loewenstein, and O'Donoghue (2004) suggest that people should possess a choice heuristic for the evaluation of sequences of rewards. On a rational basis, such heuristic manifesting itself in choosing improving sequences would be useful in everyday life – providing that people have access to the information that is necessary to extrapolate the value of a sequence. In such case, choosing a sequence that is extrapolated to be increasing could yield the most utility.

With considerations from Chapman (1996) on the preference for deteriorating sequences distributed over longer periods of time, and recent findings by Duffy, Smith, and Woods (2015), further research could also address the issue of preferences for given sequences of rewards in different economical contexts – with different formal properties of sequences, e.g., length of the internal delay, size of the increment and/or decrement of sequence rewards, and the overall, cumulated size of sequence value.

It should also be noted that our results can prove applicable in these areas of life that require increased self-control. Particularly, in addiction therapy, education, and health and consumer behavior. For example, Critchfield and Kollins (2001) have showed that the results of basic research on discounting have already contributed to the understanding of adverse behaviors, such as eating disorders, and alcohol and drug abuse. We suggest that pinpointing the relationship between the effect of different types of sequences of reinforcers, and the effect of different internal delays on behavior, can contribute to designing behavioral strategies with sequenced reinforcements that yield a desired increase in self-control. However remote in time, such goals certainly seem achievable.

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REFERENCES

Ariely, D., & Carmon, Z. (2003). Summary assessment of experiences: the whole is different from the sum of its parts. In: G. Loewenstein, D. Read, & R. Baumeister (Eds.), *Time and Decision: Economic and Psychological Perspectives on Intertemporal Choice* (pp. 323–350). New York, NY: Russell Sage Foundation.

Białaszek, W., & Ostaszewski, P. (2012). Discounting of sequences of delayed rewards of different amounts. *Behavioural processes*, *89*(1), 39–43.

Brunner, D. (1999). Preference for sequences of rewards: further tests of a parallel discounting model. *Behavioural processes*, *45*(1), 87–99.

Chapman, G. B. (1996). Expectations and preferences for sequences of health and money. *Organizational Behavior and Human Decision Processes*, *67*(1), 59–75.

Critchfield, T. S., & Kollins, S. H. (2001). Temporal discounting: Basic research and the analysis of socially important behavior. *Journal of applied behavior analysis*, *34*(1), 101–122.

Du, W., Green, L., & Myerson, J. (2002). Cross-cultural comparisons of discounting delayed and probabilistic rewards. *The Psychological Record*, *52*(4), 479.

Duffy, S., Smith, J., & Woods, K. (2015). How does the preference for increasing payments depend on the size and source of the payments?. *Management Science Letters*, *5*(12), 1071–1080.

Frank, R. H., & Hutchens, R. M. (1993). Wages, seniority, and the demand for rising consumption profiles. *Journal of Economic Behavior & Organization*, *21*(3), 251–276.

Frederick, S., & Loewenstein, G. (2008). Conflicting motives in evaluations of sequences. *Journal of Risk and Uncertainty*, *37*(2–3), 221–235.

Frederick, S., Loewenstein, G., & O'Donoghue, T. (2004). Time discounting and time preference: a critical review. In: C. F. Camerer, G. Loewenstein, & M. Rabin (Eds.), *Advances in behavioral economics* (pp. 162–222). New York, NY: Princeton University Press.

Green, L., Myerson, J., & McFadden, E. (1997). Rate of temporal discounting decreases with amount of reward. *Memory & cognition*, *25*(5), 715–723.

Hsee, C. K., Abelson, R. P., & Salovey, P. (1991). The relative weighting of position and velocity in satisfaction. *Psychological Science*, *2*(4), 263–266.

Hursh, S. R. (1980). Economic concepts for the analysis of behavior. *Journal of the experimental analysis of behavior*, *34*(2), 219–238.

Hursh, S. R. (1984). Behavioral economics. *Journal of the experimental analysis of behavior*, *42*(3), 435–452.

Kirby, K. N. (2006). The present values of delayed rewards are approximately additive. *Behavioural Processes*, *72*(3), 273–282.

Loewe, G. (2006). The development of a theory of rational intertemporal choice. Papers: revista de sociologia, (80), 195–221.

Loewenstein, G., & Prelec, D. (1991). Negative time preference. *The American Economic Review*, *81*(2), 347–352.

Loewenstein, G. F., & Prelec, D. (1993). Preferences for sequences of outcomes. *Psychological review*, *100*(1), 91.

Myerson, J., Green, L., & Warusawitharana, M. (2001). Area under the curve as a measure of discounting. *Journal of the experimental analysis of behavior*, *76*(2), 235–243.

Rachlin, H. (2004). *The science of self-control*. Boston, MA: Harvard University Press.

Read, D. (2003). Intertemporal choice. Working Paper no. 03-58, London School of Economics and Political Science: London.

Read, D., & Powell, M. (2002). Reasons for sequence preferences. *Journal of Behavioral Decision Making*, *15*(5), 433–460.

Ross, W. T., & Simonson, I. (1991). Evaluations of pairs of experiences: A preference for happy endings. *Journal of Behavioral Decision Making*, *4*(4), 273–282.

Ross, D., Sharp, C., Vuchichich, R., & Spurrett, D. (2008). Midbrain Mutiny: the picoeconomics and neuroeconomics of disordered gambling. The MIT Press, Cambridge.

Simpson, C. A., & Vuchinich, R. E. (2000). Temporal changes in the value of objects of choice: Discounting, behavior patterns, and health behavior. In: W. K. Bickel, R. E. Vuchinich (Eds.), *Reframing health behavior change with behavioral economics* (pp. 193–215). London: Lawrence Erlbaum Associates.

Schmitt, D. R., & Kemper, T. D. (1996). Preference for different sequences of increasing or decreasing rewards. *Organizational Behavior and Human Decision Processes*, *66*(1), 89–101.

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POZYTYWNA PREFERENCJA CZASOWA DLA SEKWENCJI NAGRÓD PIENIĘŻNYCH: ROLA ODSTĘPÓW POMIĘDZY NAGRODAMI

ABSTRAKT

Powszechnie uznaje się, że ludzie dążą do ciągłego polepszania swojej sytuacji. W naszym badaniu pokazujemy, że odwrotne preferencje mogą się ujawnić, jeżeli konsekwencje naszych wyborów są rozproszone w czasie. Zadaliśmy pytanie o to, w jaki sposób dyskontowane są odroczone sekwencje, w których hipotetyczne nagrody pieniężne maleją, są równe lub rosną – oraz oddzielone są od siebie krótkim (jeden miesiąc) lub długim (pięć lat) odroczeniem wewnętrznym. Wykorzystując czynnikowy schemat mieszany, przebadaliśmy 120 studentów studiów magisterskich za pomocą dostosowującej się procedury schodkowej, przeznaczonej do pomiaru procesu dyskontowania. Przewidywaliśmy, że malejące sekwencje nagród będą preferowane względem ich rosnących i równych odpowiedników. Przewidywanie to zostało potwierdzone w sytuacji długiego odroczenia wewnętrznego pomiędzy nagrodami w sekwencji. Jednakże, badani nie zawsze wybierali sekwencje z najwyższą nagrodą na początku. Jeżeli konsekwencje ich wyborów były oddzielone od siebie krótkim odroczeniem wewnętrznym, badani wyceniali różne sekwencje w podobny sposób.

Słowa kluczowe: preferencja sekwencji rosnących, pozytywna preferencja czasowa, dyskontowanie w odroczeniu, sekwencje malejące, wybór międzyokresowy