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Metaphoric construal and its effect on gaze behavior  
of the readers with better and worse working memory

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**Abstract.** Language creativity studies are now exploring new experimental methods which test the readers’ figurative thought. In the current work, we address the gaze behavior as contingent on figurative language construal in two participants’ groups with different amount of working memory. We verify the hypothesis that apart from metaphor types, novel and entrenched, gaze behavior is affected by metaphor construal patterns, here described as parameters. The study specifies the cognitive parameters of Referent construal, Event Frame construal, Perspective construal, and the linguistic parameters of graphological, lexical and syntactic construal. Regression analysis reveals several predictors of steady decrease and increase of the gaze costs within two participant groups. The participants with better working memory display higher gaze costs when the construal lacks action or dynamics; whereas the participants with worse working memory are affected by both linguistic and cognitive construal parameters including Clause-initial position for contrastive focus, Lexical synonyms and antonyms, Spontaneous or occasional event, Lack of action or dynamics. We also identified the predictors which decrease the gaze costs; the participants with worse working memory are affected by Perception (Event type), Shifting / changing, Agentive participant, Intensifiers in pre-position. Overall, the participants with worse working memory pay more attention to linguistic construal of metaphors, presumably, it creates additional affordances for metaphor construal; at the same time lower dynamicity in the cognitive construal produces higher gaze costs in both groups. The




study shows that irrespective of the metaphor type, several construal patterns produce consistent gaze costs, either increased or decreased.

**Keywords:** Construal; Figurativity; Metaphoric nominal groups; Eye-tracking; Working memory

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**Метафорическое конструирование и его влияние на  
глазодвигательное поведение у читателей с разным объемом  
рабочей памяти**

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**Информация об источниках финансирования или грантах:** Исследование выполнено при финансовой поддержке Российского фонда фундаментальных исследований, проект № 20-012-00370 «Гетерогенность текста и факторы ее успешной интерпретации читателем» в Московском государственном лингвистическом университете.

**Аннотация.** Одной из актуальных проблем лингвистики является инструментальная оценка проявлений языковой креативности. Целью настоящей работы становится экспериментальное установление значимости конструирования, когнитивного и лингвистического, для глазодвигательного восприятия окказиональных и конвенциональных метафор людьми с разным объемом рабочей памяти. Гипотеза исследования заключается в том, что характеристики глазодвигательного поведения сопряжены не столько с разными типами метафор, сколько с особенностями метафорического конструирования. Верификации подвергаются когнитивные параметры конструирования референта, события и перспективы, а также лингвистические параметры графо- и морфологического, лексического и синтаксического конструирования.

Результаты регрессионного анализа позволили установить ряд параметров – предикторов изменения глазодвигательного поведения в двух группах испытуемых. Так, для испытуемых с большим объемом рабочей памяти отсутствие динамики события существенно увеличивает глазодвигательную нагрузку при восприятии метафор; для испытуемых с меньшим объемом рабочей памяти таких параметров намного больше, это синтаксическое фокусирование, наличие синонимов в ближайшем контексте, спонтанное событие, отсутствие динамики события, и др. Установлены и параметры, которые снижают глазодвигательную нагрузку; так, для испытуемых с меньшим объемом рабочей памяти это параметры телесного конструирования, динамического события, наличие интенсификаторов в пре-позиции; представители данной группы фокусируются на лингвистических особенностях конструирования, возможно, таким образом им легче конструировать метафорические образы.

**Ключевые слова:** Конструирование; Образность; Метафорические номинативные комплексы; Окулография; Рабочая память

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## 1. Introduction

Gaze behavior studies in metaphor processing have a long history. In experimental psychology, the gaze effects and default interpretations of novel and entrenched metaphors have been vastly tested. Most commonly, they show that gaze costs contingent on entrenched metaphors are lower than on novel metaphors, which is explained by priming effects (Blasko & Connine, 1993; Blasko & Briehl, 1997), analogical reasoning (Bowdle & Gentner, 2005), lower ambiguity effects (Libben & Titone, 2008), the presence of biased priming context (Frisson & Pickering, 1999). At the same time, multiple experimental works produce sufficient evidence on individual differences in understanding metaphor and in ad hoc gaze behavior, for instance in terms of executive control (Columbus et al., 2015) which displays high contingency on gaze characteristics of higher and lower executive control readers depending on prior context. Experiments also tested the effects of selective attention on gaze behavior and metaphor comprehension (Klepousniotou et al., 2008), which have proved that in the cases of possible multiple literal and figurative

meanings activation the participants with lower comprehension skills had higher gaze costs contingent on default interpretations. These effects have also been explored as contingent on reading models (Kliegl et al., 2006; Rayner et al., 2012). These and similar experiments are aimed at specifying the individual differences in metaphor processing.

Indeed, apart from testing the individual gaze behavior in processing novel and entrenched metaphors, there are other research directions which specify the metaphor character as stimulating these differences. Considering the fact that figurative language construal displays high diversity, for instance in participant construal in terms of their animated or non-animated character (Wårwik, 2004), event construal in terms of its achievement or agentivity (Langacker, 2015; Talmy, 2000), or in perspective construal in terms of its vantage point or observation path (Verhagen, 2007; Iriskhanova, 2013), we cannot leave these characteristics unattended when selecting experiment stimuli and expecting to test individual differences in metaphor processing. Several potentially significant construal factors have been advocated in the gaze

studies of metaphor processing, with event construal specifics (Coulson & van Petten, 2002; Coulson, 2008; Thibodeau & Boroditsky, 2013), linguistic (especially syntactic) construal effects (Gibbs & Matlock, 2008), salience in metaphorical models (Giora, 2003) or pragmatic models (Giora et al., 2018), verbal and nonverbal categories distribution (Glucksberg, 2003), modulating construal in novel and entrenched metaphors (Kiose & Kharlamova, 2021).

In this study, we explore the construal effects of novel and entrenched metaphors onto individual gaze behavior. We hypothesize that despite the differences in metaphor types, figurative construal in terms of cognitive and linguistic construal may affect the gaze characteristics. To observe possible individual differences, we addressed the factor of working memory, since this factor is admitted as most significant in entrenchment effects in context (Gunter et al., 2003). This can be explained if we consider that in context novel metaphors may become entrenched through their repeated use and consequently lower gaze costs will be observed (Cardillo et al., 2012; Goldstein et al., 2012). In the previous study (Kiose & Kharlamova, 2021) we reported the results on the construal differences observed in novel and entrenched metaphors separately, however these results allowed to predict that there might be significant construal and gaze cost contingencies irrespective of metaphor novelty / entrenchment but dependent on other metaphor construal factors like agentivity or degree of abstractness.

## 2. Research methods and procedure

In cognitive linguistics, linguistic and cognitive construal are the key notions which are described through cognitive mechanisms and operations. In recent works, different construal mechanisms are considered through Event-modeling framework (Divjak et al., 2020; Hart & Queralto, 2021), which allows to explore the systemic effects of different construal patterns. Cognitive and linguistic construal patterns are explored in multiple

works extending their application to metaphor models (Boroditsky, 2000; Graumann & Kallmeyer, 2002; Dancygier & Sweetser, 2012; Goatly, 2017). In our prior studies (Kiose et al., 2020) we proposed three types of cognitive construal patterns to explore nonverbal event construal, which are Referent Construal, Event Frame Construal and Perspective Construal patterns. Following J. Pustejovsky (1995), we distinguish four types of Referent construal patterns or ways of seeing the participants, Part-whole, Kind, Functional, Life-history, which allow to explore the participant in terms of their agentivity, complexity, referential integrity, etc. Following V. Demyankov (1983), to describe Event Frame Construal we consider such patterns as event completeness, instantness, evaluation, manageability, repeatability, etc. Following O. Iriskhanova (2013), we describe Perspective construal exploring the patterns of vantage point, viewpoint, distancing, observation path, etc. Verbal construal is assessed in the patterns of linguistic foregrounding described in Iriskhanova (2014). The complete list of construal patterns attested in the stimulus is given in Appendix B.

To explore cognitive and linguistic figurative construal, we address two types of metaphors, novel and entrenched. Following Schmid (2016) and Langacker (2016) we consider the metaphors which do not exploit earlier activated metaphoric models and correspondences as novel. The following sample may demonstrate the case; here the metaphoric nominal group *новостройки* ('new buildings') refers to large new waters:

– Тоже проблема: почему рыба из малых рек уходит в новые большие водоемы?

– Проблема! А как вы думаете?.. Еще какая! У нас тут были целые рыболовецкие артели – крышка. Распускать! А у людей – образ жизни сложился, профессия...

– Назовите это: **рыба уходит на новостройки** – и дело с концом (V. Shukshin)

(fish-3SG go-3SG to new-PL building-3PL-ACC)

(Translation) There is a new problem: why does fish leave small rivers for large new waters?

– It is a problem! What do you think? A pretty big one! We had whole fishermen’s artels here, all dead. Dissolve! And people developed a way of life, a profession ...

– Name it so: **the fish goes to new buildings** – and call it a day.

In the clause *рыба уходит на новостройки* the metaphor *новостройки* is novel, which is corpus-supported. Its use in the Russian National Corpus does not allow to find similar metaphoric correspondences with *новостройка* as a fish habitat, although the NCRL frequency use of the lexeme is 684 with *новостройка* – 43, *новостройки* – 224, *новостройку* – 53, *новостройкам* – 21, *новостройке* – 70, *новостроек* – 273. It employs one of the ontological metaphor models (ANIMALS are PEOPLE), still there are two metaphor correspondences, ANIMALS’ HABITAT is PEOPLE’S HABITAT which is not novel, see *дом птицы* (Е. Гончаренко), *собачий дом* (М. Горький), and NEWLY-FORMED HABITAT FOR ANIMALS is NEWLY-MADE HABITAT FOR PEOPLE which is novel. Therefore, the metaphor is a novel one.

Importantly, entrenchment can be observed in context (Cardillo et al., 2012) and over time (Bowdle & Gentner, 2005). In this study, we address the case of textual entrenchment when one novel metaphorical nominal group is used repeatedly to refer to the same referent. These examples are not frequently present in short textual fragments being more common for larger textual spaces, however the latter will not suffice to be applied in a gaze study; besides, single repetition will not satisfy the needs of analysis since a reader may simply miss the nominal group in its first or second use, which will make us disregard his results. Therefore, for the experiment we had to select the stimulus

which demonstrated several uses of a novel metaphorical nominal group in a small textual fragment. The selected text sample from Fazil Iskander’s short story “Thirteenth Feat of Hercules” has 5 uses of novel metaphoric nominal group, where the group “*Отъявленный Лентяй*” (F. Iskander) is used three times in the text referring to a boy who is not lazy, thus this is the example of metaphoric disanalogy (Bowdle & Gentner, 2005) and twice with the modification of the form “*лентяй, добросовестный и послушный лентяй*” (F. Iskander) bearing the same reference. The Stimulus and its translation and glosses are given in Appendix A. Below, we will consider the differences in the event construal in this stimulus. In its first use, in “*Оказалось, что я держу носилки как Отъявленный Лентяй*” (F. Iskander), the novel metaphor “*Отъявленный Лентяй*” (F. Iskander) is used to refer to a single person participant of agentive type which is the speaker himself; the event is of an incomplete type, displaying space location relations, bodily construal; it presents the inner observer type (the event participant’s perspective). In terms of linguistic construal, it displays graphic foregrounding (capitalization), syntactic foregrounding (syntactic rhematic position). The second use, in “*Через некоторое время слухи об Отъявленном Лентяе дошли до директора школы*” (F. Iskander), displays weaker syntactic foregrounding, still graphical foregrounding is present. Participant construal patterns are the same, however the event construal patterns differ; here the event is completed, it has time location, however, the participant’s perspective is vague. The third and the fourth uses display modifications in linguistic form in “*Вскоре выяснилось, что никаких фокусов я не собираюсь выкидывать, что я, напротив, очень послушный и добросовестный лентяй. Более того, будучи лентяем, я вполне прилично учился*” (F. Iskander). The fifth use, in “*Так, доигрывая навязанный мне образ Отъявленного Лентяя, я пришел к золотой медали*” (F. Iskander), is still graphically

foregrounded, however the event construal patterns differ since the event in the clause with the entrenched metaphor is of incomplete type, has no space or time location, displays no bodily construal.

The eye-tracking experiment was conducted to test the gaze costs (in terms of Fixation Duration, First Fixation Duration and Fixation Count) in 5 Areas of Interest corresponding to the zones of 5 metaphoric nominal groups. The experiment was preceded with an n-back test performed in Brain Workshop 4.8.4 (Jaeggi et al., 2008) which is customarily used in memory tests (Kane et al., 2007; Farvardin et al., 2014) to identify the groups of participants who display differences in the capacity of working memory. In the n-back task, the participants are presented with several visual stimuli. They have to report whether each stimulus matches a stimulus in trials before. The test assesses the number of mistakes and the relative execution time. In the eye-tracking experiment, 60 gaze probes were received with 12 participants, with the mean age of 22. All experiment participants were native speakers (Russian) and had corrected-to-normal or normal vision. Participants were

asked to read the sample and answer the questions concerning the reference of the groups, however in this work we will consider only their gaze behavior. Pdf-formatted visual stimulus appeared for 90 seconds. In the experiment we used The SMI Red-x eye tracker (running at frequency 60 Hz and with operating distance of 60-80 cm). The eye movement data were next sampled (fixation duration, first fixation duration, fixation count in AoIs) and subjected to regression modeling.

### 3. Research Results

#### 3.1 Data preparation

There were 5 AoIs and each AoI was manually annotated. The annotations served to explore contingency on the gaze characteristics. We regarded eye movement characteristics, distinguished in eye movement control models (Reichle et al., 2003; Richter et al., 2006). The accumulated data in 5 AoIs is presented in Table 1 for 3 gaze characteristics: fixation duration per sign in the Areas of Interest (FD), first fixation duration in Areas of Interest (FFD), fixations count (FC).

**Table 1.** Gaze characteristics data in 5 AoIs

**Таблица 1.** Глазодвигательное поведение в пяти зонах интереса

Gaze events	FD (ms per sign)	FFD (ms)	FC
N	60	60	60
Mean	34.4	173	4.03
Median	28.4	159	3.0
SD	23.8	68.8	3.0
Min	0	0	0
Max	108	377	16
Shapiro-Wilk <i>p</i>	<0.001	0.003	<0.001

K-means cluster analysis, performed in IBM SPSS Statistics 20, was used to define groups of participants based on n-back test scores. As 4-cluster solution did not provide the resultant solution, the sample was divided into two clusters: 5 subjects were categorized as “demonstrating better working memory solutions (BWM)”, 7 subjects were categorized as “demonstrating worse working

memory solutions or worse working memory (WWM)”. The descriptive statistics of 12 participants’ exactness and relative execution time are as follows: the mean number of mistakes was 2.36 (Min. = 0.875, Max. = 9), the mean time per each answer was 1.69 s (Min. = 0.84, Max. = 3.47). The datasets – 5 AoIs annotations of non-verbal and verbal construal in the stimuli, and the data on 3

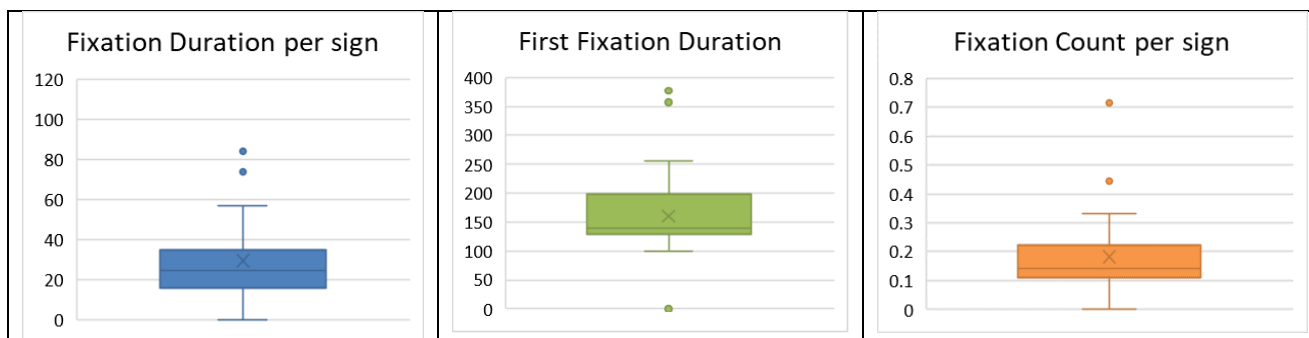
gaze characteristics for 2 participant groups, were sampled and subjected to contingency analysis and regression tests.

### 3.2 Construal effects

The gaze characteristics involved Fixation Duration per sign (ms), First Fixation Duration (ms) and Fixation Count per sign (ms). In Figure 1 we present the gaze characteristics for two groups.

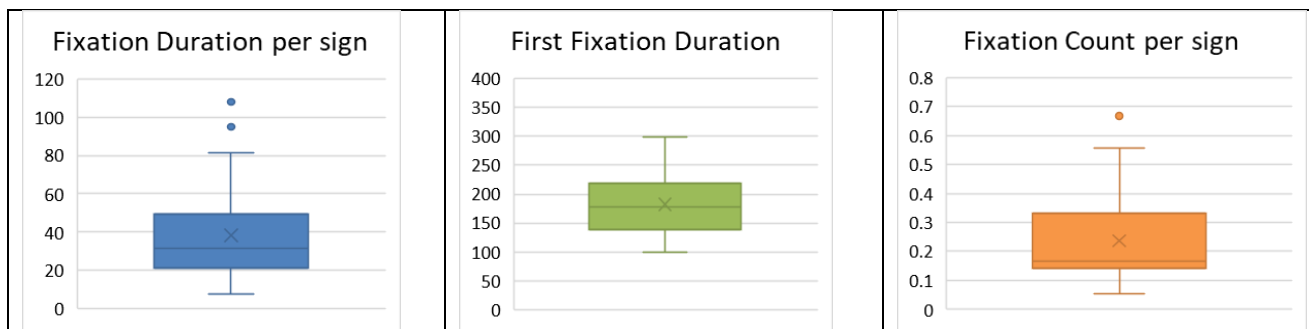
**Figure 1a.** Gaze characteristics for Group 1 (BWM), ms

**Рисунок 1а.** Показатели глазодвигательной активности в Группе 1 (с большим объемом рабочей памяти), мс



**Figure 1b.** Gaze characteristics for Group 2 (WWM), ms

**Рисунок 1б.** Показатели глазодвигательной активности в Группе 2 (с меньшим объемом рабочей памяти), мс



As seen, the gaze characteristics display difference in two groups, with all three gaze characteristics being higher in duration and count with Group 2.

For data processing we used JAMOVI software. The two datasets were preliminarily submitted to contingency analysis. The first step was to explore the effects of cognitive and linguistic construal onto gaze behavior. Since the parameter values were of nominal type (46 cognitive and linguistic construal parameters with positive values) and continuous type (3 gaze characteristics), we applied the Student's t-test. To verify the results significance, we applied Bonferroni-

Holm correction (Holm's Sequential Bonferroni Procedure) which controls the familywise Type I error rate in a less conservative manner as compared with standard Bonferroni correction. The t-tests (276 trials) were conducted for two participant groups separately, Bonferroni-Holm corrections were further calculated.

Next, regression modeling was applied to reveal the regression models predicting the gaze behavior (3 gaze characteristics) with non-aliased construal parameters (4 parameters, which are Agentive participant, True event, Perception, Positive evaluation) and with non-aliased syntactic parameters

(Clause-final position for neutral syntactic foregrounding, Position in subsidiary clause, Position in parallel structure, Position in elliptical clause) separately. The need to establish the regression model with syntactic parameters was stimulated by the collected evidence that these were the syntactic parameters that were mostly contingent on the gaze behavior with the participants of Group 2, while the participants of Group 1 demonstrated very few contingencies, overall. We will see which model suits better to describe the process of entrenchment within each of the groups. The model performance summary statistics will be presented for 6 models for 2 participant groups in 3.2.1, 3.2.2 and 3.2.3.

### 3.2.1 Construal parameters and Fixation Duration per sign

As explained above, the presence or absence of cognitive and linguistic construal parameter markers in 5 AoIs of the stimulus was previously established by the annotators. We received the data on non-verbal and verbal construal in binary format, with 1 for AoI presence and 0 for AoI absence which was further subjected to t-tests in two participants' groups. Table 2 shows the results of t-tests with 46 construal parameters in two Groups, only the parameters displaying significant p-values are given. Bonferroni-Holm corrections are also presented.

**Table 2.** Construal parameters and Fixation Duration per sign in two groups

**Таблица 2.** Параметры конструирования и продолжительность фиксаций на знак в двух группах

Construal parameters	FD in Group 1 (BWM)	FD in Group 2 (WWM)
	t [p, p Bonferroni-Holm] df=23	t [p, p Bonferroni-Holm] df=33
Agentive participant	-	-2.12 [0.042, 0.05]
Perception (Event type)	-	-3.79 [<0.001, 0.01]
Lack of action or dynamics	2.3 [0.044, 0.05]	-
Interactive relations	-	-2.59 [0.014, 0.03]
No interpersonal or interactive relations	2.3 [0.044, 0.05]	-
Spontaneous or occasional event	-	2.12 [0.042, 0.05]
Graphic foregrounding	-2.3 [0.044, 0.05]	-
Intensifiers in pre-position	-	-2.72 [0.01, 0.02]
Actional verbs	-2.3 [0.044, 0.05]	-
Repetition of the word	-	3.79 [<0.001, 0.01]
Emotives	-	-2.15 [0.039, 0.04]
Lexical synonyms and antonyms	-	2.59 [0.014, 0.03]
Clause-initial syntactic focus	-	2.72 [0.01, 0.02]
Position in subsidiary clause	-	-2.72 [0.01, 0.02]
Position in parallel structures	-	2.15 [0.039, 0.04]
Agentivity	-	-2.12 [0.042, 0.05]

The analysis has revealed significant differences in two participants' groups. The most obvious is the difference in the number of construal parameters which display significant effect on Fixation Duration. There are two parameters which lead to higher gaze costs with the BWM participants; they both display lack of dynamics and relations, at the

same time dynamicity and visual foregrounding reduce the gaze costs. The situation with WWM participants is far more complicated; whereas agentivity and dynamicity play similar role, it is additionally strengthened by intensity and bodily and emotional experience. Higher costs are identified in the situations of spontaneity,



repetition (possibly, since repeated use seemed unnatural), paradigmatic and syntagmatic foregrounding of various types. We may hypothesize that the WWM participants tend to pay more attention to different types of linguistic foregrounding in construal, presumably they serve as affordances stimulating the memory decisions. At the same time cognitive foregrounding (agentivity, dynamicity, etc.) is easier to follow, however this hypothesis needs further verification.

To establish the regression Model 1 (with non-aliased parameters), we conducted Linear regression analysis, which revealed only 4 parameters with non-aliased coefficients. Since linear regression was held during successive subjection of construal parameters, only one Participant (Agentive Participant) and three Event Frame parameters (True Event, Perception, and Positive evaluation) were included. Table 3 shows the regression models for two participants' groups predicting Fixation Duration.

**Table 3.** Regression Model 1 with non-aliased coefficients predicting Fixation Duration in two groups

**Таблица 3.** Регрессионная модель 1 с неколлинеарными параметрами для продолжительности фиксации в двух группах

Predictor	FD in AoI in Group 1 $R^2 = 0.198$				FD in AoI in Group 2 $R^2 = 0.356$			
	Estimate	SE	t	p	Estimate	SE	t	p
Intercept	15.64	10.1	1.55	0.137	21.61	7.73	2.797	0.009
Agentive participant	3.44	14.3	0.241	0.812	-3.81	10.93	-0.349	0.73
True event	15.92	14.3	1.116	0.278	14.33	10.93	1.311	0.2
Perception (Event type)	24.36	20.2	1.207	0.241	46.33	15.46	2.998	0.005
Positive evaluation	4.74	14.3	0.332	0.743	15.3	10.93	1.4	0.172

The results demonstrate that the predictability of Regression model for Group 1 is far lower ( $R^2 = 0.198$ ), besides there are no good predictors. As opposed to it, the regression model with Group 2 has higher prognostic potential ( $R^2 = 0.356$ ), and one (which may mean that there are several good predictors since there will be multiple aliased parameters) good predictor (with  $p = 0.005$ ) which is the Bodily construal (displaying perception markers). Noticeable, that Perception also displayed significance as a single parameter contingent on lower gaze costs in terms of Fixation Duration.

Since there are multiple syntactic construal parameters which display contingency on Fixation Duration, we also conducted Linear regression analysis separately for this parameter group. There are

4 non-aliased syntactic parameters which are Clause-final position for neutral syntactic foregrounding, Position in subsidiary clause, Position in parallel structure, Position in elliptical clause. There are no good predictors in Group 1, however there are two predictors in Group 2 which are Clause-final position for neutral syntactic foregrounding ( $p = 0.006$ ) and Position in elliptical clause ( $p = 0.019$ ). Since both these parameters display lack of syntactic foregrounding, we may conclude that this factor plays a decisive role in gaze costs for the WWM participants increasing the gaze costs.

### 3.2.2 Construal parameters and First Fixation Duration

Since First Fixation Duration is not contingent on the number of signs in the AoIs,

we considered its absolute values in two Groups and with all AoIs. Table 4 shows the results of t-tests with 46 construal parameters

in two Groups, only the parameters displaying significant p-values are given. Bonferroni-Holm corrections are also presented.

**Table 4.** Construal parameters and First Fixation Duration in two groups

**Таблица 4.** Параметры конструирования и продолжительность первых фиксаций в двух группах

Construal parameters	FFD in Group 1 (BWM)	FFD in Group 2 (WWM)
	t [p, p Bonferroni-Holm] df=23	t [p, p Bonferroni-Holm] df=33
True or real event	-	-2.71 [0.011, 0.025]
Shifting / changing	-	-2.71 [0.011, 0.025]
Interpersonal relations	-	-2.51 [0.017, 0.05]
Event lacking evaluation	-	-2.71 [0.011, 0.025]

The results manifest that the distributions of First Fixation Duration with the participants of Group 1 are more contingent on individual reading styles and do not display any rigid contingencies on the construal parameters, whereas in Group 2 there exist several construal parameters which produce shorter first fixations and consequently lower gaze costs. These are the parameters which demonstrate realistic events, dynamicity, interpersonality, lack of evaluation. Higher costs are identified in the situations of event fictitiousness, although in terms of event stativity and evaluation in events there are no rigid contingencies. This

might indicate that only gaze cost decrease effects are stable with Group 2, and higher gaze costs (similarly to the effects detected in Group 1) are more contingent on individual styles.

To establish the regression Model 1 (with non-aliased parameters), we conducted Linear regression analysis with 4 parameters with non-aliased coefficients, which are Participant (Agentive Participant) and three Event Frame parameters (True Event, Perception, and Positive evaluation). Table 5 shows the regression models for two participants' groups predicting First Fixation Duration.

**Table 5.** Regression Model 1 with non-aliased coefficients predicting First Fixation Duration in two groups

**Таблица 5.** Регрессионная модель 1 с неколлинеарными параметрами для продолжительности первой фиксации в двух группах

Predictor	FFD in AoI in Group 1 R <sup>2</sup> = 0.248				FFD in AoI in Group 2 R <sup>2</sup> = 0.214			
	Estimate	SE	t	p	Estimate	SE	t	p
Intercept	108.6	35.7	3.05	0.006	161.43	19.7	8.204	<.001
Agentive participant	-97.8	50.4	-1.94	0.067	30.43	27.8	1.094	0.283
True Event	105.6	50.4	2.09	0.049	34	27.8	1.222	0.231
Perception (Event type)	166.4	71.3	2.33	0.03	-30.29	39.4	-0.77	0.448
Positive evaluation	75.8	50.4	1.5	0.148	5.57	27.8	0.2	0.843

Model predictability is low in both Groups. At the same time, we may notice that

in Group 1 the cumulative effects are higher than the effects of single construal

parameters. There are two parameters which work as good predictors for the Model which are the realistic type of event and the bodily event construal (explicit perception); and agentivity of participant (however not displaying rigid contingency) also plays a role. In Group 2 there are no good predictors, which evidences in favor of stronger effects of individual construal parameters, in our case (see Table 2) they are realistic events, dynamicity, interpersonality, lack of evaluation. The results demonstrate that in terms of First Fixation Duration realistic event (True Event) is a good predictor in cumulative model with Group 1 (BWM), however as a single parameter with the same group it does not display contingency. At the same time, True Event is contingent on shorter first fixations with Group 2 (with worse memory) in terms of single effects, however it does not display any significant effect in a cumulative model. Presumably, realistic and fictitious event construal does play a role in gaze costs in both groups, however this hypothesis needs higher specification and more detailed analysis. Noticeable, that similarly to Model 1 with Fixation duration per sign, Perception also displays significance; here it serves as a good predictor with Group 1, whereas it is a good predictor in terms of fixation duration per sign with Group 2 and stimulates longer fixation duration in terms of the effects of single parameters with Group 2. These observations

suffice to prove that bodily construal effects are significant for both Groups and should necessarily be considered in event construal analysis.

The prognostic modeling of syntactic foregrounding effects which display contingency on First Fixation Duration (Linear regression analysis was conducted with 4 non-aliased syntactic parameters specified in 3.2) has shown that there is one good predictor in Group 1 which is Position in parallel structure ( $p = 0.049$ ) and two good predictors in Group 2 which are Clause-final position for neutral syntactic foregrounding ( $p = 0.028$ ) and Position in parallel structure ( $p = 0.028$ ). Since syntactic construal appears to be more significant for the participants with worse working memory, we may conclude that it allows them to relocate their attention on more syntactically focal and consequently more important information.

### 3.2.3 Construal parameters and Fixation Count per sign

Since Fixation Count displays contingency on the number of signs in the AoIs, we considered its relative values in two Groups and with all AoIs. Student's t-tests revealed that in Group 1 there are no results with significant p-values. Table 6 shows the results of t-tests with 46 construal parameters in Group 2, only the parameters displaying significant p-values are given. Bonferroni-Holm corrections are also presented.

**Table 6.** Construal parameters and Fixation Count in Group 2

**Таблица 6.** Параметры конструирования и количество фиксации в двух группах

Construal parameters	FC in Group 2 (WWM) t [p, p Bonferroni-Holm] df=33
Agentive participant	-2.21 [0.034, 0.05]
Perception (Event type)	-4.17 [ $< .001$ , 0.008]
Lack of action or dynamics	2.55 [0.016, 0.025]
No interpersonal or interactive relations	2.55 [0.016, 0.025]
Spontaneous or occasional event	2.21 [0.034, 0.05]
Graphic foregrounding	-2.55 [0.016, 0.025]
Intensification in pre-position	-2.3 [0.028, 0.033]
Action verbs	-2.55 [0.016, 0.025]

Repetition of a word	4.17 [ $<.001, 0.008$ ]
Emotives	-2.25 [0.032, 0.041]
Lexical synonyms and antonyms	3.55 [0.01, 0.017]
Clause-final position for neutral syntactic foregrounding	2.3 [0.028, 0.033]
Subsidiary clause position	-2.3 [0.028, 0.033]
Position in parallel structure	2.25 [0.032, 0.041]
Syntactic agentivity	-2.21 [0.034, 0.05]

The results seem demonstrative since they unanimously prove that gaze costs in Fixation Count similarly to other gaze characteristics are dependent on individual construal styles and not on single construal effects with the BWM participants. Meanwhile, the situation is different with the participants in Group 2. We may notice that semantic foregrounding, here expressed in agentivity, actionality, emotivity, graphic and syntactic foregrounding in most cases is contingent on lower gaze costs, whereas the

lack of semantic foregrounding (displayed in lack of dynamics, lack of interactivity) and also unexpected construal effects or the effects which require the back-up information retrieval (spontaneity, repetition, paradigmatic novelties, position in parallel structure) are more demanding.

The established regression Model 1 (with non-aliased parameters) for Fixation Count per sign with 4 parameters with non-aliased coefficients is presented in Table 7.

**Table 7.** Regression Model 1 with non-aliased coefficients predicting First Count in two groups

**Таблица 7.** Регрессионная модель 1 с неколлинеарными параметрами для количества фиксации в двух группах

Predictor	FC in AoI in Group 1 $R^2 = 0.113$				FC in AoI in Group 2 $R^2 = 0.416$			
	Estimate	SE	t	p	Estimate	SE	t	p
Intercept	0.2428	0.0714	3.401	0.003	0.1225	0.0489	2.503	0.018
Agentive participant	6.94E-17	0.101	6.87E-16	1	-0.0636	0.0692	-0.92	0.365
True Event	-0.0762	0.101	-0.7547	0.459	0.1318	0.0692	1.905	0.066
Perception (Event type)	-0.0096	0.1428	-0.0672	0.947	0.3619	0.0978	3.699	$<.001$
Positive evaluation	-0.1398	0.101	-1.3847	0.181	0.0725	0.0692	1.049	0.303

Model predictability is low in Group 1. However, the situation is different in Group 2 where its prognostic potential is high and there is one good predictor which is Bodily construal (in terms of perception). Since bodily construal effects were also noticeable in other gaze characteristics with Group 2, we may conclude that this construal type displays high importance for the participants with worse working memory. The presence of perception in construal contributes to lower gaze costs in fixation duration and fixation count as single parameters contingent on gaze

characteristics, and as model predictors, which advocates that the WWM participants may rely on pre-position bodily construal markers to develop a specific reading strategy.

#### 4. Discussion

In this section, we will consider the results which allow scaling the construal parameters in terms of their significance for gaze costs within two groups, the participants with better and worse working memory. We will also contrast the t-test results in two groups and the prognostic model

predictability within the two groups to see whether the effects revealed may really serve to identify several distinctive features in construal and gaze cost contingency.

To range the construal parameters significance, where possible, we will rely on 6 gaze identifiers deduced, t-values of parameter contingency on Fixation Duration per sign, First Fixation Duration, and Fixation

Count, and predictor values of parameters on Fixation Duration per sign, First Fixation Duration, and Fixation Count. We will consider the construal parameters to demonstrate higher significance in case they have higher values acting as single predictors. In Table 8 we present the scaled results of construal parameters predicting higher gaze costs in two groups.

**Table 8.** Construal parameters predicting higher gaze costs in two groups

**Таблица 8.** Параметры конструирования, вызывающие увеличение глазодвигательной нагрузки в двух группах

<b>Group 1 (BWM)</b>	1) Lack of action or dynamics, No interpersonal or interactive relations
<b>Group 2 (WWM)</b>	1) Clause-initial position for contrastive focus > Lexical synonyms and antonyms > Position in parallel structures > Spontaneous or occasional event 2) Repetition of a word > Lexical synonyms and antonyms > Lack of action or dynamics, No interpersonal or interactive relations > Clause-final position for neutral syntactic foregrounding > Position in parallel structure > Spontaneous or occasional event

Table 8 displays multiple effects of higher gaze costs with Group 2 which appear in Event construal and Linguistic construal which proves the dominant role of the factor of working memory as affecting the gaze costs in creative language interpretation (Gunter et al., 2003). Higher costs result from 1) foregrounding effects in lexical and syntactic levels of linguistic construal, 2) lack of dynamicity and interaction in event construal, 3) unexpected event construal. In Group 1 higher gaze cost effects are more sporadic and result from lack of dynamicity and interaction in event construal. The results demonstrate that creative language use in its novel and entrenched variants still has several common effects onto its gaze perception which appear to be steady with the participants with worse memory. Therefore, the findings extend the eye-tracking experimental results obtained in (Cardillo et al., 2012; Goldstein et al., 2012; Kiose & Kharlamova, 2021) which state the

differences only for novel and entrenched metaphors gaze costs. Even though the novel indirect name is used repeatedly, the participants face multiple challenges in the event construal in AoIs which affect their reading strategy. It presupposes the recognition of particular construal affordances where the participants intend to search for the most important information, in repetitions, parallel structures, lexical novelties. Meanwhile, the unexpectedness in the planned event construal or inability to discover these construal affordances also leads to higher gaze costs. These results prove the significance of foregrounding effects in the construal identified in (Iriskhanova, 2014), however they allow to scale these effects in respect to the readers with better and worse working memory.

Now we will address the construal parameters which are contingent on lower gaze costs. In Table 9 we present the scaled contingency results in two groups.

**Table 9.** Construal parameters predicting lower gaze costs in two groups

**Таблица 9.** Параметры конструирования, снижающие глазодвигательную нагрузку в двух группах

<b>Group 1 (BWM)</b>	1) Graphic foregrounding, Dynamic verbs
<b>Group 2 (WWM)</b>	1) Perception (Event type) > Intensifiers in pre-position, Subsidiary clause position > Interactive relations > Emotives > Agentive participant, Agentivity 2) True or real event, Shifting / changing, Event lacking evaluation > Interpersonal relations 3) Perception (Event type) > Graphic foregrounding, Action verbs > Intensification in pre-position, Subsidiary clause position > Emotives > Agentive participant, Syntactic agentivity

The results show that lower costs in Group 1 result from 1) visual foregrounding, 2) dynamicity of events. In Group 2 the effects are more complex. Lower costs result from 1) bodily event construal, 2) foregrounding and intensifying construal information, 3) dynamicity and interactivity of events, 4) emotionality in event construal. These findings additionally prove that the construal parameter typologies specifying the Referent and Event Frame construal parameters (Pustejovsky, 1995; Coulson & van Petten, 2002; Coulson, 2008; Langacker, 2015; among others), as well as the classifications of foregrounding parameters (Wärwik, 2004; Verhagen, 2007; Iriskhanova, 2013) are reliable and valid when assessing gaze contingency effects.

If we consider the best predictors for the regression models, we will see that in both groups they are Perception (Event type), and True Event in Group 1. This observation serves as empirical proof of the theoretical assumptions on the role of embodiment in metaphor construal (Boroditsky, 2000; Goatly, 2017). The prognostic role of models in two groups is different, although; there is only one model which has high prognostic value, it is the regression model for Group 2 predicting Fixation Count. In this model the construal parameter of Perception is a good predictor, which means that bodily event construal is significant for creative language use gaze perception with the participants with worse working memory.

### 5. Conclusion

The study has proved the efficiency of cognitive semantic analysis in testing the cognitive costs produced by metaphor interpretation effects. In the current work, we applied the oculographic procedure to experimentally assess the interpretational value of language construal parameters (in cognitive and linguistic construal). Most commonly, experimental studies explore the gaze costs contingent on entrenched and novel metaphors and reveal the differences in gaze costs affected by lexical priming, lexical ambiguity, the presence of analogy and disanalogy construal models. Extending these results, we hypothesized that irrespective of a metaphor type, figurative construal influences the gaze costs. In this case, these results should be considered when assessing the effects of priming, analogy and ambiguity as affecting the gaze costs in metaphor interpretation, both novel and entrenched.

In the experiment, we observed the cases of multiple use of a novel textual metaphor during which the metaphor is conventionalized and modified becoming novel again; in these cases, it is interpreted with decreased and again increased cognitive load, here assessed via gaze costs. We largely considered the role of the readers' working memory which affects novel metaphor interpretation and also the process of its entrenchment. We verified the hypothesis that gaze behavior characteristics (fixation duration, their number, first fixation duration

in the Areas of Interest) display contingency on the metaphor construal parameters and not singularly on metaphor types, novel and entrenched. The contingency analyses specified the gaze values of six groups of parameters, the cognitive parameters of Referent construal, Event Frame construal, Perspective construal, and the linguistic parameters of graphological, lexical and syntactic construal. The regression analyses established the construal parameter models of gaze behavior characteristics reveals several predictors which define the steady decrease and increase of the gaze costs within two participant groups. The study showed that the participants with higher working memory display higher gaze costs when the construal parameters Lack of action or dynamics and No interpersonal or interactive relations are active; whereas the participants with lower working memory are affected by multiple parameters including Clause-initial position for contrastive focus, Lexical synonyms and antonyms, Spontaneous or occasional event, Lack of action or dynamics, No interpersonal or interactive relations, and several others. We also identified the predictors which decrease the gaze costs; the participants with lower working memory are affected by Perception (Event type), Shifting / changing, Agentive participant, Intensifiers in pre-position, Action verbs. Therefore, the participants with lower working memory are highly sensitive to linguistic construal of metaphors, presumably, it creates additional affordances and stimulates metaphor construal, whereas linguistic construal does not display consistency with the participants with better working memory; at the same time lower dynamicity in the cognitive construal hampers metaphor interpretation in both groups. Overall, the study allowed to claim that irrespective of the metaphor type, several construal parameters produce consistent gaze costs, either increased or decreased.

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## Appendix

### Appendix A. Experiment Stimulus

«Дело в том, что в тот давний день, когда мы возделывали пустырь, один из ребят обратил внимание остальных на то, как я держу носилки. Военрук, присматривавший за нами, тоже обратил внимание на то, как я держу носилки. Надо было найти повод для веселья, и повод был найден. Оказалось, что я держу носилки как **Отъявленный Лениняй**. Это был первый кристалл, выпавший из раствора, и дальше уже шел деловитый процесс кристаллизации, которому я теперь сам помогал, чтобы окончательно докристаллизироваться в заданном направлении. Теперь все работало на образ. Если я на контрольной по математике сидел, никому не мешая, спокойно дожидаясь, покамест мой товарищ решит задачу, то все приписывали этой моей лени, а не тупости. Естественно, я не пытался в этом кого-нибудь разуверить. Развитие образа привело к тому, что я вынужден был перестать делать домашние уроки. При этом, чтобы сохранить остроту положения, я должен был достаточно хорошо учиться. Через некоторое время слухи об **Отъявленном Лениняе** дошли до директора школы, и он почему-то решил, что это именно я стащил подзорную трубу, которая полгода назад исчезла из географического кабинета. К счастью, подзорную трубу отыскали, но ко мне продолжали присматриваться, почему-то ожидая, что я собираюсь выкинуть какой-нибудь фокус. Вскоре выяснилось, что никаких фокусов я не собираюсь выкидывать, что я, напротив, очень

*послушный и добросовестный лентяй. Более того, будучи лентяем, я вполне прилично учился. Так, доигрывая навязанный мне образ **Отъявленного Ленизя**, я пришел к золотой медали. С аттестатом я сел в поезд и поехал в Москву». (Ф. Искандер)*

«The fact is that on that day when we were cultivating the wasteland, one of the guys called others' attention to how I hold the stretcher. The military instructor who looked after us also paid attention to how I hold the stretcher. It was necessary to find a reason for fun, and the reason was found. It turned out that I was holding the stretcher like a **Desperate Idler** (It turn out-PST that I hold-1SG stretcher-GEN like Desperate-NOM Idler-NOM). This was the first crystal to fall out of solution, and then an efficient crystallization process was going on, which I myself was now helping to finally crystallize in a given direction. Now everything worked for the image. If I was sitting on a math test not bothering anyone calmly waiting for my friend to solve the problem, then everyone attributed this to my laziness, not dullness. Naturally, I did not try to persuade anyone to the contrary. The development of the image led to the fact that I had to stop doing homework. At the same time to keep the situation sharp, I had to study well enough. After a while, rumors about the **Desperate Idler** reached the headmaster of the school, and for some reason he decided that it was I who stole the telescope, which disappeared from the geographical office six months before (In some time rumor-PL about Desperate-SG-PREP Idler-SG-PREP come-3SG-PST to headmaster-GEN school-GEN-POSS and he somehow decide-3SG-PST that this I steal-1SG-PST spy glass which half-year ago disappear-3SG-PST from geographical-PREP office-PREP). Fortunately, the telescope was found but they continued to look at me closely expecting for some reason that I was going to pull a trick. It soon became clear that I was not going to pull a trick but on the contrary, I was a very **obedient and conscientious idler** (It soon become-3SG-PST clear that no trick-PL I not mean-1SG pull but contrariwise I very obedient-NOM and conscientious-NOM idler-NOM). Moreover, being an **idler**, I studied well (Still further be-PTCP idler-ACC, I study-1SG-PST well). So, finishing image of the **Desperate Idler** imposed on me I came to the gold medal (So finish-PTCP impose-PPRT me-DAT image Desperate-GEN Idler-GEN I come-1SG-PST to gold-DAT medal-DAT). With the certificate I got on the train and went to Moscow».

## Appendix B. Construal parameters

Construal Type	Parameter Group	Parameter
<b>Cognitive construal: Referent</b>	Agentivity	Agentive participant
		Patient / Inactive participant
	Number	Single participant / object
	Reference	Person-participant
	Referential integrity	Integral participant / object
	Personalization	Author / Speaker
<b>Cognitive construal: Event Frame</b>	Truth	True or real event
		Fictitious event
	Type	Shifting / changing
		Perception
		Lack of action or dynamics
	Relations	Interpersonal relations
		Interactive relations
		No interpersonal or interactive relations
	Manageability	Spontaneous or occasional event
		Manageable event
Completeness	Completed event	
	Incomplete event	
Instantness	Flash event	
	Developing event	
Achievement	Absence of event achievement	

	Evaluation	Positive evaluation Negative evaluation Event lacking evaluation		
	Space location	Event located in space Event with no space location		
	Time location	Event located in time Event with no time location		
	Repeatability	Single event Repeated event		
	Cause and effect	Event with cause and effect stated Event without cause and effect stated		
<b>Cognitive construal: Perspective</b>	Viewpoint	Central area / elements Peripheral area / elements		
	Distancing	Zooming out		
	Observation Path	Multidirectional but distinct path Vague path		
	Key Participant Centrality	Regular key participant		
	Event Centrality	Secondary event		
<b>Linguistic construal: Phonographic and Morphemic</b>		Graphic foregrounding Verbal predicate Noun in the Nominative Case Common noun Intensifiers in pre-position Actional verbal predicate		
	<b>Linguistic construal: Lexical</b>		Repetition of a noun or nominal group Emotives Lexical synonyms and antonyms Polysemous words Lexical tropes	
		<b>Linguistic construal: Syntactic</b>		Clause-final position for neutral syntactic foregrounding Clause-initial position for contrastive focus Main clause position Relative clause position following mental and emotional state predicates in the main clause Position in parallel structures Elliptical clause Nominal clause First-person construal Agentivity Performative clause

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